48783

Radio-Electronics

SEPTEMBER 1992

Combined with Electronics NOW®

BUILD THIS DSP VOICE-EFFECTS BOARD

Use digital signal processing technology to change your voice or create fun effects!

NOT WORKING TO NETWORKING

Basic and advanced equipment for troubleshooting LAN's

THE SLOPING VEE ANTENNA

The perfect home-built antenna for hams and shortwave enthusiasts!

AMATEUR TV DOWNCONVERTER

Use a standard TV to view ATV signals

CIRCUIT COOKBOOK

Learn—or re-learn—how to use the 555 timer

09

0 09128 48783 0

$3.50 U.S.
$3.95 CAN

A GERNSBACK PUBLICATION

September 1992 Electronics NOW

Vol. 63 No. 9

BUILD THIS

COMPUTERS

TECHNOLOGY

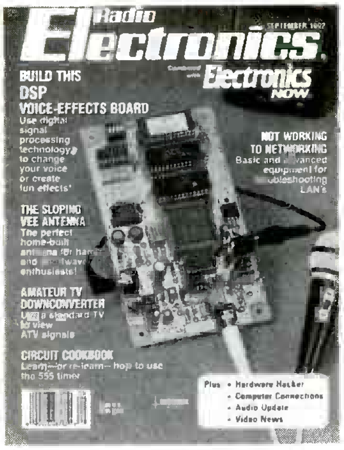
DEPARTMENTS

PAGE 58

PAGE 79

AND MORE

ON THE COVER



One of the latest electronic buzz-words is "digital signal processing" or DSP. We're not surprised to hear so much talk about it. DSP is being used in everything from compact disc players, to weather satellites, to the retrieval of photographs from NASA space missions. If you're curious about DSP technology, turn to page 37. Our VFX Digital Processors lets you take a hands-on approach to an exciting new technology, and have some fun while you're at it. The VFX (voice effects) processor uses DSP techniques to alter the pitch of your voice, or to produce reverb and echo effects. It's much less expensive than any commercially available DSP product, and you'll learn about the technology as you build and use it.

COMING NEXT MONTH

THE OCTOBER ISSUE GOES ON SALE SEPTEMBER 3.

BUILD A HIGH-EFFICIENCY FM HANDI-TALKIE
This small, light-weight transceiver is powerful and efficient, offers narrow-band FM modulation and can be designed to operate anywhere from 27 to 32 mHz.

BUILD A 60-Hz POWER INVERTER
It will provide over 200 watts to your line-powered devices.

DESIGNING HIGH-POWER, LOW-DISTORTION AMPLIFIERS
Real-world applications from a simple 20-watt composite amplifier to a 70-watt bridge amp.

DIFFERENTIAL TEST PROBES
How and why to use a differential probe.

ELECTRONICS NOW, (ISSN 0033-7862) September 1992. Published monthly by Gernsback Publications, Inc., 500-B Bi-County Boulevard, Farmingdale, NY 11735. Second-Class Postage paid at Farmingdale, NY and additional mailing offices. Second-Class mail registration No. R125166280, authorized at Toronto, Canada. One-year subscription rate U.S.A. and possessions $19.97, Canada $27.79 (includes G.S.T. Canadian Goods and Services Tax Registration No. R125166280), all other countries $28.97. All subscription orders payable in U.S.A. funds only, via international postal money order or check drawn on a U.S.A. bank. Single copies $2.95. © 1992 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

POSTMASTER: Please send address changes to ELECTRONICS NOW, Subscription Dept., Box 55115, Boulder, CO 80321-5115.

Electronics NOW®

Hugo Gernsback (1884-1967) founder

Larry Steckler, EHF, CET, editor-in-chief and publisher

EDITORIAL DEPARTMENT
Brian C. Fenton, editor
Marc Spiwak, associate editor
Neil Sclater, associate editor
Teri Scaduto, assistant editor
Jeffrey K. Holtzman computer editor
Robert Grossblatt, circuits editor
Larry Klein, audio editor
David Lachenbruch contributing editor
Don Lancaster contributing editor
Kathy Terenzi, editorial assistant

ART DEPARTMENT
Andre Duzant, art director
Injae Lee, illustrator
Russell C. Truelson, illustrator

PRODUCTION DEPARTMENT
Ruby M. Yee, production director
Karen S. Brown advertising production
Marcella Amoroso production assistant
Lisa Rachowitz editorial production

CIRCULATION DEPARTMENT
Jacqueline P. Cheeseboro circulation director
Wendy Alanko circulation analyst
Theresa Lombardo circulation assistant
Michele Torrillo, reprint bookstore

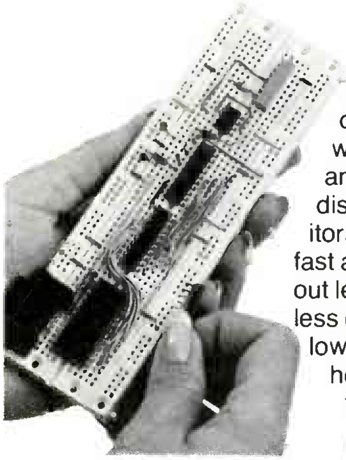
Typography by Mates Graphics
Cover photo by Diversified Photo Services

Electronics Now is indexed in *Applied Science & Technology Index* and *Readers Guide to Periodical Literature*.
Microfilm & Microfiche editions are available. Contact circulation department for details.

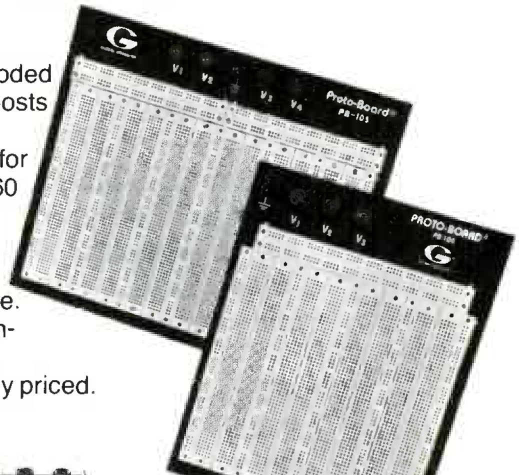
Advertising Sales Offices listed on page 102.
Electronics Now Executive and Administrative Offices
1-516-293-3000.
Subscriber Customer Service:
1-800-288-0652.
Order Entry for New Subscribers:
1-800-999-7139.

Audit Bureau of Circulations Member

5 WAYS TO STOP WASTING TIME IN ELECTRONICS.



Stop wasting your time soldering. Save hours of soldering, desoldering, resoldering with Quick Test™ sockets and bus strips. Connect/disconnect resistors, capacitors, transistors, ICs, etc. as fast as you can push in/pull out leads. Interlock for limitless expandability. Priced as low as $1.60, you'll wonder how you've done without them!

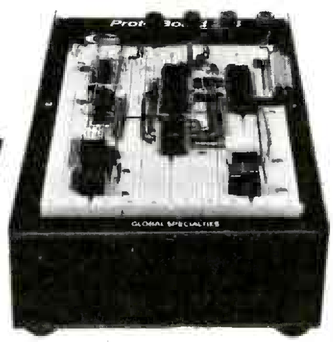


5-color coded binding posts and 17 sockets, for over 4,560 contact points. Lifetime guarantee. American-made. Affordably priced.

2. Stop wasting your time breadboarding.

Here are three popular PROTO BOARD® Brand solderless breadboarding systems that meet any budget or time schedule. First the diminutive PB-10's 840 contact points and 3-color binding posts. PB-102 has 1,240 tie points, accepting up to 12 16-pin ICs. Finally, PB-103, with 2,250 contact points, and up to 24 16-pin capacity. They're affordable, American-made, lifetime guaranteed. You'll soon see why PROTO BOARD Brand is Today's Standard for Quality in Breadboarding.

PROTO BOARD® BRAND



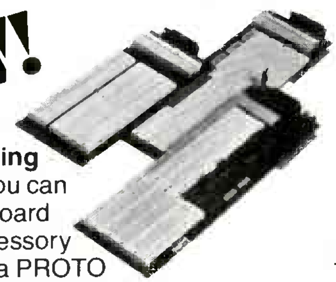
4. Stop wasting your time plugging-in external power.

We've added the power to the breadboard. And, what power! Up to triple voltage power, +5V, +12V, −12V, regulated/current limited and DC. Up to 2,250 tie points, with 24 IC capacity and 14 pin DIPs. Now you can create, test and modify TTL, CMOS, Op-Amps and even microprocessor circuits. Plus, there is the standard Global Lifetime Guarantee on the sockets. And, wait 'til you see the modest prices!

3. Stop wasting your time jury-rigging

large numbers of circuits. Here are two oversized PROTO BOARDS Brand, with expanded area, tie points, and more to keep your ideas together. PB-104 features 3,060 tie points, which can handle to 32 16-pin ICs with ease. Four color coded binding posts, and roomy 9.2" x 8" metal panel make it big...but simple. The humungous PB-105 lets you load up to 48 16-pin ICs, and much more onto its

5. NEW!



Stop wasting time designing computer circuits. Now you can use your solderless breadboard concepts for designing accessory circuits. PROTOCARD® is a PROTO BOARD Brand which fits any standard slot in your IBM, PC/XT or PC/AT computer. Some modules even include built-in basic decoder circuits for memory and I/O addressing. Breadboard areas up to 3,360 contact points. Buffered versions eliminate loading of pc buses.

Easy does it!™

Call toll-free for details
1-800-572-1028

GLOBAL SPECIALTIES

Global Specialties. An Interplex Electronics Company.
70 Fulton Terrace. New Haven, CT 06512.
Telephone: (203) 624-3103. © Interplex Electronics 1989.
All Global Specialties breadboarding products made in USA.

CIRCLE 188 ON FREE INFORMATION CARD

A0011

EDITORIAL

NOW'S THE TIME

Now, according to Webster's New World Dictionary, means "at the present time; at this moment." **Electronics Now** is just what its name implies: a compilation of what is happening in electronics at this moment!

Electronics Now brings you the latest news, the newest products, the most useful training, the most exciting projects, the newest how-to information. We help you learn how it works, how to keep it working, and, of course, how to make your own. We even show you what may happen tomorrow.

Above all else, we remain *your* electronics magazine. We know that the great majority (89%) of you earn your living in electronics. But you are the engineers and technicians to whom being an electronics professional is more than just a job. In your spare time—your leisure time—your personal time—you still want to know and learn more about electronics.

You want to know how Caller ID works. You want to know how digital audio tape compares to digital compact cassettes. You need to know about cellular telephone services and the personal communication networks of tomorrow. You need to know what microprocessor your next computer will have. You have to know what the next generation IC's will be like.

Bringing you information on those and other subjects is our forte. We work and strive to stay on top, to learn, to explore, and follow late-breaking developments in electronics. And we do it *now!* That's where our new name—**Electronics Now**—comes from. That's what we bring to you —today and tomorrow— **Electronics Now**!

Stay with us as we evolve and grow to meet the ever growing challenge of the electronics revolution. Stay with us as we continue our quest for the most exciting, most revolutionary, and most daring developments of today and tomorrow. Become, through our pages, a part of the most important and influential segment of our modern world. Come with us as we become **Electronics Now.**

Larry Steckler, EHF/CET
Editor-in-Chief and Publisher

WHAT'S NEWS

A review of the latest happenings in electronics.

World's smallest hard-disk drive

Hewlett-Packard Company introduced the world's smallest hard-disk drive in June. Its 1.3-inch Kittyhawk Personal Storage Module can store up to 21.4 megabytes of data (formatted). The introduction of the matchbox-size drive by HP, not known for its expertise in that technology, seems to assure continued life for rotating disk memories. HP's development makes it highly unlikely that disk drives will be driven out of the market by semiconductor memory modules in the forseeable future.

The drive was developed for palmtop, pen-based and sub notebook-size computers whose manufacturers are continually seeking component size, weight, and power reductions. The disk drive package measures 0.4 inch × 2 inches × 1.44 inches, and it weighs about one ounce. The platters rotate at 5400 rpm, and average seek time is less than 18 milliseconds.

HP says the drive —which will be priced at $250 in high volume—is far more resistant to shock than the 1.8-inch and 2.4-inch drives now available. In addition to applications in existing products, HP predicts that Kittyhawk will find a place in such future products as printers, fax machines, medical equipment, communications gear, and digital imagers. Company officials even see a place for it in consumer video-game cartridges and as data storage media for cellular telephones and digital copiers.

The sub-mini disk drive was developed in cooperation with several companies including AT&T Microelectronics (Berkeley Heights, NJ) and Citizen Watch Co., Ltd., of Japan. Working with AT&T Microelectronics, HP was able to reduce the 20 to 30 IC's typical of most of today's 1.8- and 2.5-inch drives to just seven.

According to HP, the cost of semiconductor memory equivalent

HEWLETT-PACKARD'S 1.3-INCH DRIVE shown here actual size.

to the capacity of the Kittyhawk is about five times the price of the drive—and that is before the learning curve price reductions have taken effect. Twenty megabytes of semiconductor memory now has an OEM price of about $1000 ($50 per Mbyte); by comparison, at Kittyhawk's present OEM prices, the cost of memory is $12 per Mbyte.

The drive module stores data like a standard Winchester drive, and it connects with a Personal Computer Memory Card International Association (PCMCIA) or standard AT interface. The 21.4-Mbyte drive has two platters and three heads. The modules contain a sensor that detects impact and causes them to shift to a self-protective mode to preserve data.

Advanced MRI technique

Advanced magnetic resonance imaging (MRI) now permits the measurement of the flexibility of blood vessels, a key predictor of heart disease. Scientists at GE Research and Development Center (Schenectady, NY), working closely with researchers from the Imperial College of Science, Technology, and Medicine (London, U.K), have developed a non-invasive technique based on MRI technology that simultaneously determines blood-flow velocities at different points along a blood vessel.

The measurements obtained can then be used to calculate the speed at which a pressure pulse travels away from the heart and down a vessel after the heart contracts. Those wave propagation speeds permit the computation of vessel-wall flexibility, a factor in the determination of the presence of diseases such as atherosclerosis.

GE's MRI technique is expected to be able to follow changes in blood-vessel flexibility as people age or as diseases develop. Because it relies on MRI angiography,there is no need to insert a pressure transducer on the end of a catheter that must be snaked through the arteries, a potentially dangerous invasive process.

A BLOOD-FLOW VELOCITY measurement made with an MRI imaging technique is studied by GE scientists Charles Dumoulin and Robert Darrow.

In MRI inspection of internal organs and tissues is done with a combination of powerful magnetic field, radio-frequency emissions and computer computation. A superconducting magnet within the barrel-shaped MRI equipment can produce a 1.5 Tesla field within its one-meter bore where the patient is located.

The patient within the bore is *continued on page 21*

VIDEO NEWS

What's new in the fast-changing video industry.

DAVID LACHENBRUCH

• **Flat panels for HDTV.** There's still no substitute for the CRT when it comes to large-screen resolution, but that doesn't mean that developers around the world aren't still trying to find that elusive giant picture on the wall for HDTV. Two promising developments recently surfaced in Japan.

Flat plasma display. The prestigious Japan Broadcasting Corporation (NHK), Japan's public-television broadcaster, recently held an impressive progress-report demonstration of a thin glass sandwich HDTV plasma display panel that it says could be commercialized as soon as 1997. The system is being developed as a joint effort with Matsushita (Panasonic), NEC, Oki Electric, and Dai Nippon Printing. Texas Instruments has a contract to develop semiconductors for the system. NHK is now demonstrating a working model HDTV display panel with a 16:9 widescreen aspect ratio. the model is three inches thick and weighs less than 18 pounds.

NHK concedes that there's more work to do, but thinks the answers to the remaining problems are in sight. The screen has 1344 display cells horizontally and 800 vertically, for a resolution of 1,075,000 pixels, but it still falls short of the necessary brightness and life for a consumer display. The final version will have smaller cell size. NHK is promising to show a 55-inch working prototype next year.

Ferroelectric LCD. Working with a technology that others have rejected, Canon of Japan believes that it has found the solution to the need for giant thin color screens with no flicker and with a wide display angle for digital HDTV. While others work with the frustratingly difficult problems of active matrix LCD's, Canon has chosen to gamble on ferroelectric LCD (FELCD), a technology known since 1974. Canon is already planning to build several plants to mass-produce consumer HDTV panels.

Canon scientists believe that there is no theoretical limit to the size of FELCD screens. FELCD material differs from active matrix LCD transistors in that it's bi-stable—it can only be switched off or on. Once switched on, an FELCD molecule remains on until turned off, and vice versa. That would make it ideally suited to digital TV transmission if the problem of color rendition and gray scale could be solved. Canon says it has done this by calling on its work in black-and-white and color printers.

Canon says that it will start making computer monitors using the FELCD material next year, moving to color in 1994. The company already has displayed a still color screen with nearly HDTV resolution—four times better than computer VGA color CRT monitors. The planned 15-inch computer display has a resolution of 1280 × 1024 pixels, and the proposed 16:9 HDTV display is scheduled to have 1920 pixels in each of 1152 horizontal lines.

• **Widescreen sets in the U.S.** Thomson Consumer Electronics continues to dole out information about its widescreen 16:9 aspect ratio TV sets just a little at a time. The first sets, due out late this year under the RCA and ProScan labels, will have 34-inch picture tubes made in Thomson's tube plant in Italy. The company is shooting for a price of $4000–$5000 for the first sets, less than the price tags for Thomson widescreen sets that are already available in Europe. However, Thomson plans to start manufacturing widescreen tubes in the U.S. in 1994, and its goal for that time is a 34-inch widescreen set at about the price of today's 35-inch standard aspect ration (4:3) sets, which now start at less than $2000. In addition to the 34-inch direct-view set, Thomson plans to offer widescreen projection sets in larger sizes beginning next year.

• **Hughes-JVC projection pact.** Hughes Aircraft, which has manufactured multi-million dollar video projectors for the Pentagon, is gearing up for civilian production. Hughes has been seeking a consumer-electronics partner to develop a consumer version of its liquid-crystal lightvalve (LCLV) projection system. It finally found that partner in Japan's JVC. Hughes-JVC Technology Corp., 60% owned by Hughes and 40% by JVC, will develop consumer and commercial versions of LCLV projectors. The system combines a high-resolution CRT for image generation with separate LCD panels and an external light source to provide a very bright picture with high resolution. It is a candidate for future giant-screen HDTV projection sets.

This fall, Hughes-JVC will market professional models already developed by Hughes, priced from $8000 to more than a million dollars; consumer versions will cost from $2000 to $7000. JVC will manufacture consumer projectors and key components in Japan, and will distribute LCLV projectors worldwide through its sales network. Hughes said that HDTV resolution has been achieved with LCLV projectors, and 35mm-film resolution is the next target it will be shooting for.

• **8mm video decks here.** The success of the 8mm video format in camcorders must be followed by decks for showing and editing home videos. Sony was the only source 8mm decks, but two others have appeared. The compact decks with hi-fi stereo sound, which carry the RCA and Samsung brand names, are expected to sell for about $499. They're both made by Korea's Samsung. In the future is a dual-well 8mm/VHS deck to transfer 8mm videos to VHS cassettes and for editing home videos. Go-Video has already shown a prototype model, due next year. **R-E**

Q & A

Write to Q & A, Electronics Now, 500-B Bi-County Blvd., Farmingdale, NY 11735

DOUBLE AND HIGH DENSITY

Is there any truth to the rumor I've heard that the only difference between 3½-inch double- and high-density disks is the extra hole in the corner of the plastic package? Just about everybody I know buys the double-density variety and then punches a hole in the plastic case to turn the disks into high-density ones. I've done it myself and can't see any difference between these disks and the ones with "HD" stamped on them.—F. Foeg, Frish, CA

This is one of those times when I have to say that your guess is as good as mine. I've done the same thing to double-density disks and have never had a problem either. I know people who swear they're different but I've never had a practical example of it.

I remember reading a long description of the chemical difference in the media but it seems to have made little impression on me since all I remember is that the article was long and technical—the details have disappeared completely from my mind.

From a practical point of view, I've had more trouble with "real" high-density 3½-inch disks than with the ones I've punched or drilled into existence. This is just as true for name-brand disks as it is for the generic (and cheaper) variety.

Just about the only piece of hard information I have for you is the fact that some older high-density 3½-inch disk drives don't have the LED and sensor setup to look for the extra hole. Those drives are usually found on the older PS2 computers from IBM.

I know that this letter—and the answer—will spark a host of mail from people who are into disk media chemistry. That may be a good thing because this rumor about 3½-inch disks has been floating around since the high-density variety first

FIG.1—A SECOND HOLE INDICATES that a disk is high-density.

came on the market. If people out there really have the answer, and the credentials to back it up, I look forward to hearing from them and I'll be sure to pass the "real" information along.

THE APPLE FAMILY

I'm thinking about buying a used Apple IIe for my son since there are some good buys around, but I'm not sure about the difference between these computers and the other members of the Apple family. Also, I'd like to know if I can use my color TV for a monitor or will everything be unreadable?—S. Gibbs, Redondo Beach, CA

Apple isn't what Apple once was. It's sad but true that while Apple made a lot of money with the Apple II series by saturation selling in the educational market (mostly grade schools), they seemed to have shifted their corporate focus to the Macintosh. While there are some similarities between all the members of the Apple II family, they are a completely different breed from the Macintosh.

Once upon a time, Apple II computers were targeted mostly at the schools and the Macintoshes were aimed at the graphic arts, but this seems to have changed. Apple has reduced the amount of corporate resources devoted to the Apple II and has been touting the Macintosh as an alternative to IBM compatibles in the business world.

To answer your first question more specifically, there's a big difference between the Apple IIe and the Apple IIgs. The "e" stands for "enhanced" to highlight the difference between it and the older Apple II+ it replaced. The "gs" stands for "graphics/sound" and is a way of emphasizing the difference between it and the older Apple IIe you're thinking of buying.

While the Apple IIgs can run a lot of the software written for the Apple IIe, the reverse isn't true at all. The hardware is very different and so are the capabilities of the two machines. If you have some specific software in mind, a used Apple IIe can be a good buy but, if you're sold on the idea of having one of the Apple II series of computers, spring for the extra bucks and hunt up a used Apple IIgs.

It may interest you to know that friends of mine who teach the computer courses in grade schools tell me that it's getting harder and harder to find new software for the Apple II computers—even for the top of the line Apple IIgs. You should check with people in the schools near you and find out for yourself since even the world's greatest computer isn't worth anything if the larger software companies are withdrawing their support. Remember these people are market driven and they may know something we don't. It's not always wise to rely completely on the advice of the salesmen in the Apple stores. They make their money selling computers, not writing the software that will run on them.

As far as using a TV is concerned, it might be OK for games but if you want to do anything more serious, you'll find it entirely unsuitable. You might save some money by not buying a real monitor but it's a safe bet that all those savings will go into eye exams and new glasses.

Welcome to. . .

SCIENCE PROBE!®

The Amateur Scientist's Journal

Embark on an irresistible new journey into the realm of mystery, challenge, and exploration! The perfect magazine for the budding scientist, the serious amateur, the professional who would like to relax, and those who simply want to gaze at the stars.

Science PROBE! — the *only* magazine devoted entirely to Amateur Scientists! If you are fascinated by science in all its many forms . . . if you can't stay away from a microscope, telescope, calipers, or test tube — we invite you to share the wonders in every issue of **Science PROBE!** You will join a community of Amateur and Student Scientists who enthusiastically seek scientific knowledge or follow scientific pursuits for their own sakes and not merely as a profession.

Obtain your next issue of **Science PROBE!** by visiting a quality Newsstand, Convenience Store, or Supermarket or by reserving your personal copy through the mail by completing the coupon below.

From your very first issue of **Science PROBE!** you will be involved in a world of scientific facts, experiments, and studies pursued by amateur scientists who are university students, investors, academicians, engineers, or office workers, salesmen, farmers—whose *quest* is to probe into the mysteries of science and reveal them to all.

Plan to become a **Science PROBE!** reader!

Articles to appear in upcoming issues of **Science PROBE!** are:

Inside Internet—A Scientific Computer Network
Make your own Seismometer
Operate a Solar-Powered Weather Station
Assemble a Solid-State Portable Barometer
The Bicycle—A Traveling Scientific Laboratory

If you're fascinated by science in all its many forms, if you are compelled to experiment and explore, then Science PROBE! is your kind of magazine!

For Faster Service—Call Today:
1-800-777-5489

7RJ29

Science PROBE!
500-B Bi-County Boulevard
Farmingdale, NY 11735

Please forward my copy of **Science PROBE!** as soon as it comes off the press. I am enclosing $3.50-U.S.A. ($4.23-Canada-includes G.S.T.) plus $1.00 for shipping and handling. Better still, please enroll me as a subscriber and send the next four (4) quarterly issues of Science Probe. I am enclosing $9.95-U.S.A. (Canada: $16.00—includes G.S.T.)

☐ Next Issue Only ☐ Next Four Issues (1 Year)

Offers valid in the U.S.A. and Canada only. No foreign orders.

Name ______________________

Address ______________________

City ______________ State ______________ ZIP __________

All Orders payable in U.S.A. Funds only.

ON SALE AT QUALITY NEWSSTANDS, CONVENIENCE STORES AND SUPERMARKETS
GET YOUR COPY TODAY—$3.50-U.S.A.—$3.95-Canada

VIDEO IC's

I'm interested in building some video devices but I'm having a hard time locating the IC's that are best suited to the circuits I have in mind. Do you have any supplier that specializes in carrying these chips?—M. Brown, London, UK

I sympathize with you because I've frequently run into the same problem myself. It's a hard and fast rule that the more specialized the IC, the harder it is to find—especially in single quantities and without having to meet any minimum order.

The best place to begin your hunt for these parts is with the very people who make them—the IC manufacturers. If you're lucky, you'll be able to get some freebie "engineering samples" from them. This is only true if you get the right person on the phone and you identify yourself in such a way as to let them think it's worth their while to send you the stuff you want.

Remember, they're in the business of making chips for sale and if they believe that a small sample now can lead to a large order later on, you'll get what you need.

A second line of approach is to find out who their distributors are in your area and trying the same line with them. Your chances aren't as good with a distributor, but you never know. The salesperson might let you pay for a few parts (and shipping), without having to meet their minimum order quantity.

The last alternative—although you might not like it—is to fill out the minimum order by stocking up on parts you'll be able to use later on. This means stuff that may be needed for something else you have in mind but don't intend to actually start for a while.

Getting anything in single quantities is the hardest thing an experimenter can do. There are, however, suppliers who stock a wide variety of components and low or no minimum orders.

SPEEDING CURSOR

I recently upgraded from my old XT computer and got a much faster 386SX that runs at 20 MHz. Everything runs much faster now, but I find that the cursor speed hasn't changed much. Is there anything I can do about this because speeding up the cursor will make my new computer seem to run even faster.—B. Geoff, Fischer, IN

Although your expectations haven't quite been met, I guarantee that making such a major change in your computer horsepower has also made a change in the speed of your cursor. The reason you haven't seen as much of a change as you would like is simply that the speed of the cursor is dependent on three separate factors:

- Basic computer speed
- Basic video speed
- Basic keyboard speed

and all you've done is changed one of these factors.

Now that you have a computer that runs at a furious rate of speed, the cursor speed is being limited by the speed of either your video adapter or your keyboard—whichever is less.

Remember that when the keyboard sends an instruction to move the cursor, the computer tells the video adapter to do it. The computer does its part of the job pretty quickly, but the other two components operate much more slowly—particularly the keyboard.

However, it's a good thing that the keyboard is the slowest component because the keyboard repeat rate can be changed with software. (There isn't much you can do about the speed of your video adapter, short of spending a lot of money for fast video card.)

There are several public domain programs (and some commercial ones as well) for changing the keyboard repeat rate, but all of them have one slight disadvantage: they steal a certain amount, however little, of valuable memory. That can be a really big problem.

The answer is a small public domain program called FAST.COM that cuts the keyboard repeat delay to a bare minimum. I've been using it for several years without any trouble, and I run it automatically every time I turn on my computer. I've put it on the RE-BBS (516-293-2283, 1200/2400, 8N1) so you can download it and see if it works. **R-E**

LETTERS

Write to Letters, Electronics Now, 500-B Bi-County Blvd., Farmingdale, NY 11735

SOLID-STATE RELAY UPDATE

Regarding the article, "Solid-State Relay" (**Radio-Electronics**, May 1992), a very important feature is the zero-current switch-off characteristic inherent in the triac.

The interruption of the circuit at the instant the current is zero avoids voltage spikes that could be produced by the stored energy (E) in the distributed inductance of the power line and leakage inductance of the mains (line) transformer (L) if the current is suddenly interrupted at a non-zero value, as occurs with mechanical contact breakers. As we know, $E = ½ Li^2$. At the instant the current crosses zero, the stored energy is also zero.

These voltage transients, which are caused by switching heavy currents, are often the reason for failure of electronic equipment connected to the same line. The solid-state relay prevents such damage.

LEO BATISTA
Professor of Electric Automation
University of Sao Paulo
Sao Paulo, Brazil

A REAL HUM-DINGER

I appreciated the response to the 60-hertz hum question that appeared in *Ask R-E* in the June issue of **Radio-Electronics**. I had the same problem with my speaker system. I took your advice, and my problems were solved. Thanks!

JEFF FRUSCELLA
Kirtland, OH

ANOTHER HUM STOPPER

I enjoy reading *Ask R-E* each month. The 60-hertz hum problem described in the June issue could be caused by a ground loop. When components of a stereo system that are connected by patch cords receive their power from different 120-volt receptacles, a ground loop can be formed by a small amount of alternating current flowing in the shield of a shielded patch cord. That current flow is caused by a small potential difference in the neutral conductor wiring in a building's 120-volt circuits.

There is help for this type of hum problem. Radio Shack has a stereo ground-loop isolator, No. 270-054, which is a patch cord with two audio isolation transformers included. Those transformers break the ground-loop circuit, thereby stopping the current flow that causes the hum.

The ground loop isolator is listed on page 60 of Radio Shack's 1992 catalog in the automotive section. It can be used in line-level circuits of any audio equipment. I have successfully used this device in audio component hookups.

JACK P. SONNEMAN
Fayetteville, OH

ROSICRUCIANS, ALIVE AND WELL

I am writing in response to the item in *Ask R-E* (**Radio-Electronics**, June 1992) about FM antennas that use household wiring. Perhaps they have disappeared, which is fine by me, but Rosicrucians (AMORC) haven't. I subscribe to **Radio-Electronics** and have done so for quite some time. I am also a member of the Rosicrucian Order, AMORC, and have been a member for just as long, if not longer.

Until the time comes when I no longer receive the valued information that I do from both **Radio-Electronics** and AMORC, I will be affiliated with both. Your questions are welcome.

CHARLES R. BAILEY
2123 Grand St. N.E.
Minneapolis, MN 55418

TURN-SIGNAL AMPLIFIER

Regarding the request from W. Baker in *Ask R-E* (**Radio-Electronics**, April 1992) for a turn-signal amplifier, I have designed a simple, low-cost device that is intended to solve that problem.

The product requires no wiring in any vehicle, be it a bus, truck, or automobile, and operates with a time delay. A 2800-Hz beep is generated after a fixed-time delay and is repeated at this same delay for as long as the turn-signal switch is on. For example, when the turn-signal switch is selected to indicate a turn, 45 seconds later if the selector switch is still on, a 2800-Hz beep is emitted. The beep is repeated 45 seconds later, and will keep occurring at 45-second intervals for as long as the turn signal remains on. The time delay can be designed for any value. Most customers will likely prefer a 60-second delay, but there will be 30-second and 45-second delays available, or any other that the market might desire. Two volumes of sound are selectable by a slide switch.

The product is simply installed in any vehicle in less than two minutes, and will be available from my company for less than $20 starting in December 1992.

ALBERT P. GREGORY
A.G. Technologies
27211 El Pico Lane
Sun City, CA 92486

TURN-SIGNAL AMPLIFIER

In April's *Ask R-E*, your response to W. Baker's request for a turn signal amplifier—to purchase and add a chime—is expensive and gives an undesirable indication. The "chime" is not something most people want to hear every time their turn-signal lamps flash. Here are two other practical solutions.

Wagner Lighting now markets a fully solid-state, two-terminal automotive flasher. One specification that has been an issue since the project started is the audio output, since there is no bimetallic blade or relay to make the sound. An audio transducer was added to generate the familiar click that drivers associate with flashers.

Because a solid-state flasher re-

quires an external audio transducer, Wagner's new flasher has incorporated an attention timer that beeps for eight flashes after a delay of about three minutes. Beeps alert the driver that his turn signal flasher has been left on. Because this flasher has two terminals, it can replace any existing automotive turn-signal flasher.

Another way to get the driver's attention is by making the click louder. A capacitor in series with a speaker across the load and battery terminal of the flasher will create a click at every lamp on/off transition. When the flasher turns the lamps on, a voltage spike will dissipate through the speaker and create a "click." The same thing will happen when the flasher turns the lamps off. The larger the capacitor and speaker, the louder the click. A value of 47 microfarads works well with a 1½-inch speaker.

I've enjoyed **Radio-Electronics** for years and use it to keep my design and practical skills up to date. Keep up the good work.

TIMOTHY W. BROOKS
Senior Design Engineer
Wagner Lighting
Sevierville, TN

TV AND X RAYS

I'm writing in regard to the item about TV and X-rays that appeared in *Video News* (**Radio-Electronics**, June 1992). I'm aware that the changes in modern-day TV sets—including solid-state circuitry and redesigned shielded CRT's—probably make them safer to be near than ever.

However, I'm also aware that many manufacturers design their products very close to the product safety guidelines as a matter of cost containment. Many individuals, including office workers, children who play video games, and students may spend considerable time in close proximity to CRT's—either in TV sets or computer terminals. That doesn't even take into account the increasing time that many children spend watching TV.

In the auto industry, we are buying safety in the form of redesigned car bodies, safety restraints, air bags, safety glass, anti-lock brakes, and making sure that we crash-proof this and that.

I agree that we must not hamper the electronics industry, but at the same time, I believe that we must do more to safeguard people against radiation, which is both invisible and harmful.

DONALD HANG
North Canton, OH

SNOOPER STOPPER SUGGESTION

The article "The Snooper Stopper" (**Radio-Electronics**, April 1992) was very interesting. But if a person is only interested in protecting his cable box from the bullet and ID signal, then why not use an FM-trap, which is available from Radio Shack (Cat. No. 15-577) for $3.69? That would save about $20 compared to the cost of your project, and it needs no adjusting.

MATT STANTON
Shrewsbury, MA

R-E

WHAT'S NEWS
continued from page 6

probed with high-frequency radio signals. Those signals, under the influence of the magnetic field, "excite' the nuclei of the hydrogen atoms concentrated in blood and body organs, causing them to resonate. Those resonance signals are transmitted to a computer which converts them into digital data. Computer software reconstructs the data into a picture of the object being imaged on the computer's monitor.

A flow encoding procedure that distinguishes between resonance signals emitted by moving hydrogen atoms in the bloodstream and those in the stationary organs and structures sets GE's MRI angiography technique apart. Signals emitted by the motionless hydrogen atoms are suppressed while those from the moving atoms are highlighted. The technique can measure and calculate the flexibility of the aorta and various major arteries as well as most blood vessels.

To explore the clinical relevance of the quantitative measurement technique, GE and Imperial College researchers will examine how various agents such as nicotine and nitroglycerine alter the flow dynamics of blood within a vessel.

Military technology for law enforcement

In an effort to shed its type casting as an exclusive defense contractor, the Westinghouse Electronics Systems Group (Baltimore, MD) has unveiled a shopping list of law-enforcement related products that it has developed. They are intended for the war on drugs and are expected to make law enforcement safer and more effective. Among the products and systems are:

- A vehicle equipped with advanced electronics providing an automatic communications link to criminal and motor-vehicle data banks, and still-frame video capture and transmission.
- A multi-sensor surveillance aircraft equipped with advanced sensors, communications, and navigation systems for aerial surveillance.
- A handheld instrument that detects trace amounts of illicit drugs or explosives and displays its findings. The instrument does a chemical analysis of a card that is passed over a suspect container.
- Software for computer-assisted report entry and law enforcement management.

By down-linking the multi-sensor aircraft's infrared and radar image to a ground base, the aircraft can also serve as an airborne command center to direct and coordinate ground activities. The vehicle-integrated payload-elevated reconnaissance (VIPER) system integrates radar, electro-optical, communications, and computer technologies into a mobile target-detection and reporting system intended for border surveillance. These are commercial versions of military systems that the company has developed over the past five decades. **R-E**

Beckman Industrial DM10XL Digital Multimeter

High-quality, innovative meters at a hard-to-beat price.

CIRCLE 10 ON FREE INFORMATION CARD

Multimeter buyers on a budget have never had it so easy—nor have they ever had it so hard. It used to be difficult to find a low-cost DMM that was full-featured and built with an eye toward safety. These days, it's easier than ever to find such meters, but it's getting more difficult to choose from among them. The latest crop of low-cost high-quality DMM's to hit the market are from Beckman Industrial (Instrumentation Products Division, 3883 Ruffin Road, San Diego, CA 92123.) Beckman's *DM15XL, DM10XL, and DM5XL* range in price from $34.95 to $59.95. The DM10XL, which we examined, costs $44.95.

The first thing we noticed about the *DM10XL* was its 3½-digit (2000-count) LCD readout. The large (0.7-inch) digits are very easy to read. We also noticed the meter's non-traditional color—a charcoal-gray cabinet with green labels and accents. Although we certainly wouldn't buy a DMM because of its color, the people at Beckman say they did a lot of market research that led them to choose the green shade.

The dimensions of the *DM10XL* are roughly 6×3×1¼ inches. the meter's face is dominated by a large rotary function-selector knob roughly in the center. The LCD is above the knob, and a row of 4 input jacks is below it. Along the left front edge is what we regard as the unit's most innovative feature: A row of LED's give a rough idea of the voltage level at the probes even if the meter's battery is dead! It's a good feature because many DMM users are careless about replacing the battery when the low-battery annunciator indicates that it's time to do just that. (We assume that's because they don't know that a low battery can reduce a meter's accuracy tremendously, which could result in potentially dangerous situations.) Beckman calls the feature the "Safety Tester."

The Safety Tester feature also makes sense for someone who doesn't use a DMM regularly—a home-owner, for example, who occasionally uses a DMM when working on a home-wiring project or when doing some work on his car. Even when he pulls the meter out of his tool box with a dead battery, he'll be able to use it for basic, low-precision measurements, because the Safety Tester is powered by the voltage being measured, not by the DMM's battery.

Seven LED's indicate the voltage being measured: One yellow LED is used to indicate a negative voltage (or, in combination with another LED, an AC voltage.) A row of six red LED's indicates the voltage level; the levels indicated are 6, 12, 24, 50, 110, and 230 volts.

The DMM section of the meter measures AC volts in two ranges; (200 and 740 volts), DC voltage in five ranges (200 mV, 2, 20, 200, and 1000 volts); and resistance in six ranges (200, 2K, 20K, 200K, 2000K, and 20 megohms). A diode-test/continuity feature is also available.

The *DM10XL* can measure DC current over five ranges (200 μA, 2 mA, 20 mA 200 mA, and 10 A). One test lead must be moved for current measurement to one of two current jacks—one jack handles current levels up to 200 milliamps; the second handles 10 amperes. Beckman has included two important safety features here. First, both current inputs are fused to protect both the user and the meter. Second, the meter will sound a warning tone if you have the test leads set up for current measurement while the function switch is in a voltage-measurement range. That's important because trying to measure a voltage with the test leads set for current could cause an excessively high current to flow.

Along with the fusing, the DM10XL also provides good overload protection on all functions and ranges. That's an important safety consideration missing from many low-cost meters.

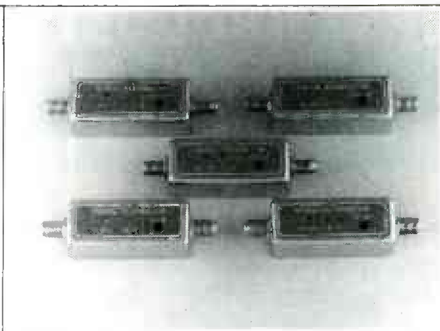
The accuracy specifications of the *DM10XL* are impressive for a low-cost meter. DC accuracy is rated at ±0.7%+1 digit; AC accuracy at ±1%+4 digits. DC current is rated at ±1%+1 digit for readings in the 200-μA to 200-mA ranges, and at ±2%+3 digits for readings in the 10-amp range.

The lowest-cost meter in the series, the *DM5XL* does not offer the Safety Tester feature and, in general, provides lower accuracy and reduced measurement capabilities. The *DM15XL* also lacks the Safety Tester, but adds AC current measurement and a logic-probe mode.

We were impressed by the convenience and safety features built into the $44.95 *DM10XL*. We recommend it highly. **R-E**

Electronics NOW® mini-ADS

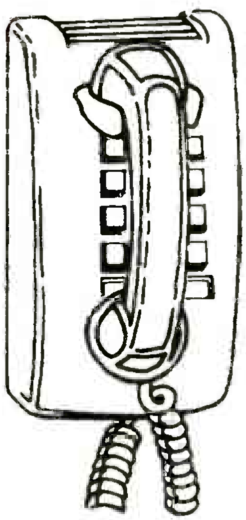
ELEVEN-PIECE RACHET TOOL KIT Includes reversible ratchet handle, extension bar, six bits, two precision screwdrivers, and a cutter. Comes in fitted case. Get one for your shop, another for your car, another for your tool kit. To order send **$11.75** USA shipping only. **ELECTRONIC TECHNOLOGY TODAY INC., PO Box 240, Massapequa Park, NY 11762-0240.**



TUNABLE 50dB NOTCH FILTERS—for TV. Can be tuned precisely to required frequency. Model 23H-Ch's 2-3 (50-66 Mhz) Model 46FM-Ch's 4-6 plus FM (66-108 Mhz) Model 713-Ch's 7-13 (174-216 Mhz) Model 1417-Ch's 14-17 (120-144 Mhz) Model 1822-Ch's 18-22 (144-174 Mhz) **$30** each, includes shipping. Visa, MC, or check. (C.O.D. $5 extra). Fast delivery, 30 day money back. Quantity prices to **$16. STAR CIRCUITS, P.O. Box 94917, Las Vegas, Nevada 89193, 1-800-535-7827.**

FREE CATALOG! ELECTRONIC TOOLS & TEST EQUIPMENT—Jensen's new Master Catalog, available free, presents major brand name electronics tools, tool kits, and test instruments, plus unique, hard-to-find products for assembly and repair and custom field service kits available only from Jensen. All fully described and illustrated. Enjoy free technical support and rapid, post-paid delivery anywhere in the Continental USA. **JENSEN TOOLS, INC., 7815 S. 46th St., Phoenix, AZ 85044. Phone: 602-968-6231; FAX 1-800-366-9662.**

CIRCLE 115 ON FREE INFORMATION CARD

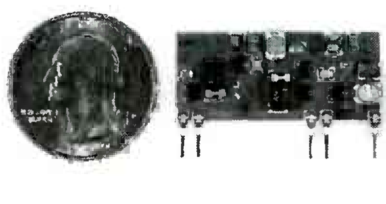


CALL NOW AND
RESERVE YOUR SPACE

- 6 × rate $940.00 per each insertion.
- Fast reader service cycle.
- Short lead time for the placement of ads.
- We typeset and layout the ad at no additional charge.

Call 516-293-3000 to reserve space. Ask for Arline Fishman. Limited number of pages available. Mail materials to: mini-ADS, ELECTRONICS NOW, 500-B Bi-County Blvd., Farmingdale, NY 11735.

FAX: 516-293-3115



TWO TRANSMITTERS IN ONE! 5 MINUTE ASSEMBLY! MONEYBACK GUARANTEE! New Law Enforcement grade device on a single chip is the most sensitive, powerful, stable room transmitter you can buy. Uses any 3V-12V battery. Or attach to telephone line to monitor all telephone conversations over 1 mile away without batteries! 100mW output! 80-130MHZ. Receive on any FM radio or wideband scanner. VT-75 microtransmitter. **$49.95 + 1.50** S&H. VISA, MC, MO. COD's add **$4.00. DECO INDUSTRIES, Box 607, Bedford Hills, NY 10507. 1-800-759-5553.**

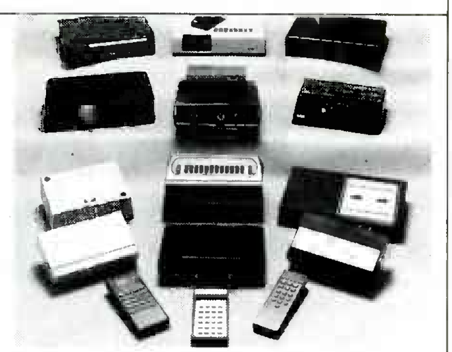
CIRCLE 127 ON FREE INFORMATION CARD

$495 FOR A PROGRAMMABLE DC POWER SUPPLY IS NOW A REALITY! • GPIB Interface Standard • Output Voltage/ Current Programming & Readback • Local & Remote GPIB Operations • Remote Sense Function • Programmable Overvoltage and Overcurrent Protection • Software Calibration • Superior Line/Load Regulation • Output Enable/Disable • 3 Year Warranty. FREE Orientation Video available. For details, call: **AMERICAN RELIANCE INC. 800-654-9838 FAX: 818-575-0801.**

CIRCLE 176 ON FREE INFORMATION CARD

APPLIANCE REPAIR HANDBOOKS—13 volumes by service experts; easy-to-understand diagrams, illustrations. For major appliances (air conditioners, refrigerators, washers, dryers, microwaves, etc.), elec. housewares, personal-care appliances. Basics of solid state, setting up shop, test instruments. **$2.65 to $5.90 each.** Free brochure. **APPLIANCE SERVICE, PO Box 789, Lombard, IL 60148. 1-708-932-9550.**

CIRCLE 84 ON FREE INFORMATION CARD



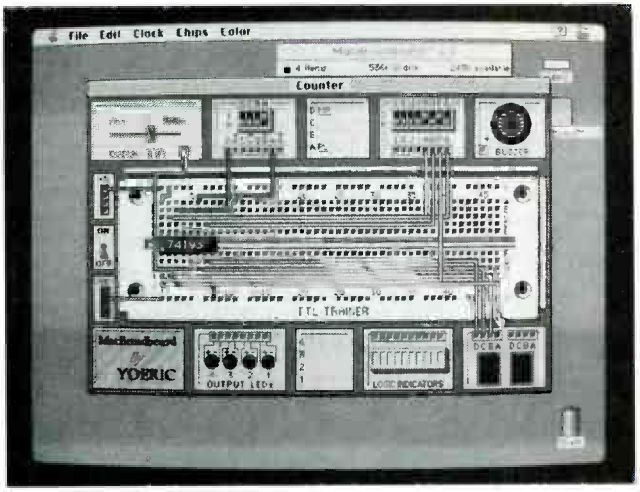
CABLE TV CONVERTERS AND DESCRAMBLERS SB-3, TRI-BI, MLD, M35B, DRZ-DIC. Call for catalog and price list. Special combos available. We ship COD. Quantity discounts. Call for pricing on other products. Dealers wanted. FREE CATALOG. We stand behind our products where others fail. One year warranty. **ACE PRODUCTS, 1-800-234-0726.**

CIRCLE 75 ON FREE INFORMATION CARD

NEW PRODUCTS

Use the Free Information Card for more details on these products.

MACINTOSH DIGITAL-CIRCUITS TRAINER. Owners and users of a Macintosh computer (512ke with System 4.1 or greater) who want to learn more about digital electronics can do so with *Yoeric Software's MacBreadboard 1.0*. Intended for hobbyists and students, the transistor-transistor logic (TTL) trainer was designed to act like the hardware simulators used in many digital circuit courses. Unlike those simulators which are based on a schematic approach, *MacBreadboard* provides a computer representation of a real-world object; the student manipulates IC chips and conductors, not individual gates.



CIRCLE 16 ON FREE INFORMATION CARD

Students select a TTL device by number (i.e. 7400) from a menu, place it on the representation of a PC board on the MAC computer's screen, and "draw" conductors to connect the power supply, resistors, capacitors, switches and other components just as they would in putting together a lab breadboard. According to Yoeric, the program permits students to simulate their laboratory assignments before actually doing them. The program is said to be able to supplement or be an alternative to a formal course on digital circuits.

MacBreadboard permits the student to select from among over 30 two-state devices, breadboard, power supply, wires, LED's, buzzer, seven-segment displays, switches, and a logic probe. Timing diagrams of circuits that have been simulated can be displayed and printed out. A "snapshot" of the breadboard can also be printed. Integrated circuit schematics can be displayed by double-clicking on the symbol of a device. The program runs in color, gray scale, and black-and-white. In the color mode, the traces can be colored by length or node, or the user can specify the color desired. A 50-page manual with diagrams of sample circuits that can be simulated is included.

MacBreadboard 1.0 costs $59.95; educational discounts are available.—**Yoeric Software**, 600 South Churton #24, Hillsborough, NC 27278; Phone: 919-644-1620.

PACKET MODEM/TERMINAL MODE CONTROLLER A Commodore 64/128 computer and a handheld VHF or HF single-sideband transceiver with the *MFJ-1271* are your tickets for admission to packet communication. MFJ's modem/terminal mode controller plugs into your Commodore's rear cassette port. It works both

CIRCLE 17 ON FREE INFORMATION CARD

VHF packet at 1200 baud and HF packet at 300 baud. A data carrier detected circuit and adjustable threshold control reduces noise susceptibility and increases the chances of making QSO connections—especially on HF bands.

A DCD circuit with a LED indicates when you are receiving signals properly. The device also features remote packet operation, mailbox-like message forwarding, and Net/ROM emulation. It uses *MFJ Enterprises's* Digicom/64 public software (*MFJ-1293*).

The *MFJ-1271* costs $49.95.—**MFJ Enterprises, Inc.**, P.O. Box 494, Mississippi State, MS 39762; Phone: 601-323-5869 (for orders: 1-800-647-1800); Fax: 601-323-6551.

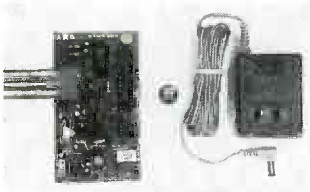
GENERAL-PURPOSE CUTTER. Cable TV and computer network installers, and technicians working with different kinds of coaxial cable and wire need sharp, general purpose cutters. GC Electronics

CIRCLE 18 ON FREE INFORMATION CARD

says it meets this need with its *No.12-457* 5-inch cutter. The tool is said to cut through all sizes of coaxial cable cleanly and crisply, without crushing the cable. It is also capable of cutting other kinds of wire used in electrical and electronic work.

The *No. 12-457 cutter* sells for $3.50.—**GC Electronics**, 1801 Morgan Street, Rockford, IL 61102.

AUDIO REFERENCE GENERATORS. The *ARG-440* and *ARG-1000* audio reference generators from *Tobin Cinema Systems* are said to generate pure, accurate 440-Hz (A4 to musicians) and 1000-Hz tones. The generators also provide precision "pink" and



CIRCLE 19 ON FREE INFORMATION CARD

"white" noise for audio tests.

A 440-Hz frequency standard is used in tuning musical instruments and even whole orchestras. The frequency can also verify that tape speed is correct and that 0 VU reference levels are set. A frequency of 1000 Hz is the traditional reference level. Both models of audio reference generator have stated accuracies of 10 parts per million, 3 ppm (0.0003%) typical.

Pink noise applied to tape heads after the reference tone permit playback equalization to be precisely set when used with a real-time analyzer. That noise can also be used for room equalization. Moreover, pink and white noise can be mixed to simulate the sound of rain, a waterfall, surf, or various hissing noises.

The outputs of the audio reference generators are electronically balanced at 600 ohms and deliver 0 dBm. They can also be unterminated at +6 dBu, unbalanced at 0 dBu, or loaded for a lower signal level. Each generator set includes a calibrated circuit board, color-coded detachable 16-wire cable, a wall-outlet AC to DC converter, and a mating DC power plug. Both can be operated from any +12- to +35-volt DC source.

ARG-440 and *ARG-1000* audio reference generators are priced at $150.—**Tobin Cinema Systems**, 3227 49th Avenue SW, Seattle, WA 98116; Phone: 206-932-7280.

ALLIGATOR CLIPS. A family of five alligator clips from *ITT Pomona* permits the safe electrical testing of components and systems carrying up to 250 volts. The clips are available in a range of sizes: large heavy duty, large, medium, miniature, and disposable. All alligator clips are coated with durable plastic insulation to prevent shock hazard, shorting, or grounding to conductive surfaces.

Tinned copper-alloy jaws firmly grasp wires or leads and receptacles with connectors accept 2- to 4-mm (0.087- to 0.157-inch) lead wires. The miniature and disposable clips are intended for tests on densly populated circuit boards in restricted locations. They are also useful is such medical applications as electrocardiogram testing. The larger clips are suitable for testing for high-current withstand capability and electrostatic-control products.

CIRCLE 20 ON FREE INFORMATION CARD

The large, heavy-duty *Model 5785* grips objects up to 9.5-mm (0.37 inch) in diameter. It has an overall length of 81 mm (3.19-inch), and it accepts a sheathed banana plug. It will protect against 250 volts. The large *Model 5786* clip grips objects up

to 10 mm (0.39 inch) in diameter. It includes a screw connection for lead wires up to 18 AWG (2.4 mm). Its overall length is 80.5 mm (3.17 inches).

The *Model 5787*, 56-mm (2.20-inches) long medium clip, connects to a standard 4-mm banana jack. The *Model 5788* miniature clip has a miniature banana jack and an overall length of 40 mm (1.57 inches). The disposable *Model 5791* clip, with an overall length of 53 mm (2.09 inches), has a button fix/release for lead retention and a standard banana jack.

The alligator clips are priced from $.98 to $3.45 each.—**ITT Pomona Electronics**, Customer Service, 1500 East Ninth Street, P.O. Box 2767, Pomona, CA 91769; Phone: 714-469-2900; Fax: 714-629-3317.

INTEGRATED SURFACE MOUNT WORKSTATION. Manufacturers who perform paste and place surface-mount component assembly in small volume can improve their yields and their productivity with the *SMT-6000*pick/ place/ dispense system from *OK Industries*.

The mechanically assisted, solder-paste dispensing and component placement system is designed to achieve placement rates of up to 600 components per hour. It integrates a solder-paste dispenser and vacuum pick-up head onto a single arm assembly. That arm can be moved in the X-Y-Z-0 axes while the operator's hand is stabilized on a movable hand rest.

Needle positioning for paste dispensing, is said to be precise and repeatable, reducing placement location error by as much as 67%. According to OK In-

CIRCLE 21 ON FREE INFORMATION CARD

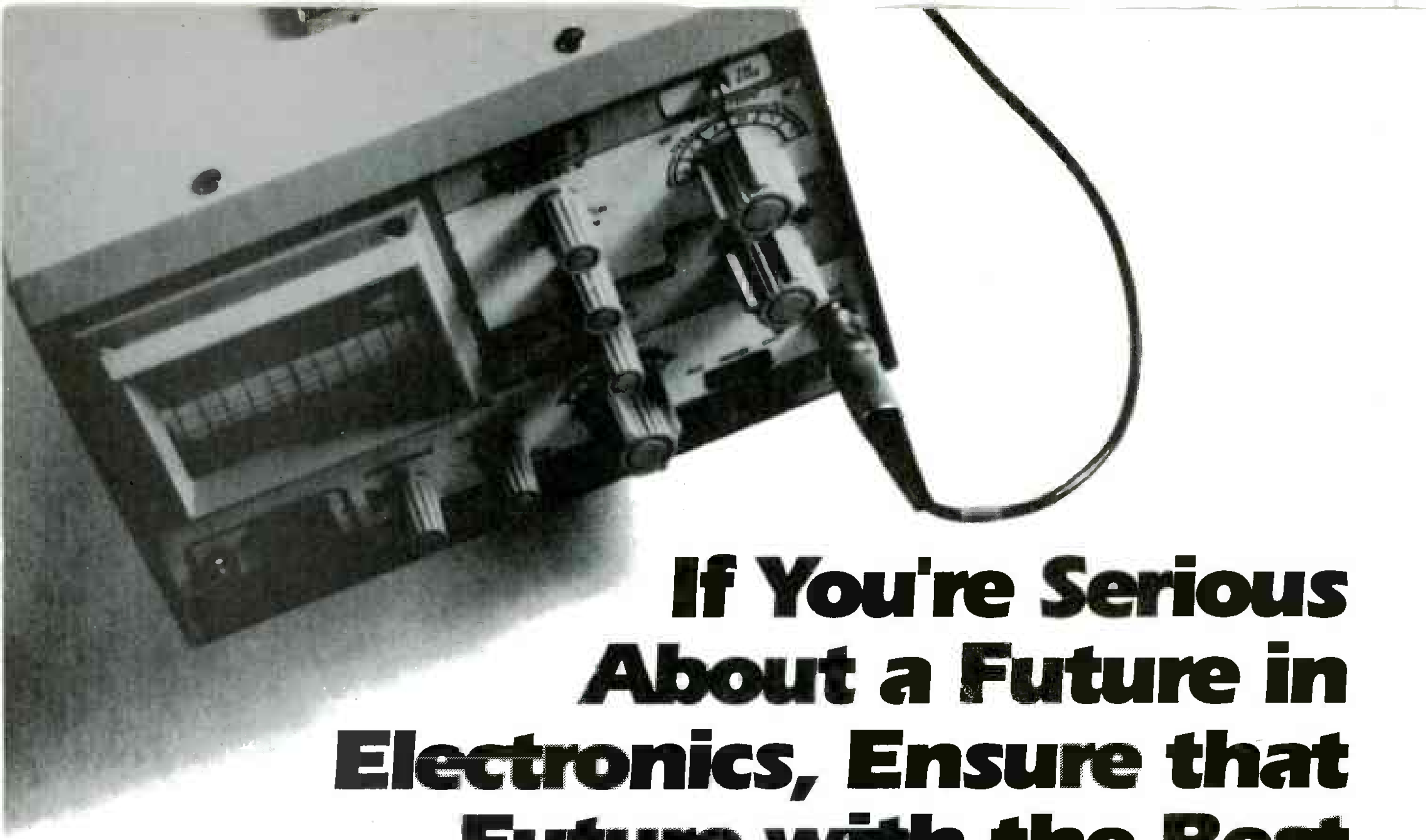
dustries, the mechanical assistance of arm assembly provides a three-fold increase in production over manual pick-and-place methods. For prototyping and batch production, a board can be pasted and populated in one workstation while secured in the adjustable, locking PC board holder. Movement is minimized because the board remains fixed during both the pasting and populating operations.

The *SMT-6000* is sold complete with a 45-compartment carousel, 12-inch and 15-inch PC board holders, a self-contained vacuum source for pick-and-place operations, time/ pressure controls for dispensing, a hand rest, and a pick/place nozzle kit. Optional accessories such as stick and reel component feeders, a light/magnifier, interchangeable spare carousels, and a feeder-mounting bracket are also available.

The *SMT-6000* SMT workstation sells for $3750.—**OK Industries, Inc.**, 4 Executive Plaza, Yonkers, NY 10701; Phone: 914-969-6800; Fax: 914-969-6650.

TRANSDUCER POWER SUPPLY. The *Model 4130* encapsulated power supply from *Calex* offers adjustable voltage output for powering transducers, strain gages, and many kinds of laboratory equipment. The power supply provides 4 to 15 volts DC at up to 1590 milliamperes, enough power for three


WHOOSSHHH!
THE FASTEST, EASIEST CROSS-REFERENCING OF ORIGINAL DEVICES TO NTE REPLACEMENT PARTS!
NTE'S NEW SOFTWARE
QUICK Cross™
"QUICK Cross" is the industry's first PC-based software cross-reference to NTE's highly successful line of semiconductors and relays!
Just type in any of a quarter of a million industry device numbers — U.S., Japanese, and European — and you'll get the ideal replacement from over 4,750 NTE devices in about one second.
All NTE parts carry a two-year warranty and most are available off the shelf.
"QUICK Cross" 5¼" and 3½" floppy diskette MS-DOS versions are available direct from NTE or through your local NTE distributor. For your nearest one, call NTE toll-free 1-800-631-1250 (including Canada) or (201) 748-5089.
FAX: (201) 748-6224.
NTE
NTE ELECTRONICS, INC.
A WORLDWIDE REPUTATION FOR QUALITY, SERVICE AND VALUE
☐ YES, PLEASE SEND ME THE FOLLOWING NUMBER OF COPIES OF "QUICK Cross" SOFTWARE ON FLOPPY DISKETTES
___ 5¼" (1.2M) $5.00 ea.
___ 3½" (720K) $6.00 ea.
___ 5¼" (360K) $7.50 ea.
Enclosed please find my check or money order for $______ (U.S. funds only.)
Name
Company
Address
City ______ State ______ Zip ______
Attach this coupon to your letterhead and mail to:
NTE, 44 Farrand St., Bloomfield, NJ 07003
RE992
* "QUICK Cross" software runs in MS-DOS on any IBM PC or compatible with 640K of RAM, a small hard drive, and a 5¼" or a 3½" floppy drive. NTE's database occupies only 2.4 Megabytes of hard disk space when loaded. It is a public domain release.
MS-DOS is a registered trademark of Microsoft Corporation.
IBM is a registered trademark of International Business Machines.
CIRCLE 180 ON FREE INFORMATION CARD

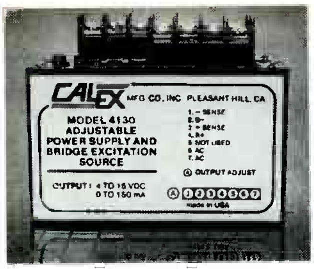


If You're Serious About a Future in Electronics, Ensure that Future with the Best Educational Training Available.

FREE!

SEND FOR YOUR CIE HOME STUDY COURSE CATALOG AND RECEIVE A FREE 24 PAGE CIE ELECTRONICS SYMBOL HANDBOOK!

Includes hundreds of the most frequently used electronic symbols. Published by CIE exclusively for our students and alumni. Yours free when you request a CIE Course Catalog.



CIRCLE 22 ON FREE INFORMATION CARD

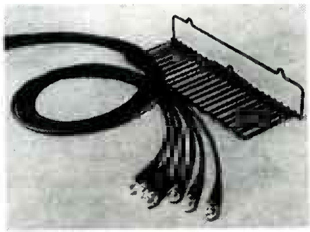
350-ohm gages or transducers that require 10-volt excitation.

Voltage can be adjusted with a built-in potentiometer. Line and load regulation are 0.05%. Ripple and noise are less than 0.5 millivolt rms. The power supply has built-in remote sensing, it is short-circuit protected, and it has an internal thermal shutdown switch. The *Model 4130* can operate at full load to temperatures of 70°C. It measures 3.75 × 2 × 2.87 inches and weighs only 18 ounces. The case has two molded-in mounting holes, and mounting bolts are provided with the supply.

Options for input voltages for the *Model 4130* are 110, 115, 220, 230, or 240 volts AC. Prices start at $122.—**Calex Mfg. Co., Inc.**, 2401 Stanwell Drive, Concord, CA 94520-4841; Phone: 800-542-3355; Fax: 510-687-3333.

COAXIAL ADAPTER CABLE KIT AND CONNECTOR KIT. *Test Probes' universal coaxial adapter cable kit, TPI-5010*, is intended for use with the company's TPI-3000A connector kit. Each of the six adapter cables in the kit accepts all combinations of BNC, TNC, SMA, N, UHF, Mini-UHF, F, and RCA connectors.

According to the manufacturer, any combination of two connectors from the 24 available in the *TPI-3000A* kit can be attached to the ends of one of the six universal cables in the *TPI-5010* kit. Because no crimping or soldering is required, the cables can be used repeatedly and in different configurations. The six RG-58 cables in the kit are double-braid shielded, 48 inches long, and have soft poly-


CIRCLE 23 ON FREE INFORMATION CARD

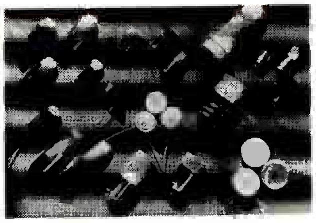
vinyl chloride (PVC) jackets.

The *TPI-3000A* connector kit include two male and two female connectors for BNC, N, UHF, and TNC adapters and one male and one female connector for the SMA, Mini-UHF, F, and RCA adapters along with six universal interfaces.

All connectors have silver-plated machined brass shells and gold-plated contacts. Both kits are said to be convenient for servicing communications equipment and local-area networks in the field, and interfacing or connecting for various RF systems and test equipment.

The *TPI-5010* kit containing six cables and a plastic-coated wall rack is priced at $98. The *TPI-3000A* connector kit with 24 connectors sells for $150.—**Test Probes, Inc.**, 9178 Brown Deer Road, San Diego, CA 92121; Phone: 800-368-5719.

BRIGHT LED LAMPS. The light-emitting diode lamps in this new family from *Lumex Opto/Components* are intended as replace-


CIRCLE 24 ON FREE INFORMATION CARD

ments for incandescent lamps in existing products. *McLED's* are made with from two to eight LED dies to obtain light output comparable to that of the incandescent bulb it replaces. The multi-LED lamps are offered with wire ends or standard incandescent lamp bases. They are said to run cooler and save the time and cost of frequent filament lamp replacement in the field.

The lamps are being sold as replacements for miniature and sub-miniature incandescent lamps with ratings from 2 to 20 volts AC or DC. The AC lamp replacements include miniature rectifier bridges to permit them to operate from AC sources. (Individual LED dies draw currents of 2 to 25 milliamperes at 1.5 to 2.8 volts DC.) The DC lamp replacements can be mounted directly on PC boards or front panels. Lumex obtains a near-white light output for its lamps by mixing LED dies that emit different colors on the same lamp header.

The prices of *McLED's* vary from $1.00 to $10 each, depending on order quantity, color, and package.—**Lumex Opto/Components Inc.**, 292 East Hellen Road, Palatine, IL 60067; Phone: 708-359-2790; Fax: 708-359-8904.

DIFFERENTIAL OSCILLOSCOPE PROBE. Two different signals can be measured on one oscilloscope channel with this active differential oscilloscope probe, and there is no need for a ground reference to make the measurement. The model ADF15, from *Test Probes, Inc.* was designed to permit the oscilloscope to be grounded for safety while measurements are made without isolation ampli-


CIRCLE 25 ON FREE INFORMATION CARD

fiers. This feature is said to eliminate errors caused by the voltage differences between two amplifiers and two probes.

The *ADF15* is intended for making high voltage differential measurements in switching power supplies, motor controllers that include thyristors, and power MOSFET's. It can also make accurate measurements of small signal differences in the presence of high common-mode voltage. The probe's bandwidth covers the range of DC to 15 MHz and it has a switchable ×20 to ×200 attenuation mode.

The probe is powered by four AA batteries or an external 6-volt DC converter (not supplied). The price includes standard probes, alligator clips, and spring-tip probes with banana-plug leads.

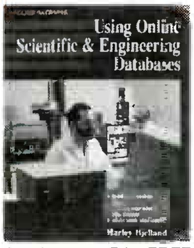
The *ADF15* probe is priced at $375.—**Test Probes, Inc.**, 9178 Brown Deer Road, San Diego, CA 92121; Phone: 619-535-9292. **R-E**

NEW LIT

Use The Free Information Card for fast response.

USING ONLINE SCIENTIFIC & ENGINEERING DATABASES; by Harley Bjelland. Windcrest/McGraw-Hill, Blue Ridge Summit, PA 17294-0850; $26.95.

Engineers, technicians, scientists, hobbyists, and technical writers always seem to be hungry for facts, and they might spend hours searching for just the right information before they start or complete a project. But we are now undergoing an information explosion, and it seems that the leading edge of scientific and engineering knowledge always seems to elude our ability to keep up. Books, magazines, technical papers and other printed materials are no longer the only sources of technical data; on-line computer databases are helping out by providing current information that is easily accessible through your modem-equipped PC.



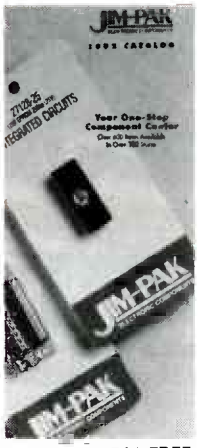
CIRCLE 26 ON FREE INFORMATION CARD

This book explains how to conduct successful on-line scientific and engineering datbase search with a minimum investment of time, effort, and expense. It describes the required computer hardware and software and explains the advantages and disadvantages of each database service. Step-by-step, illustrated instructions tell you how to tap into the power of on-line databases, and sample searches show exactly what you'll see as you work your way through specific database menus. Also explained are ways to save money by using command-line searches and other shortcuts.

Descriptions are given for major technical and consumer on-line databases including EasyNet, Dialog, BRS, MEAD, STN, ORBIT, Dow Jones, and EPIC. Techniques are presented for evaluating information obtained through on-line systems and putting it to profitable use.

1992 CATALOG; from Jim-Pak Electronic Components, 1355 Shoreway Road, Belmont, CA 94002; free.

This 30-page free brochure from Jim-Pak contains listings and illustrations of over 600 of its products for electronic hobbyists and professionals. For example, you'll find listings of the company's



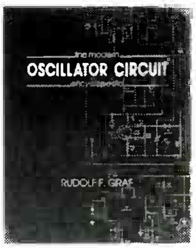
CIRCLE 27 ON FREE INFORMATION CARD

offerings in resistors, capacitors, trimmers, and potentiometers. You'll also be able to find active devices from diodes and LED lamps to digital and linear integrated circuits, microprocessors, and memories. Packaging products being offered include breadboards, enclosures, connectors, fans, heat sinks and power supplies. Manufacturing equipment from Jim-Pak includes soldering irons and hand tools. Reference and text books of interest to the electronics community are also listed in the catalog. A state-by-state listing of over 300 of Jim-Pak's stores is included.

THE MODERN OSCILLATOR CIRCUIT ENCYCLOPEDIA; by Rudolf F. Graf. TAB Books, Division of McGraw-Hill Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-822-8138; $12.95.

This circuit encyclopedia is a handy reference for those who want instant access to more than 250 proven, practical oscillator circuit designs. Some of the circuits contain late-model ICs that simplify their construction and reduce the number of components needed. Needless to say, they add to the versatility and reliability of the resulting oscillator.

Mr. Graf's encyclopedia includes schematics for virtually every type of oscillator circuit that has ever been designed—some that are very familiar and others that are obscure—even to experts. The names of many of the oscillator circuits are familiar to students and seasoned professionals alike. Their operation is taught in engineering classes as well as vocational and military tech schools. There are, for example, the old familiar Armstrong, Clapp, Colpitts, Franklin, Hartley, Hertz, Miller, Pierce and Wien-bridge oscillators as well as audio, blocking, crystal, multivibrator and electron-coupled versions.

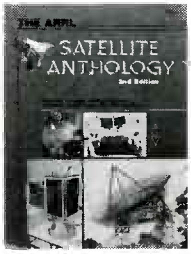


CIRCLE 28 ON FREE INFORMATION CARD

The schematics and descriptions are organized by application for easy reference. The circuit schematics and descriptive text have been reproduced in the same form in which they were originally published in such sources as **Radio-Electronics.** This was done by Mr. Graf to prevent transcription errors and make them instantly recognizable to readers who might have seen them in the past. The original source for each circuit is listed in a section at the back of the encyclopedia. That permits readers to refer back to the source publications for additional information on construction and application.

THE ARRL SATELLITE ANTHOLOGY: 2nd Edition; from The American Radio Relay League, 225 Main Street, Newington, CT 06111; $8.00.

In the 30 years since the first amateur-radio satellite was launched, satellite technology has become increasingly sophisticated. Nevertheless, communication with satellites has become easier. This collection of articles from ARRL's *QST* magazine is intended to help amateur radio operators participate in satellite communications; they dispel the myth that satellite operating is expensive and difficult.



CIRCLE 29 ON FREE INFORMATION CARD

Amateurs can access satellites with equipment they already own. The informative articles discuss active amateur satellites, their operating features, and how to access them. Several articles, whose content is still valid today, were retained from the first edition. Subjects include satellite tracking and conversing with other operators in other countries. More recent articles discuss presently operating satellites such as AMSAT-OSCAR 13, and look at the next generation of OSCAR satellites.

TROUBLESHOOTING & REPAIRING ELECTRONIC MUSIC SYNTHESIZERS; by Delton T. Horn. TAB Books, Division of McGraw-Hill Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-822-8138; $16.95.

As music synthesizers become more popular, there is an increasing demand for instruction material on their maintenance and repair. This book was written for musicians who want to repair their own equipment as well as electronic hobbyists and technicians who need a reliable source of information on synthesizer troubleshooting and repair. Mr. Horn's book gives complete, step-by-step instructions for servicing synthesizers and replacing their components. Both the older analog and more modern digital instruments are covered.

The first half of the book is devoted to locating and repairing problems that commonly occur in analog synthesizers. Those include nonexistent, weak, or noisy output signals. Also described are methods for repairing voltage sources, function generators and keyboards.

The book's second half covers digital synthesizers. It gives instructions for re-

CIRCLE 30 ON FREE INFORMATION CARD

pairing digital oscillators, amplifiers, and their power supplies. Topics discussed include logic probes and logic pulsers. One whole chapter is devoted to MIDI with discussion of cabling, channels and circuitry. Instructions are given on what to do if your synthesizer fails to respond to MIDI commands. In addition, the book offers advice on how to restore old or unusable synthesizers as well as how to modify and expand existing units.

GET THE LATEST ADVANCES IN ELECTRONICS

WITH A SUBSCRIPTION TO

Electronics NOW

Radio Electronics® Combined with Electronics Now®

ENJOY THE WORLD OF ELECTRONICS EACH MONTH!

Subscribe to the best electronics magazine—the one that brings you the latest high-tech construction projects, feature articles on new technology, practical troubleshooting techniques, circuit design fundamentals, and much more.

Electronics Now looks to the future and shows you what new video, audio and computer products are on the horizon. What's more you'll find helpful, monthly departments such as Video News, Equipment Reports, Hardware Hacker, Audio Update, Drawing Board, Computer Connections, New Products, and more. All designed to give you instruction, tips, and fun.

Electronics Now gives you exciting articles like:

- Buyer's Guide to Digital Oscilloscopes
- Build A Scanner Converter
- Single-Chip Voice Recorder
- Build A MIDI Interface for your PC
- Troubleshoot Microprocessor Circuits
- Build A High-Power Amplifier for your Car
- Add Music On Hold to your Phone
- All About Binaural Recording
- VGA-to-NTSC Converter

FOR FASTER SERVICE CALL TODAY

1-800-999-7139

DON'T DELAY SUBSCRIBE TODAY!

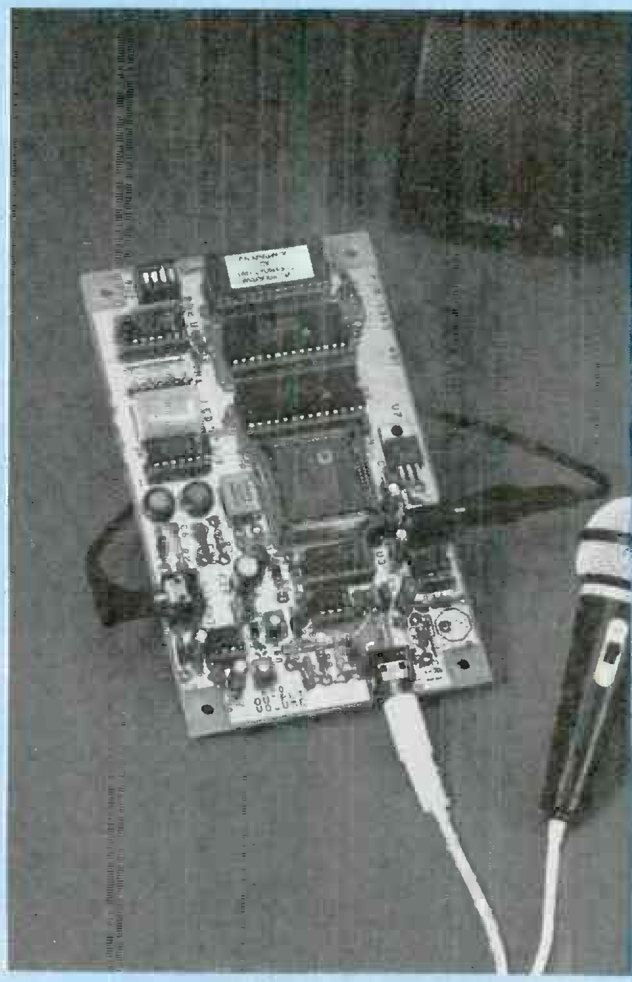
Just fill out the order card in this magazine and mail it in today.

5REJ9

VFX DIGITAL SIGNAL PROCESSOR

WOULD YOU LIKE TO CHANGE THE pitch of your voice or create such special audio effects as echo or reverb? We will show you how to build a voice effects processor (or VFX processor, for short) that can generate such unusual effects. We'll explain the basic algorithms used to perform these DSP (digital signal processing) techniques, and examine the heart of the VFX hardware, the Analog Devices-2105 digital signal processing microcomputer. If you're on a tight budget, you'll appreciate that this project costs much less than any commercial single-effect generator.

Before we describe the details of the hardware and software, let's look at what the VFX processor does. The VFX processor accepts audio signals, digitally processes the information in one of three user-selected modes, and amplifies the signal for listening with a speaker or a pair of headphones. All you need besides the VFX processor is a microphone, a pair of headphones, and a 9-volt DC power source—all of which are available from the source given in the Parts List.



A little DSP goes a long way in generating unusual sound effects.

CRAIG BORAX and DAVID BECK

Basic operation

The VFX block diagram is shown in Fig. 1. A four-position DIP switch (of which only three are used) puts the VFX into one of four operating modes: harmonizer, echo, reverb, and test. Table 1 shows the DIP switch positions for each mode. The harmonizer voice effect raises or lowers the pitch of your voice. A high pitch makes you sound as if you're breathing helium, and a low pitch makes you sound like a baritone singer. In this mode, a single-digit LED readout indicates the pitch change level; 0 is the maximum down shift (ꝶ%?œ Hz) and 9 is the maximum upshift (+305 Hz). The VFX board powers up in level 4, which is no shift at all. A SHIFT button lets you step through the range of pitch shifts; after 9 the processor returns to 0. Each pitch shift increment is approximately 51 Hz; we'll explain why later.

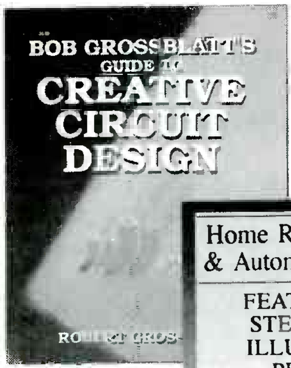
The echo effect has an adjustable delay; you can decrease the echo delay time by pressing the SHIFT button. In this mode the LED displays a number from 9 to 0 indicating a delay time of 0.63 to 0 seconds. Each press of the SHIFT button decreases the time delay by 70 milliseconds.

The reverb effect is similar to the echo effect, except that the delay time is fixed at 78 milliseconds and the amplitude of the feedback signal is adjustable from 0.5 to 0 with the SHIFT button. The effect is more subtle than the echo effect and simulates the acoustics of a large room.

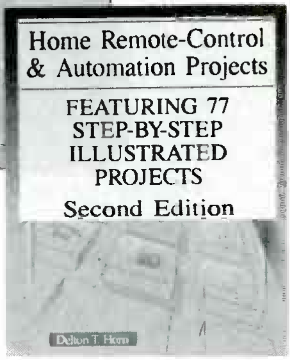
The test mode helps troubleshoot the VFX board. The test mode will be discussed in greater detail later on.

The basic circuit

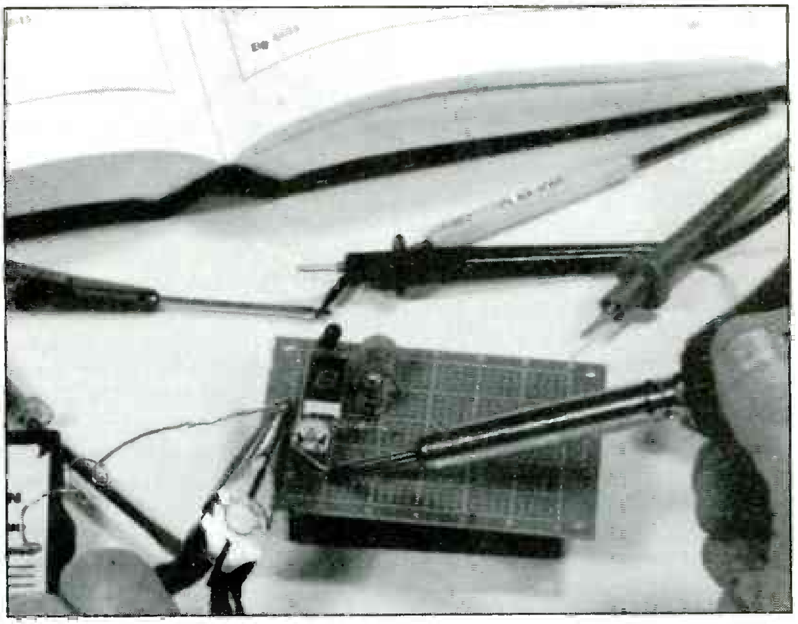
As shown in the block diagram (Fig. 1), the VFX processor consists of a microphone input circuit that uses a National Semiconductor TP3054 CODEC (coder-decoder), an Analog Devices ADSP-2105 DSP (digital signal processor), an 8K × 8 EPROM (eraseable program-

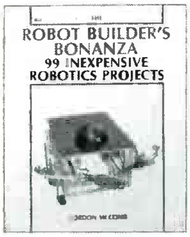


3610 $28.95

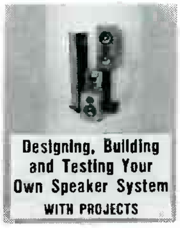


3765 $29.95

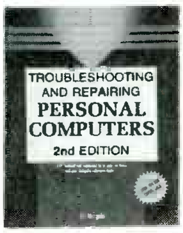




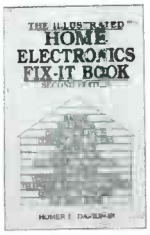
2800P $16.95
Softcover



3374P $16.95
Softcover

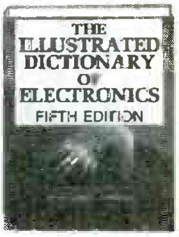


3677-XX $34.95
Counts as 2

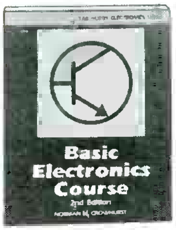


2883P $18.95
Softcover

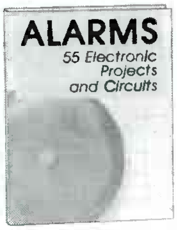
1604P $17.95
Softcover



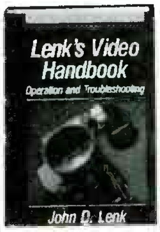
3345P $24.95
Softcover



2613P $17.95
Softcover

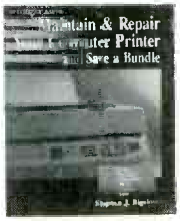


2996P $14.95
Softcover

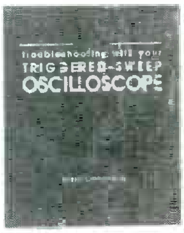


10018 $39.95

1367P $29.95
Softcover

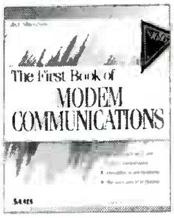


3922 $26.95

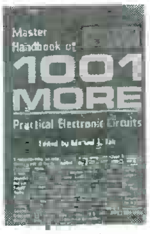


3659 $27.95

3279-XX $36.95
Counts as 2



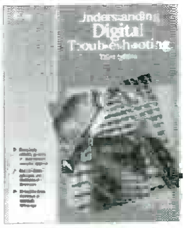
586023-XX $26.95
Counts as 2



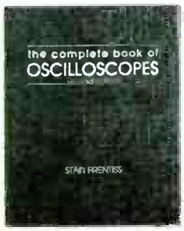
804P-XX $21.95
Counts as 2/Softcover

3550-XX $34.95
Counts as 2

3107P $18.95
Softcover

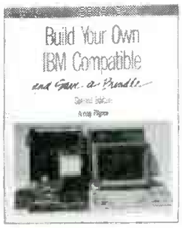


9457P $24.95
Softcover

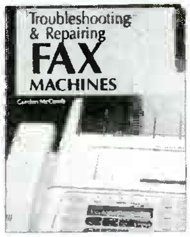


3825 $26.95

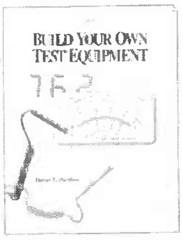
585885 $29.95



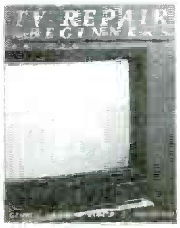
3804P-XX $19.95
Counts as 2/Softcover



3778 $26.95



3475 $27.95



3627P $19.95
Softcover

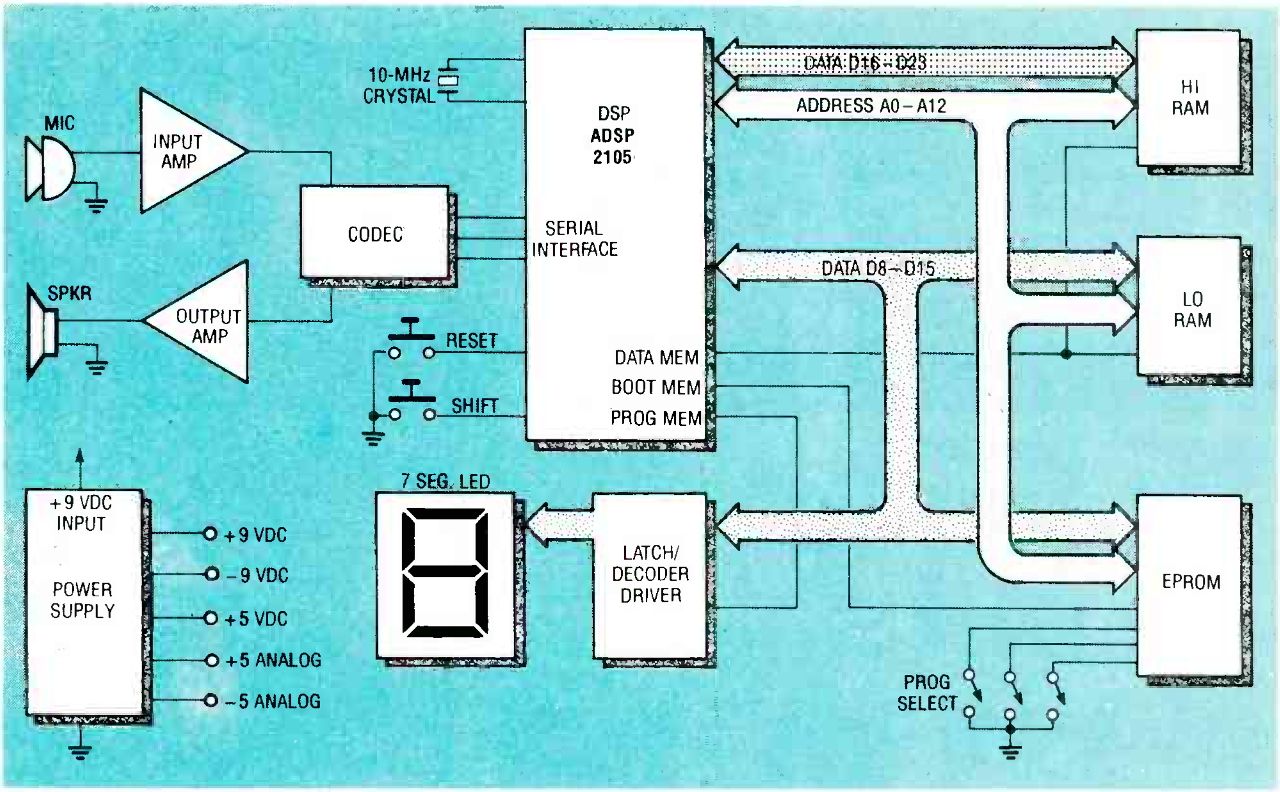


FIG. 1—VFX BLOCK DIAGRAM. The VFX has a microphone input, a CODEC, a DSP, EPROM, SRAM, power-supply circuitry, and audio conditioning.

mable read-only memory), two 8K × 8 SRAM's (static-random access memory), power-supply circuitry, and audio conditioning. The CODEC incorporates an input anti-aliasing filter, an A/D converter, a D/A converter, an output filter, and control circuitry. The SRAM's provide 8K × 16-bit words of data storage to supplement the 2105's internal 512 words. The DSP can access external memory in 100 nanoseconds but has an internal wait-state generator to allow the use of slower devices. The VFX processor has three wait states programmed for external data memory access.

The VFX processor performs four functions; the theory of operation for each implemented in hardware is virtually identical. The software makes the hardware perform these multiple effects. The EPROM hex code will be posted on the RE-BBS (516-293-2283, 1200/2400, 8N1), as a file called VFX.HEX. Let's look at the algorithms used for each effect.

Algorithms

The harmonizer shifts the pitch of an audio signal, such as music or speech, up or down. One of the most widely known uses of this technique is seen in the novelty musical group, the Chipmunks. Recorded in the early 60's, the Chipmunks' up-pitch effect was made simply by playing back audio tapes at a higher speed. Today, the high-tech approach is to use digital signal processing.

The principal algorithms performed by the DSP hardware for the harmonizer are the fast Fourier transform (FFT) and the inverse FFT (IFFT). Those algorithms convert the audio signal in the time domain to the frequency domain, and then back again. Figure 2 shows an original audio signal and the data at each stage in the process as it is spectrum-shifted. Figure 2-*a* plots the audio input versus time. Figure 2-*b* shows the frequency spectrum of the audio signal in 2-*a*. Figure 2-*c* shows the original spectrum at the top and the up-shifted spectrum at the bottom. Figure 2-*d* shows the original audio signal on top with the processed audio signal, which contains higher-frequency components, at the bottom.

The timing of the algorithm of the harmonizer is shown in Fig.

TABLE 1—DIP SWITCH SETTINGS

	S1-a	S1-b	S1-c	S1-d
Harmonizer	X	ON	ON	ON
Echo	X	OFF	ON	ON
Reverb	X	ON	OFF	ON
Test Mode	X	OFF	OFF	ON

THE FFT

The Fourier series and its related transforms and algorithms are widely used in electronics. The Fourier transform (FT) is a mathematical method for converting a signal from the time domain to the frequency domain, or simply a way of expressing a continuous waveform as a series of sine waves. The fast Fourier transform (FFT) is an algorithm enhanced for computer computation of a discrete Fourier transform (DFT), which is the digital equivalent of the Fourier transform. **R-E**

3, and its block diagram is shown in Fig. 4. In Fig. 3, the input signal from the microphone is sampled at a 6.5-kHz rate. At that rate buffer #1 is filled in 19.7 milliseconds with 128 samples. (That determines the pitch resolution because the resolution in the frequency domain is the inverse of the sampling period, or 50.7 Hz.) Then the next 128 samples are stored in buffer #2. (The double-throw switch in Fig. 4 is there to suggest the toggling from one buffer to the other.) While buffer #2 is being filled, the VFX processor begins the harmonizing effect by processing buffer #1 through a 128-point FFT, then comes the shift, and then the IFFT. The entire FFT/Shift/IFFT algorithm takes approximately 6 milliseconds so that all processing is finished before the next buffer is filled. That allows real-time processing with a minimal two-buffer delay of 39.3 milliseconds between the time the microphone input arrives at the VFX processor and when it is output to the speaker.

The echo-effect algorithm uses a digital implementation of an adjustable-length analog delay line as shown in Fig. 5. The input signal from the microphone is sampled at a 6.5-kHz rate. It is then summed with the delayed signal received n × 455 periods ago (where n is a number from zero to nine as shown on the VFX's LED display). The delay line is implemented in 4K of external SRAM. The software allows the adjustment of the delay from 0.63 to 0 milliseconds.

The reverb effect is very similar to the echo effect (see Fig. 6) except that the length of the delay line is fixed at 78 milliseconds, and the reflection factor is adjustable from 0% to 50% with the SHIFT button. The reflection factor determines the attenuation of the signal before it is stored in the delay line and simulates the reflection factor of a room.

The test mode can be used during hardware checkout to isolate problems with your VFX board. We'll discuss how to use the test mode later.

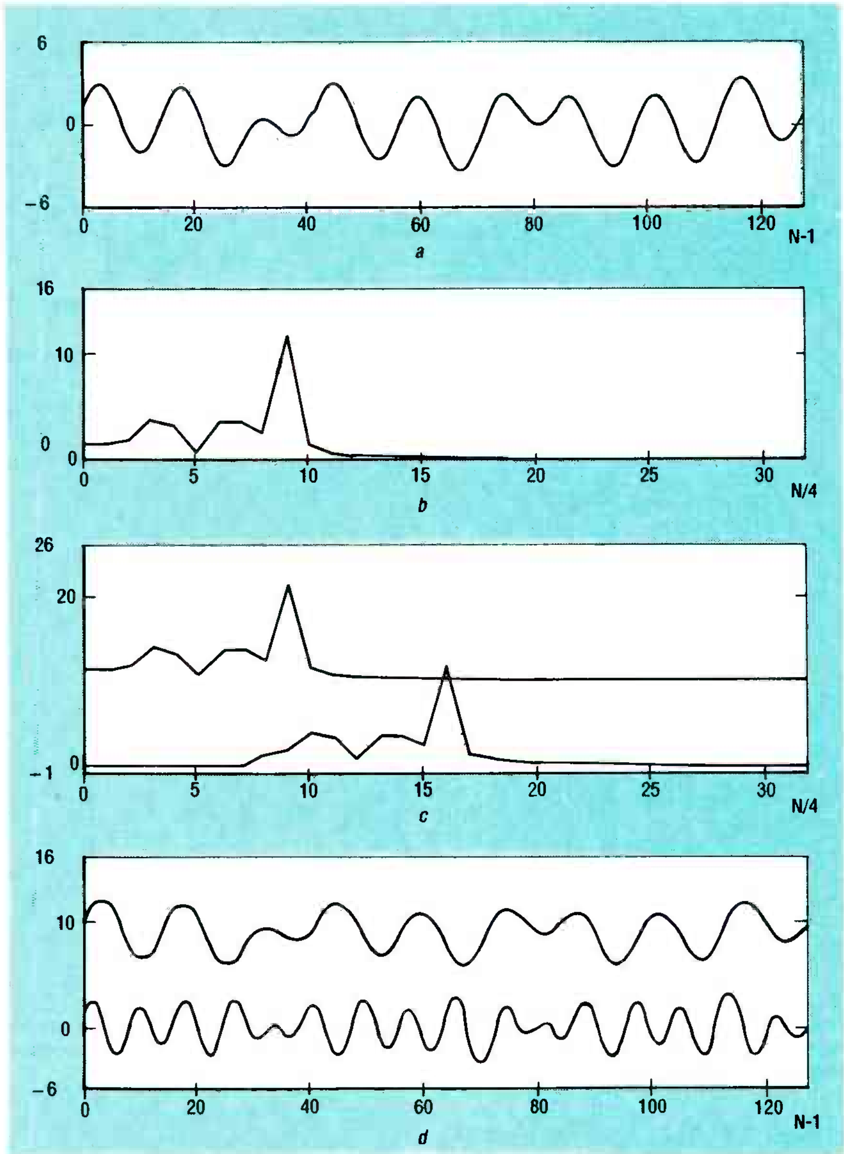


FIG. 2—HARMONIZER ALGORITHM. **In *a* you see the audio input vs. time, *b* shows the frequency spectrum of the audio signal, *c* shows the original spectrum at the top and the up-shifted spectrum at the bottom, and *d* shows the original audio signal on top with the processed audio signal at the bottom.**

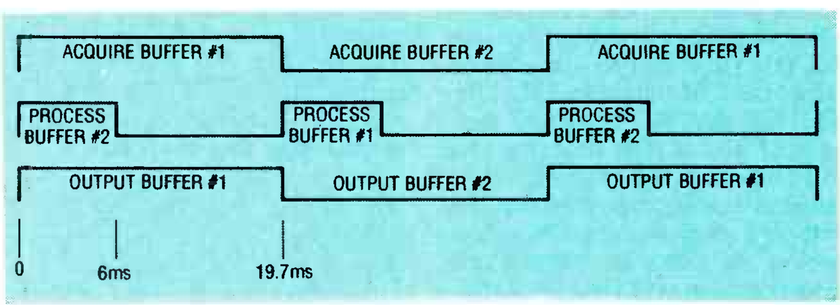


FIG. 3—HARMONIZER TIMING DIAGRAM. **The input signal is sampled at a 6.5-kHz rate and fills buffer #1 in 19.7 milliseconds with 128 samples. The next 128 samples are stored in buffer #2.**

Circuitry

The schematic diagram for the VFX processor is shown in Fig. 7. The ADSP-2105 DSP microprocessor, IC1, has 1K × 24-bit words of fast program memory (PM) on chip. An on-chip oscillator requires a 10-MHz

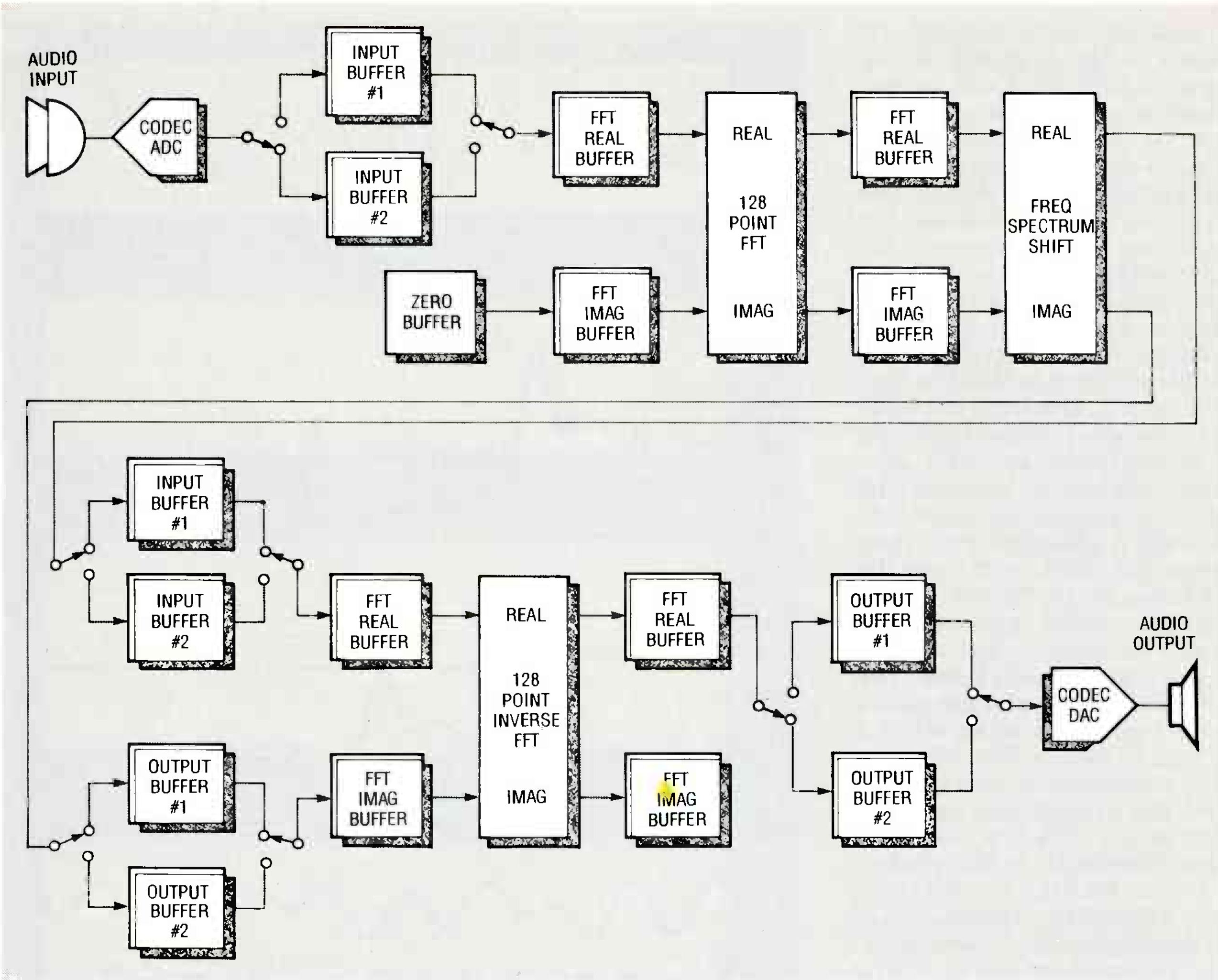


FIG. 4—HARMONIZER BLOCK DIAGRAM. The double-throw switches indicate the toggling from one buffer to the other. While buffer #2 is being filled, the VFX processor begins processing buffer #1.

crystal (XTAL1) and two small capacitors (C1 and C2). On power-up and after a reset, the 2105 boots the program from the EPROM (IC2) into the on-board memory. The boot function is built into the 2105 and it allows a slower and inexpensive EPROM (250 ns) to supply the 1K words (3K bytes) of PM. The $\overline{\text{BOOT MEMORY SELECT}}$ ($\overline{\text{BMS}}$) output of the 2105 selects the EPROM, and the addressing is automatically generated on the external address bus. The selection of the program booted can be programmed by the 2105, but to simplify the VFX hardware and software, the program is selected by setting the three most-significant bits (MSB's) of the EPROM's address with DIP switch S1.

In addition to the on-board PM, there is 0.5K × 16-bit words

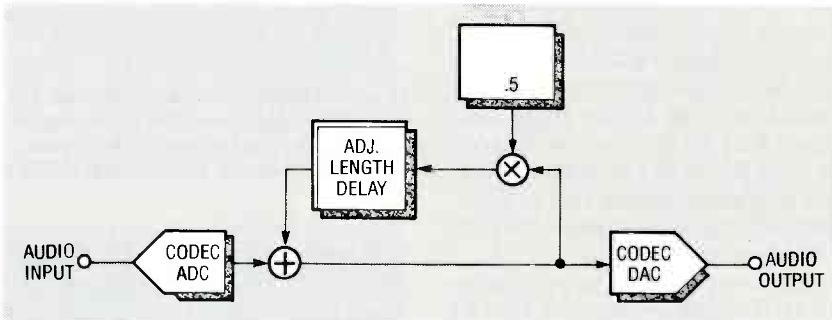


FIG. 5—ECHO-EFFECT BLOCK DIAGRAM. A digital implementation of an adjustable-length analog delay line is used.

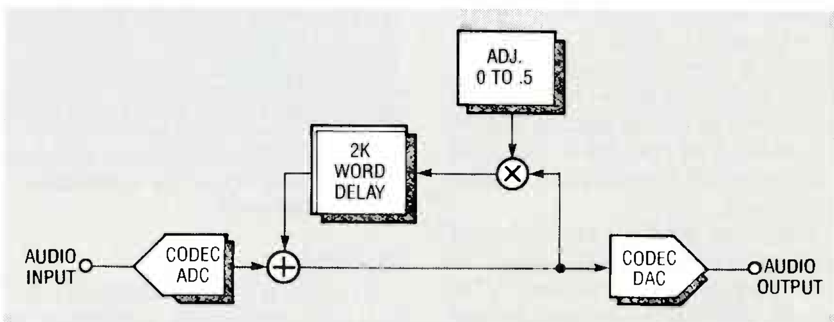


FIG. 6—REVERB EFFECT BLOCK DIAGRAM. The length of the delay line is fixed at 78 milliseconds, and the reflection factor is adjustable from 0% to 50%.

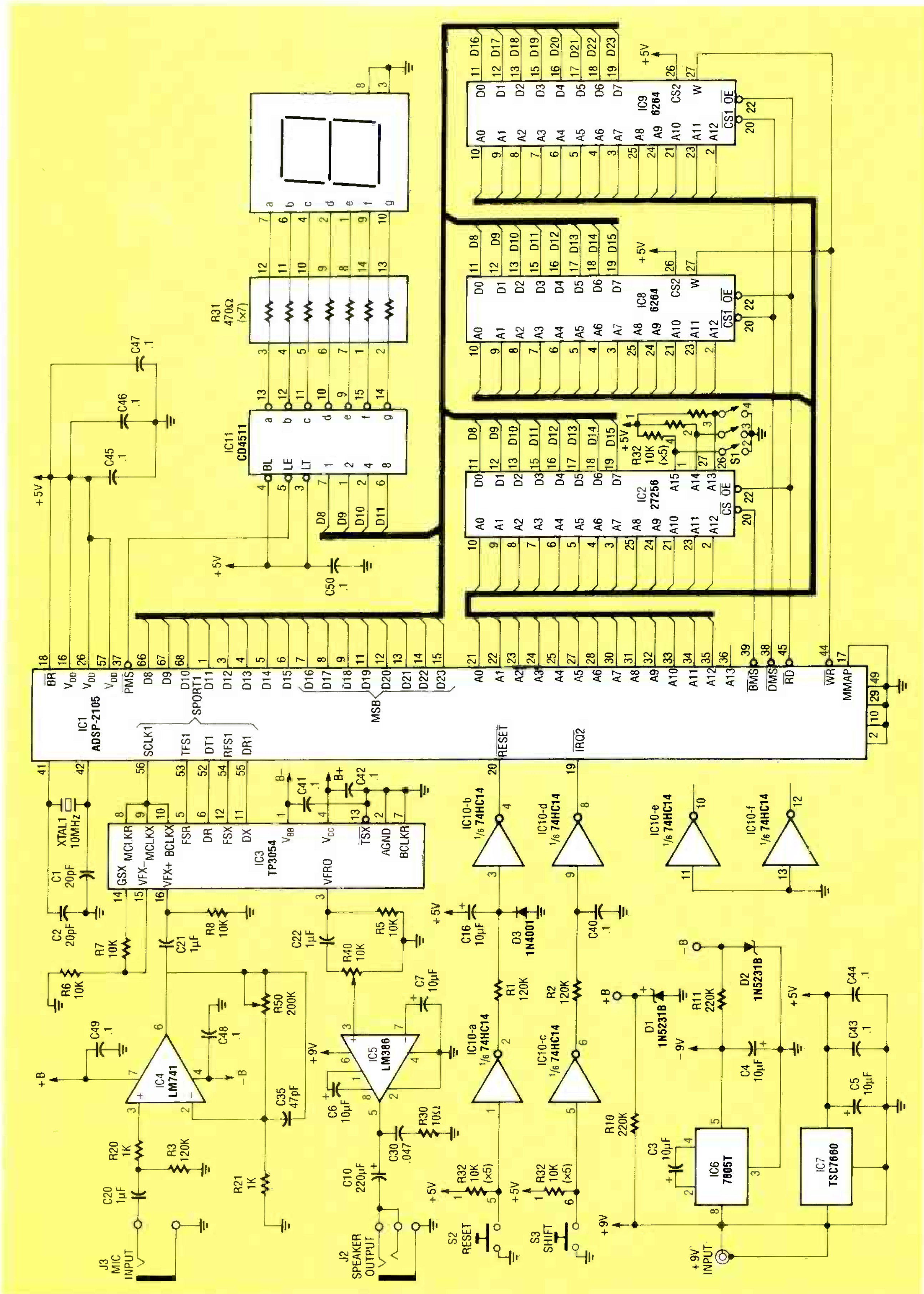


FIG. 7—VFX SCHEMATIC. The DSP microprocessor (IC1) has 1K × 24-bit words of fast program memory (PM) on chip. On power-up, the 2105 boots the program from the EPROM IC2 into the on-board memory.

THE ADSP-2105

The Analog Devices ADSP-2105 is the engine of the VFX processor. The ADSP-2105 is a second-generation digital signal processing (DSP) microcomputer based on the earlier ADSP-2100. It has significant architectural improvements over earlier generations (see block diagram in Fig. 10). The 2105 has built-in data memory RAM (0.5K × 16 bits) and program memory RAM (1K × 24 bits) so it really is a DSP microcomputer and not a microprocessor. Both of those memory banks are expandable with off-chip fast static RAM. That allows the program memory to be loaded, using the resident boot memory loader, from a slow PROM or EPROM (250 nanosecond access) and keeps high-speed data transfer inside the chip to reduce EMI and board-layout requirements.

The program and data memory can be easily expanded off-chip—as has been done with the VFX processor—when the internal data memory is not sufficient for the algorithms. The chip has resources built-in to simplify external memory hardware interfacing. They include separate selects for program memory, data memory, and boot memory, and a programmable wait-state generator to allow for slow external memories.

The 2105 incorporates several peripheral devices and their associated interrupts. There is a built-in 16-bit interval timer with programmable prescaler and interrupts. A high-speed synchronous serial interface (SPORT1) can interface to µ-law and A-law CODEC's using hardware companding as well as digital audio-oriented D/A and A/D converters. Additionally, the serial port can connect multiple 2105's together in parallel processing applications.

The ADSP-2105 also offers high performance by virtue of its instruction set. With a 100-nanosecond cycle time, multiple operations per cycle, and zero-overhead looping, the numerical performance of the chip is respectable. In addition, the 1-micron low-power CMOS processing holds power dissipation to less than 1 watt; a powerdown mode reduces the power consumption to a mere 80 milliwatts.

The ADSP-2105 incorporates three execution units:

- Barrel shifter
- Arithmetic Logic Unit (ALU)
- Multiplier Accumulator (MAC)

The three units are optimized for their specific function, and are, therefore, very fast, completing any instruction in one cycle. Access to the three execution units is made via registers associated with each execution unit. For example, the ALU has the following 16-bit registers:

AX0, AX1, AY0, AY1, AR, and AF

The MAC has:

MX0, MX1, MY0, MY1, MR0, MR1, MR2,

LISTING 1

```
START:
            I0=buffer#1;              {Address of buffer#1 in DMD}
            M0=1;                     {Post modify value}
            I4=buffer#2;              {Address of buffer#2 in PMD}
            M0=1;                     {Post modify value}
        CNTR=2048;                    {Number of words in buffer}
DO MOVE_BUFFER UNTIL CE;              {Do loop}
AR=PM(I4,M4);
DM(I0,M0)=AR;
MOV_BUFFER:                   {End of the loop}
```

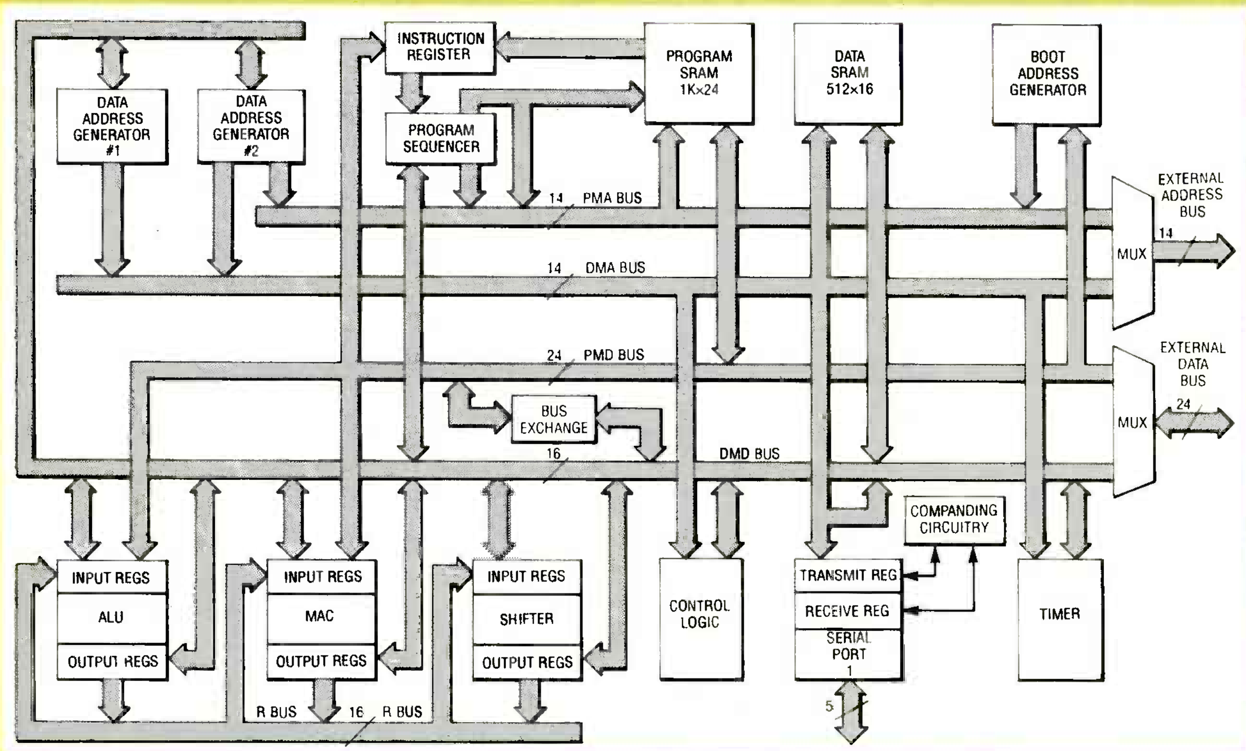


FIG. 10—ADSP-2105 BLOCK DIAGRAM. The 2105 has built-in data memory and program memory implemented in fast SRAM. That keeps high-speed data transfer inside the chip.

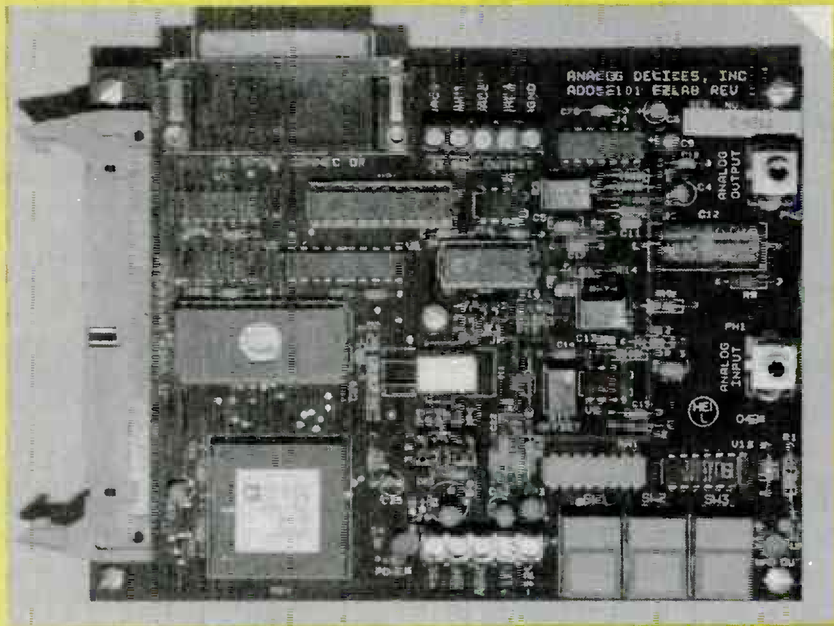


FIG. 11—THE EZ-LAB KIT includes a demo board, an ADSP-2101/5 family assembler, linker, and other miscellaneous development software. You can design and debug software for certain applications at minimal cost.

and MF
The barrel shifter has:
SB, SI, SE, SR1 and SR0

In addition, the ADSP-2105 incorporates two data address generators (DAG's), one of which can perform the bit reversing that is required for certain FFT algorithms. One DAG accesses program-memory data (PMD) and the other accesses data-memory data (DMD). The DAG's use a set of three registers to control indirect addressing and circular buffers. Those are the index registers (I0 to I7), the modify registers (M0 to M7), and the length registers (L0 to L7). For example, by setting up the registers so that I0 has the starting address, M0 has a value of 1, and L0 is zero, blocks of data can be moved from one buffer to another with very little programming (see Listing 1).

To be successful, any microcomputer, including a digital signal processor, must have readily available low-cost software tools. Analog Devices has supplied the ADSP-2105 with quality software tools at a reasonable price. The assembly language is algebraic and straightforward. Included is a powerful personal computer-based software simulator that allows software debugging without an expensive in-circuit emulator (ICE).

The ADSP-2105 has the same kind of interrupt handling capabilities as other microcomputers. The interrupts can be individually masked or enabled, edge-triggered or level sensitive. Interrupts are vectored to the program memory locations shown in Listing 2. A second mirror set of Data registers can be enabled to facilitate fast context switching during its interrupt servicing. The device has on-chip clock generation circuitry and is packaged in a 68-lead plastic leaded chip carrier (PLCC).

LISTING 2

```
IRQ2                        0004h
SPORT0 (Transmit)           0008h
SPORT0 (Receive)            000Ch
SPORT1 (Transmit)           0010h
SPORT2 (Receive)            0014h
TIMER                       0018h
```

The VFX processor described in this article was developed with Analog Devices' ADSP-2101 EZ-Lab Kit (see Fig. 11). The Analog Devices EZ-Lab kit includes an EZ-LAB demonstration board, an ADSP-2101/5 family assembler, linker and other miscellaneous development software, including the essential simulator. With this package one can design and debug software for certain applications with excellent results at minimal cost. Of course, an in-circuit emulator (ICE) will speed up the development process, although, of course, at a much higher price: the EZ-Lab kit sells for less than $500 dollars, and an emulator costs more than $2000 dollars. For people with limited capital resources and small to medium complexity algorithms, the kit is great. **R-E**

of on-board data memory (DM). Since that is not enough to perform the 128-point FFT and IFFT, two external static RAM's are also attached to the data bus, one for the high byte (IC9), and one for the low byte (IC8) of the memory. That 2×8K bytes of SRAM addressed by the 2105 is accessed when the DATA MEMORY SELECT (DMS) strobe is active.

The seven-segment LED display adds to the interactivity of the VFX processor, and is written to as if it was external program memory. The PROGRAM MEMORY SELECT (PMS) signal from the 2105 is activated to latch data from the bus into IC11 (the seven-segment BCD latch/decoder/driver), which then drives the seven segment display. No decoding is required for the selection of IC11 because there is no external program memory in the system.

The VFX processor uses a CODEC to digitize the audio input and convert it into a serial data stream. The CODEC interfaces directly with the 2105's synchronous serial port SPORT1, which includes pins 52–56. SPORT1 is configured for 8-bit synchronous data transfer with word-framing sync pulses and μ-law companding. The 2105 generates a 1.66-MHz serial clock (SCLK1) and 6.5-kHz framing pulses on TRANSMIT FRAME SYNC (TFS1) and RECEIVE FRAME SYNC (RFS1) to synchronize the data transfer.

The CODEC implements μ-law companding, which improves the dynamic range of the conversion by taking advantage of human perception of sound; that is, that the ear is much more sensitive to noise in low-level (volume) signals than in high-level signals. The CODEC receives and transmits 8 bits of data, and the digital signal processor has built-in companding hardware to convert it into a 14-bit number.

The other components of the VFX processor are the power supply and analog components. The VFX board accepts +9 volts DC and generates −9, +5, +5.1, and −5.1 volts DC. Voltage converter IC7 (a TSC7660)

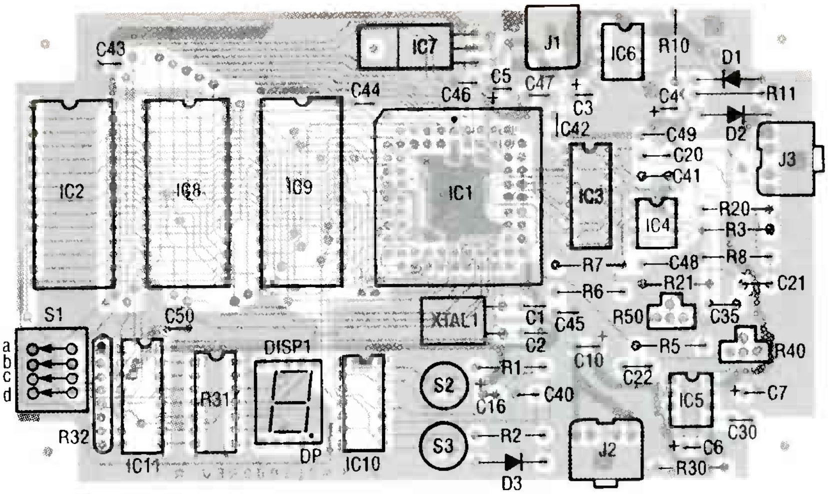


FIG. 8—PARTS-PLACEMENT DIAGRAM. Make sure that you install the mono jack at J1 and the stereo jack at J2.

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted.
R1–R3—120,000 ohms
R4, R9, R12–R19, R22–R29, R33–R39, R41–R49—not used
R5–R8—10,000 ohms
R10, R11—220,000 ohms
R20, R21—1000 ohms
R30—10 ohms
R31—470 ohms (×7), 14-pin DIP
R32—10,000 ohms (×5), 6-pin SIP
R40—10,000 ohms, multiturn potentiometer
R50—200,000 ohms, multiturn potentiometer
Capacitors
C1, C2—20 pF, 100 volts, ceramic
C3–C7—10 µF, 35 volts, electrolytic
C8, C9, C11–C15, C17–C19, C23–C29, C31–C34, C36–C39—not used
C10—220 µF, 25 volts, electrolytic
C16—10 µF, 6.3 volts, Tantalum electrolytic
C20–C22—1 µF, 50 volts, ceramic
C30—0.047 µF, 100 volts, ceramic
C35—47 pF, 100 volts, ceramic
C40–C50—0.1 µF, 100 volts, ceramic
Semiconductors
IC1—ADSP-2105KP40 DSP processor
IC2—27256-25 32K×8 EPROM (256K)
IC3—TP3054J CODEC
IC4—LM741N op-amp
IC5—LM386N-3 audio amplifier
IC6—7660SCPA voltage converter
IC7—7805T 5-volt regulator
IC8, IC9—6264-15 SRAM, 150 ns
IC10—74HC14N hex Schmitt trigger inverter
IC11—CD4511 7-segment decoder/driver
D1, D2—1N5231B 5.1-volt Zener diode
D3—1N4001 diode
DISP1—LTS6780R 7-segment common cathode LED
Other components
XTAL1—10-MHz crystal
S1—4-position DIP switch
S2, S3—momentary pushbutton, N.O.
J1—2mm DC power jack
J2—mini stereo jack
J3—mini mono jack
Miscellaneous: IC sockets, 9-volt DC wall transformer, microphone, headphones, PC board, solder, etc.
Note: The following items are available from American Distributors, Inc., 9 Whippany Road, Whippany, NJ 07981 (800) 877-0510:
- **VFX kit (includes PC board and all PC-mounted components)—$105**

(plated through holes, solder masked and silkscreened)
- **9-volt wall transformer—$12**
- **Headphones—$15**
- **Microphone—$16**

Add $5 shipping and handling. Check, MasterCard, or Visa.

generates the negative supply from the positive supply. A 5-volt DC regulator (IC7, a 7805) supplies +5 volts DC to the 2105 and all logic IC's, and two Zener regulators (D1 and D2) generate the analog voltages of plus and minus 5.1 volts DC. Op-amp IC4 and audio amplifier IC5 condition and amplify the audio input and output, respectively.

Construction

The VFX processor is easy to build. All the necessary components including a double-sided PC board, all IC's, semiconductors, and passive components are available from the source given in the Parts List. A microphone, DC wall outlet transformer, and headphones are also available if you don't already have them. We've provided foil patterns in case you want to make your own PC board.

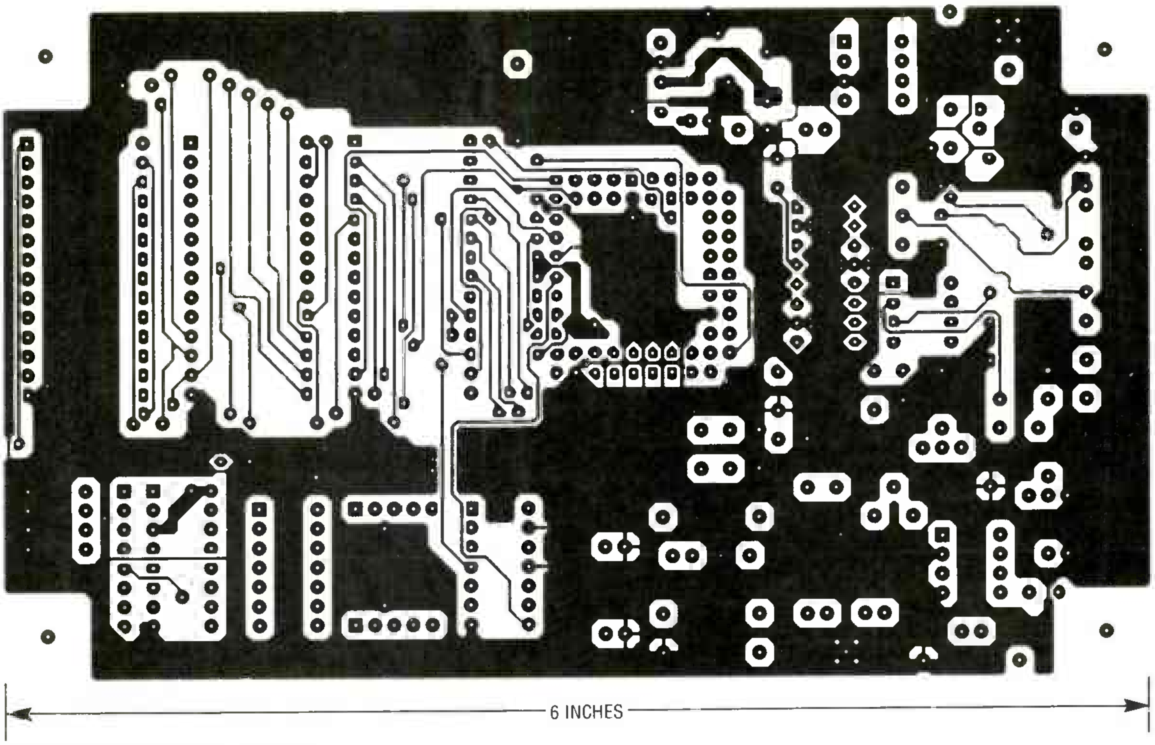
Following Fig. 8 as a guide, mount the components beginning with the resistors. Next install the capacitors, the crystal, switches, jacks, voltage regulator (IC7), and then all of the IC sockets. Make sure you don't install the input and output jacks in the wrong locations. The output jack has three terminals so that if you use headphones you'll hear sound from both sides. Be sure to orient the polarized capacitors correctly. Do not install the IC's yet and don't remove them from their packaging just yet either. When you've completed the soldering, carefully double check parts placement and look for solder splashes and bridging. The completed VFX card is shown in Fig. 9.

Hardware checkout

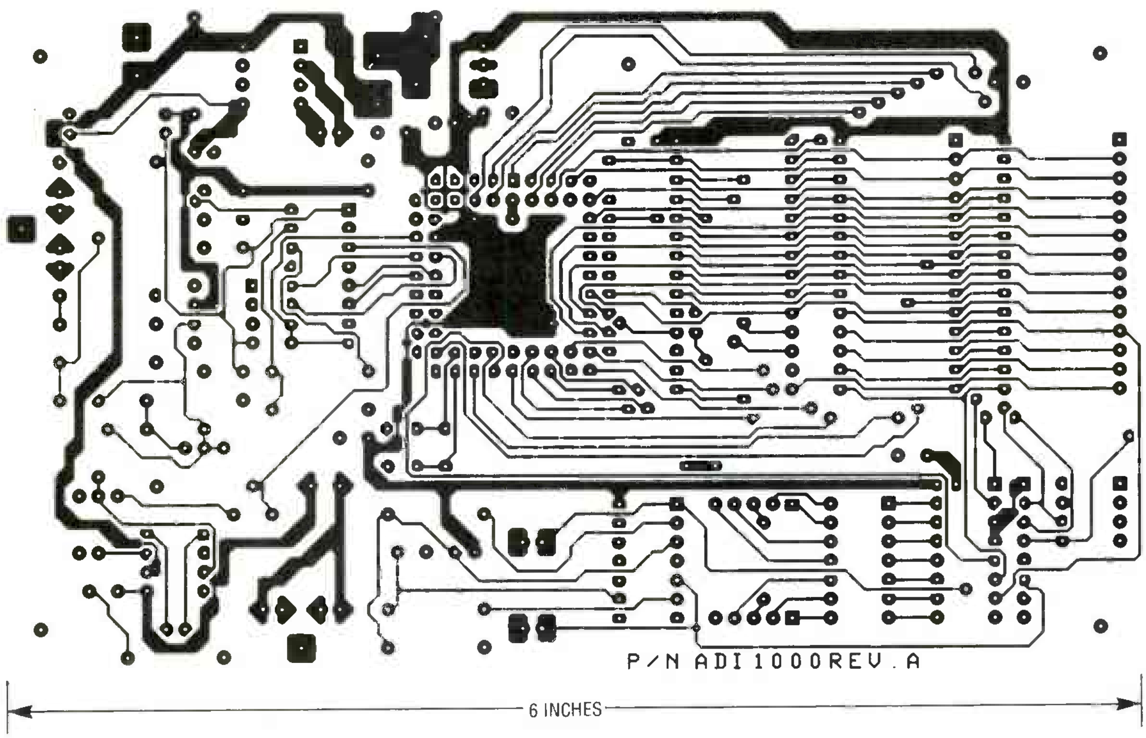
Now we will perform a hardware checkout, one IC at a time. Precautions against static discharge should be followed when handling the IC's. Electrostatic discharge can cause very subtle damage in the IC that can be hard to find—the kind that is

FILTER DESIGN SOFTWARE

The digital filter used in the echo and reverb effect was designed with the filter and digital analysis software (FDAS) from Momentum Data Systems software. The software was used to implement a finite impulse response (FIR) filter. The optional code generator wrote the source code for the filter, given its characteristics. The package also runs on the ADSP-2101 processor and other family members. The FDAS software can also implement other kinds of digital filters than FIR, including infinite impulse response (IIR) and some analog equivalents. **R-E**



COMPONENT SIDE of the VFX board.



SOLDER SIDE of the VFX board.

worth avoiding.

First apply 9-volt DC power to J1 and verify that there is 5 volts on the power pins of each IC socket. When verified, remove power from the board and plug in IC6, the negative-supply generator. Now reapply 9-volts DC to J1 and measure pin 5 of IC6; the voltage should be the negative of the voltage on IC6 pin 8 or −12 volts (whichever is less).

Next, check pins 1 and 4 of IC3 for −5 volts ± 0.2 volt and +5.0 ± 0.2 volt, respectively. Install IC1, IC2, IC10, and IC11 in their respective sockets. For the RAM test, set all the S1 DIP switches to the "on" position and apply power to the board. The LED display should show the number "6." Press the SHIFT

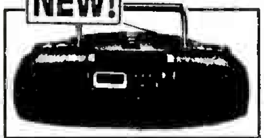
continued on page 94

47st. Photo®

The latest in electronics is only a phone call away! 1-800-221-7774

In N.Y. or if busy call: 1-718-722-4750. Please mention code ES892.

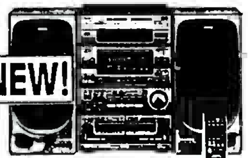
NEW!



AIWA CSD-EX1
PORTABLE LCD RADIO CASSETTE CD PLAYER
- High power output
- Power saving switch plus auto stop
- 20-selection random programmable memory CD
- AM wide/FM stereo tuner

(AIW-427)
Sugg. Retail $179.95 — Our Price $139^95

NEW!



AIWA NSX-330
30W/ch HI-FI MINI COMPONENT SYSTEM WITH SURROUND SOUND
- Super T-bass

Includes:
- 3-preset graphic equalizer
- 5-band spectrum analyzer
- Wireless remote
- FM/AM tuner with 32-station random preset
- Dual auto reverse cass. w/Dolby B NR
- Optical digital output terminal
- 3-way speaker

(AIW-424)
Sugg. Retail $560.00 — Our Price $399^95

NEW!

AIWA XP-7
PORTABLE CD PLAYER WITH IN CAR USE
- 1-bit dual D/A converter
- 8-times oversampling digital filter
- Optical digital output terminal
- 24-random programmable memory
- Heat-resistant for in car use
- Random play with 3-way repeat

Includes: Rechargeable battery BP-50, stereo headphones with remote control, AC adaptor recharger, and connection cord.
(AIW-420)
Sugg. Retail $280.00 — Our Price $249^95

BONUS! Free case with purchase of E-63 *$59 Value!*

CANON E-63
8mm CAMCORDER WITH 8:1 POWER ZOOM
- High speed shutter
- 180° FlexiGrip
- 2-lux low light
- Sports finder
- Wireless Remote

(CAN-6300)
Super Value!

NEW!

PANASONIC RQ-S35V
AM/FM STEREO CASSETTE PLAYER WITH AUTO REVERSE
- Ultra compact size
- Digital synthesizer tuner with 7AM/7FM presets
- S-XBS & Dolby NR
- LCD tpae/radio display
- Dual clock/alarm functions
- One button wired remote

Includes: Rechargeble battery and charger.
(PAN-2754)
Sugg. Retail $209.95 — Our Price $169^95

SONY WM-WX50
WALKMAN® STEREO CASSETTE PLAYER

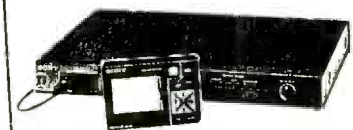
NEW!

WIRELESS HEADSET!
- Broadcasts up to 9 ft.
- Auto reverse Mega Bass 2x sound system with variable control
- Dolby NR

(SON-3483)
Sugg. Retail $249.95 — Our Price $179^95

SHARP IQ-8400
ELECTRONIC ORGANIZER
- 256 KB memory
- Typewriter style keyboard
- Hi-contrast 40 char. by 8 line screen
- Month/week & day calendar
- 3 phone directories
- Business Card function

(SHA-8400)
Sugg. Retail $499.95 — Our Price $319^95

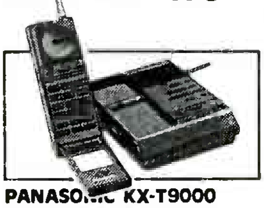


SONY XVT-600
ADD PRO STYLE SUPERIMPOSED TITLES TO YOUR VIDEOS!
- 15 color picture computer superimposes picture title or background to video
- Draw lines, add color— endless possibilities!

(SON-409)
Sugg. Retail $600 — *SALE!* $109^95

PANASONIC KX-T4300
CORDLESSPHONE WITH ANSWERING MACHINE
- 10 channel access • Rubber antenna
- Tone/pulse • 2-way paging
- 10-number speed dial • Message alert
- LED readout
- 11-function tone remote
- Auto logic operation.

(PAN-4300)
Sugg. Retail $199.95 — Our Price $159^95



PANASONIC KX-T9000
900Mhz POCKET-SIZED FOLDING CORDLESSPHONE
- Operates on 902/928Mhz
- Sound Charger technology
- 30ch auto scan • Auto intercom
- 2 interchangeable batteries
- 2-way paging & auto intercom
- 10, 20 digit no. auto dial
- Handset Auto switch to 'talk' mode

(PAN-9000)
Sugg. Retail $499.95 — $399^95

NEW!

CASIO BP-100
BLOOD PRESSURE MONITOR WATCH
- Water resistant to 50 meter
- 12/24-hour formats
- 3 multi-function alarms
- Altimeter, Depth meter & Barometer
- Countdown alarm
- 1/100 stopwatch

(CAS-826)
Sugg. Retail $169.95 — Our Price $129^95

PANASONIC CTP-2066S
20" STEREO MONITOR-RECEIVER WITH S-VHS INPUT (Over 500 lines horizontal resolution)
- Audio/Video Input Jacks
- Unified TV/VCR remote
- Clock, Sleep-timer & on-timer

(PAN-2796)
Sugg. Retail $499.95 — *SALE!* $357^95

- Cameras
- Darkroom Supplies
- Video Equipment
- Televisions
- Hi-Fi Stereo Equipment
- Portable/Personal Audio
- Telephones
- Cellular Phones
- Computer Equipment
- Business Machines
- Calculators/Organizers
- Electronic Games
- Watches/Sunglasses
- Small Home Appliances
- Jewelry

Mail Order Dept.:
455 Smith Street, Brooklyn, N.Y. 11231

ES AUG. 92

Visit our superstores at:

67 West 47th Street — Bet. 5th & 6th, NYC CA. LIC. #800189-691860
115 West 45th Street — Bet. 6th & B'way, NYC CA. LIC. #800191-811628

1-212-921-1287

Sun. 10:00-5:00, Mon.-Thurs. 9:30-6:00, *Fri. 9:30-2:00,* Closed Saturday

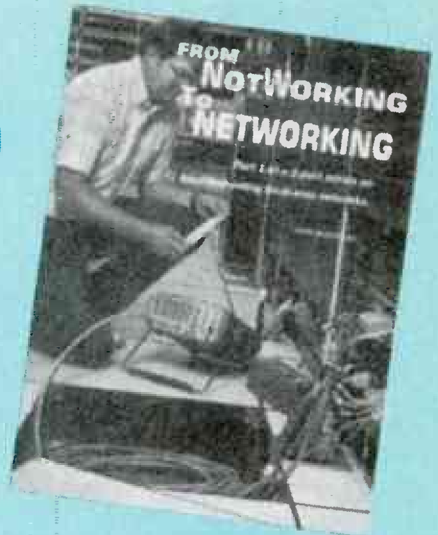
A New York Landmark for over 26 years!

Toll-free line is open SUN. 10-5, DAILY 8-7, FRI. 8-2

Local lines are open SUN. 10-5, DAILY 9:30-6, FRI. 9:30-2

OVERNIGHT DELIVERY to any point in the continental USA AVAILABLE at additional cost

FROM NotWorking To NETWORKING



Learn about basic and advanced equipment for troubleshooting LAN's.

GARY McCLELLAN

THIS IS PART 2 OF A THREE-PART SEries on troubleshooting local-area networks (LAN's). In Part 1 we presented technical background on network technologies including cable types, topologies, signal schemes, and access protocols. This time we introduce the tools and test equipment necessary to service LAN's quickly and effectively. Next time we'll put our knowledge to work in diagnosing and solving easy and difficult network problems.

Experts say that cable faults cause more than 70% of all network failures. Cable faults may sound simple in theory but, in practice, diagnosing and locating them can bring strong men to tears. However, common sense, good test equipment, and intelligent substitution techniques can take you a long way toward rapid, inexpensive repair.

Common sense helps you localize the problem to avoid wasting time performing irrelevant tests. Good test instruments are your eyes and ears into the LAN; equipment can be as simple as a $20 digital multimeter (DMM) or as complex as a time-domain reflectometer (TDR) costing thousands of dollars. (A TDR uses radar-like techniques to measure the distance to a cable fault. Typically a test instrument transmits a signal and measures the time it takes for its reflection to return to the source.)

Gone are the days of mindlessly swapping computers, boards, and cables. Instead we use intelligent swapping to localize a problem, and then use appropriate test equipment to find the suspect part. Next we install a substitute, and if the LAN comes to life, that part remains. Otherwise, we will repeat the process until the fault disappears and the LAN comes on-line.

Some training firms claim that only a screwdriver is required to service a LAN. We won't go that far—but with the techniques discussed here, we'll come close.

Hand tools

Common hand tools are useful in servicing LAN's. Table 1 describes the basic requirements; you'll probably add other, more specialized tools to the list as time goes on.

One quick and easy way to get the tools you need is to buy a Jensen tool kit. For example, the reasonably priced JTK-5 tool kit contains all the essentials for servicing Ethernet LAN's. Also check with Jensen for tools and tool kits suitable for twisted-pair and Token Ring LAN's.

Probably the most common problem in LAN service is connectors. Sooner or later, you'll have to replace a bad one. The best way to learn the proper techniques is to work with someone already skilled in the art. Failing that, there are other resources. Try a local electronic parts distributor for manufacturer's literature on connector installation. Or locate a copy of the *Radio Amateur's Handbook*, published by the American Radio Relay League. The Construction Practices chapter of that handbook describes the proper way to install BNC-type coaxial connectors. You might also contact AMP and other manufacturers to request assembly information on their crimp-on coax and RJ-xx series connectors. The sidebar lists several sources of information.

The DMM

No service technician in his right mind would be caught dead without a DMM; it is literally indispensable. You can use it to service LAN's, and also to check building AC-line power and repair electronic equipment of all types. DMM's are available with a dazzling variety of features. If you are shopping for a DMM, choose a 3½-digit unit, like the one shown in Fig. 1, that is easy to use, has the features you really need, and has a low price. Minimum LAN-specific requirements for a DMM include a 0 to 200 ohms range, a continuity beeper, a 0

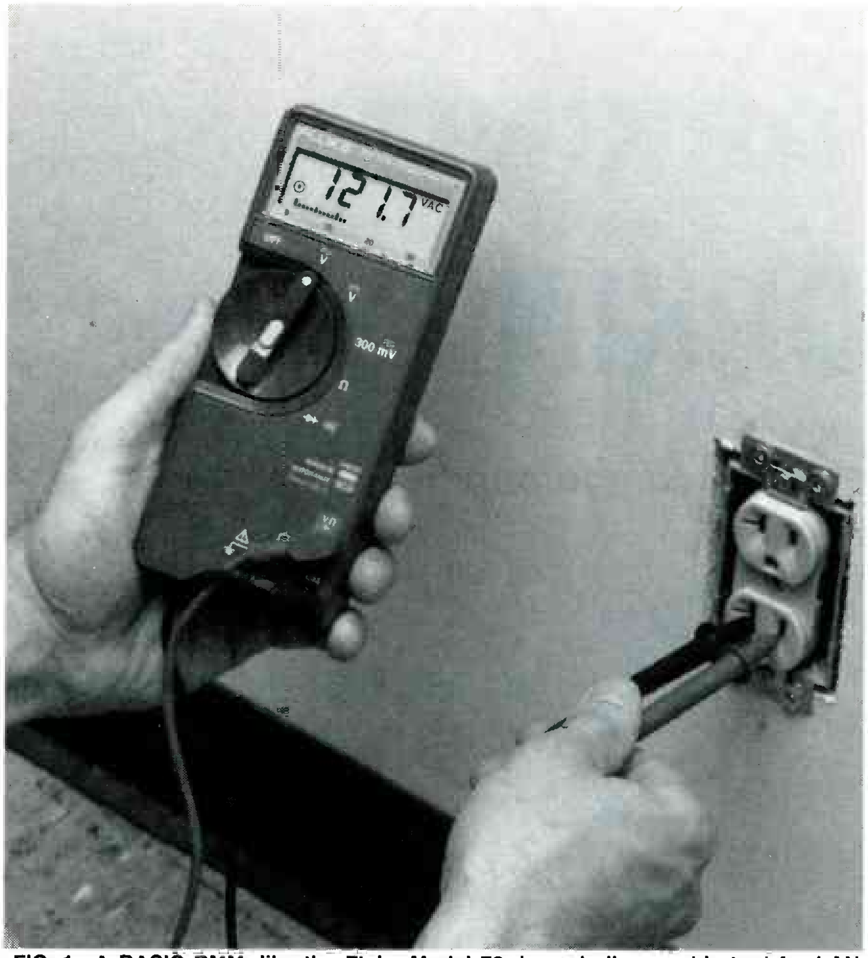


FIG. 1—A BASIC DMM, like the Fluke Model 70, is an indispensable tool for LAN troubleshooting.

to 20-volts DC range, and a 0 to 200-volts AC range. Most DMM's sold today meet those minimum specifications.

Let's discuss briefly how you can use a DMM for LAN servicing. Resistance and continuity are probably the most used functions in LAN servicing. Use the ohms function to measure the resistance of cables and terminator resistors, and to locate shorts or opens in cables and connectors. A low-end range of 0 to 200 ohms is important because coaxial cables typically measure less than 5.0 ohms end-to-end, and twisted pair less than 20.0 ohms. To make this type of measurement, first power down the network to avoid affecting LAN operation. Disconnect questionable cables before making measurements.

High-resistance cables can have partially severed wires or bad connectors. Test all terminators (connector bodies containing 50-, 91-, or 100-ohm resistors) to ensure proper resistance. Use the continuity function to locate shorts and opens in cables and connectors. Audible beeps are especially useful when working in dark or tight places like plenums (dropped ceilings).

The DC function is useful as well. Ethernet LAN's carry 5-volt power and data to the transceivers attached to the backbone cable. Use the DMM to verify that power is present at the transceiver if it does not have a Power Good indicator. You can also use the DC volts function to verify voltages in emergency lights and uninterruptable power supplies (UPS's).

Last but not least, use the AC volts function to measure AC power outlets and noise levels on the LAN cables. It is not uncommon for power problems to cause trouble on a LAN, particularly when the file server or hub computer is affected. Then the whole network may crash. Just check the outlet voltage with a DMM, and if it is outside the 105 to 125-volt AC operating range of most computers, call an electrician!

Noise problems can be a big headache, especially on LAN's with unshielded twisted-pair (UTP) cable. Noise causes random data errors and, in serious cases, can crash the network. Measure noise with a DMM by connecting it to one end of the cable, making sure the other and is terminated properly. The DMM reading for a good UTP cable can be in the range of 5 millivolts or less. A high reading can uncover unusual faults such as a coil of excess cable or cable routed too close to EMI sources such as fluorescent lighting fixtures. In fact, the author once determined that a 50-foot coil of excess UTP left on top of a light fixture by an installer was causing intermittent problems on a newly installed LAN. The problem drove everyone crazy for months! Using a DMM as a noise meter has limited utility because DMM's measure voltage in the kHz range, not in the 4 to 16-MHz range typical of most networks protocols.

Worse, DMM's don't measure impulse noise, which is especially disruptive to LAN operation. For that type of measurement, we must go to more specialized equipment such as that described in the following sections.

Microtest cable scanner

Microtest was the first company to provide specialized, all-in-one LAN test equipment such as the Microtest Cable Scanner. This handheld instrument contains everything you need to troubleshoot LAN cables, including ohmmeter, noise meter, time domain reflectometer (TDR), Ethernet activity monitor, and cable tracer. Best of all, the Cable Scanner is reasonably priced and readily available. Figure 2 shows the Cable Scanner and several other similar models.

Although optimized for Ethernet LAN's, the Cable Scanner also tests unshielded twisted

FIG. 2—MICROTEST'S HANDHELD LAN TESTERS combine most-needed features in easy-to-use, hand-held packages. Clockwise from upper left are the Cable Scanner, the Ring Scanner, the Pair Scanner, and the Quick Scanner.

pair (UTP), shielded twisted pair (STP), Token Ring, and RS-232 cables with simple adapters. In addition, Microtest offers specialized scanners specifically for testing unique features of other cable.

Key features of the Cable Scanner include resistance and continuity functions, a basic noise meter, and a TDR. The noise meter is a simple AC voltmeter that reads millivolt noise in the 1-kHz range; it has no capability for measuring impulse noise. Due to the shielding nature of coaxial cable, noise problems are less common in Ethernet systems—but they do happen. The Cable Scanner is adept at sensing 60-Hz power-line noise that often appears in problematic coaxial cable systems.

The TDR function can locate shorts and opens in LAN cables. Operating it is as simple as pushing a button. The device then injects pulses into the cable where they travel until they strike a fault, and subsequently bounce back to the instrument. The Cable Scanner measures the travel time, calculates distance to the fault, and then displays the distance. All you have to do is inspect the cable at that distance and repair the fault.

Remember that for a TDR to work properly, all equipment must be turned off. Otherwise, data on the line could cause false distance readings—not to mention what it would do to on-line computers! You should also know that all TDR's have a blind spot, or dead zone, from where the instrument connects to some distance down the cable. The Cable Scanner cannot detect faults occurring within the first 25 feet of cable. If you suspect a fault in that section, inspect the cable manually, or make another measurement from the other end of the cable.

The Cable Scanner's Ethernet activity monitor is useful for spotting bad transceivers and other cases of network overload. Recall from Part 1 of this series that Ethernet works on a first-come, first-served basis, somewhat like an old-fashioned telephone party line. Whoever speaks first gets the line. Should something go wrong—for example, a transceiver that "jabbers" or talks all the time—traffic could soar to 100% usage. That, in turn, would prevent other computers on the network from exchanging data because their collision sense multiple access (CSMA) circuitry would force them to wait continually. The result is that LAN operation would come to a grinding halt.

The activity monitor counts the number of data packets (messages) sent between computers on the network over a set time period (for example, one second or one minute). Then it calculates percent usage. You then look up that value on a chart to determine whether there are problems. If so, you must troubleshoot to locate the cause of the fault.

The Cable Scanner also has an optional cable tracer that allows you to trace a specific cable as it runs through the building alongside others. This is a handy feature because LAN cables look alike, making it easy to waste time tracing the wrong cable. To operate the cable tracer, you must also purchase a cigarette-pack-size receiver. In operation, the Cable Scanner sends a special signal over the cable under test. Then you hold the receiver next to each cable in turn; the one that produces a warble tone is the one you want.

Microtest also sells more specialized instruments for testing other kinds of cables. For UTP/STP cables there is the Pair Scanner, which addresses major twisted-pair concerns including impulse noise and signal loss through the cable. The Pair Scanner also has switching capabilities for selecting different transmit/receive pairs, as well as a hub computer test function. For Token Ring cabling there is the Ring Scanner, which isolates faulty multistation access units (MAU's), determines whether the ring maintains continuity, and monitors network traffic. Interestingly, it can simulate network faults, so you can perform "fire drills" on a good LAN and get a feel for symptoms before they occur. All Microtest products provide a serial output for logging data or printing hard copy reports.

Paladin Patch Check

Growing popularity of UTP-based LAN's has created a market for special test tools. One good example is a simple, low-cost cable tester from Paladin Corporation called Patch Check. Patch Check, shown in Fig. 3, identifies the most common faults in UTP systems, namely bad connectors, shorts, and opens.

Patch Check tests the full range of UTP systems, from single- to four-pair cables terminated in RJ-11 or RJ-45 connectors. Operation is simply a matter of snapping both ends of the cable into the unit, pushing the Test button, and watching the indicators. Bad connections or opens appear as one or more unilluminated LED's; shorts appear as multiple simultaneously lit indicators. Paladin also offers a remote indicator for situations where you can't get at both ends of the cable.

Patch Check can save lots of time. For example, in resolving one problem described in Part 3 of this series, the author checked a cable with Patch Check in ten seconds, vs. five minutes on a DMM!

FIG. 3—PALADIN'S PATCH CHECK provides instant go/no-go testing of RJ-11 and RJ-45 telephone-style connectors, used for shielded and unshielded twisted-pair wiring.

Tektronix 1502C TDR

Of all the equipment discussed in these articles, the Tektronix 1502C TDR is oldest and best established. For finding tough problems it can't be beat. It can identify badly crimped connectors, crushed coaxial cables, wiring chewed by rodents, and more. It is sensitive enough to locate problems to within inches on the cable. The 1502C is a state-of-the-art version of a line of analog TDR's that goes back several decades.

The 1502C looks much like a benchtop oscilloscope, as shown in Fig. 4. However, instead of the usual cathode ray tube (CRT), the 1502C has a liquid crystal display (LCD) to reduce power consumption and weight. A removable reticle fits over the display, which shows cable impedance vs. distance. The operating controls are simple, and there are less of them than on an oscilloscope. An excellent operator's manual helps new or infrequent users operate the device.

Key features of the 1502C include a negative-going output pulse, which shuts down live Ethernet transceivers, and a *zoom* feature that allows you to examine tiny faults which show up as impedance spikes on the display. Zoom helps you find problems like rusty connectors or bad crimps. In Part III we will show how we found an unauthorized cable tap using these features.

One important feature is the propagation-rate control. It's important because it determines the distance accuracy of the TDR. As you might recall from physics class, electrons travel at the speed of light in a vacuum. But in the real world of copper cabling, signals travel much slower. The speed reduction is due to insulation quality and conductor diameter. The propagation-rate control calibrates the equipment to compensate for the slower conduction in the cable, thereby providing correct distance indications.

RESOURCES

Following are addresses of manufacturers whose products were discussed in this article. Contact them for current pricing and more information.

- **Paladin Corporation, 3543 Old Conejo Rd., Newbury Park, CA 92123, (800) 272-8665.**
- **Jensen Tools, Inc., 7815 S. 46th Street, Phoenix, AZ, 85044, (602) 968-6231.**
- **MicroTest, Inc., 3519 E. Shea Blvd. Suite 134, Phoenix, AZ 85028, (800) 526-9675.**
- *Radio Amateur's Handbook,* **American Radio Relay League, Newington, CT 06111.**
- **Tektronix, Inc., Redmond Division, 625 S. E. Salmon Dr., Redmond, OR 97756, (800) 833-9200.**
- **AMP, Inc., P.O. Box 3608, Harrisburg, PA 17105, (717) 561-6168.**

Typically you set the propagation rate by consulting a chart published by the cable manufacturer or LAN equipment vendor. Values are usually expressed as a percentage of the speed of light, c. The higher the percentage, the faster the signals travel through the cable. Typical Ethernet backbone cable has a propagation rate of 0.76c. Some sources refer to propagation rate as the numer-

FIG. 4—TEKTRONIX' 1502C TIME DOMAIN REFLECTOMETER provides analog display of distance versus impedance. A knowledgeable technician can interpret the display to locate subtle LAN cable faults.

ical value of propagation (NVP) or velocity factor (VF). The terms all mean the same thing. Regardless of name, it is important to set the propagation rate control of your TDR if you want it to display meaningful, accurate readings.

Operating the 1502C is straightforward. You begin by powering down the LAN equipment on the questionable cable segment and removing any terminator resistors. (Terminators can trick a TDR into displaying fantastic cable lengths.) Then connect the TDR to the cable through an impedance adapter, install the correct display reticle, and apply power. Then adjust the controls, and you'll receive a visual indication of cable quality.

Tektronix makes several other TDR's. The 1503C analog TDR accommodates cables as long as 50,000 feet, and has an Ethernet option. The 1503C looks like a good choice for cable TV or aircraft carrier applications. Tektronix also makes the TMA-802, a moderately priced digital TDR and Ethernet activity monitor.

Analog vs. digital

In this article, we have described two types of TDR's: digital (Microtest) and analog (Tektronix). Each type of TDR has its own advantages and disadvantages; both instruments are widely used in LAN servicing.

The major differences between the two are in information display and sensitivity to minor faults. Push a button on a digital TDR, and you'll read something like *Short 40 Ft* on the display. Digital TDR's are great for novice users because they make it easy to understand results. Their drawback, however, is that they report only major faults, missing minor ones that often cause the most frustrating problems.

Turn on an analog TDR and you'll see a oscilloscope-style wavy line over a black reticle calibrated in impedance vs. distance. Clearly the analog TDR is intended for more experienced users who can disregard the dead zone, interpret impedance changes, and read distance from the reticle. Analog TDR's also have an amazing sensitivity to rusty contacts in connectors, water-logged cables, and other faults that can go undetected with less-sensitive instruments.

Network certification

Another issue is network certification, which is becoming increasingly important as corporations continue the downsizing trend. Downsizing involves using networks of PC's to perform mission-critical applications formerly run on mainframes. *Mission-critical* means that the health and competitiveness of the company depend critically on the computer systems that support the company. Without a reliable network, workers can't do their jobs, so goods and services are delivered to customers late. If customer dissatisfaction increases, the company suffers, and so do jobs. Clearly, we all have a vested interest in keeping our LAN networks running reliably.

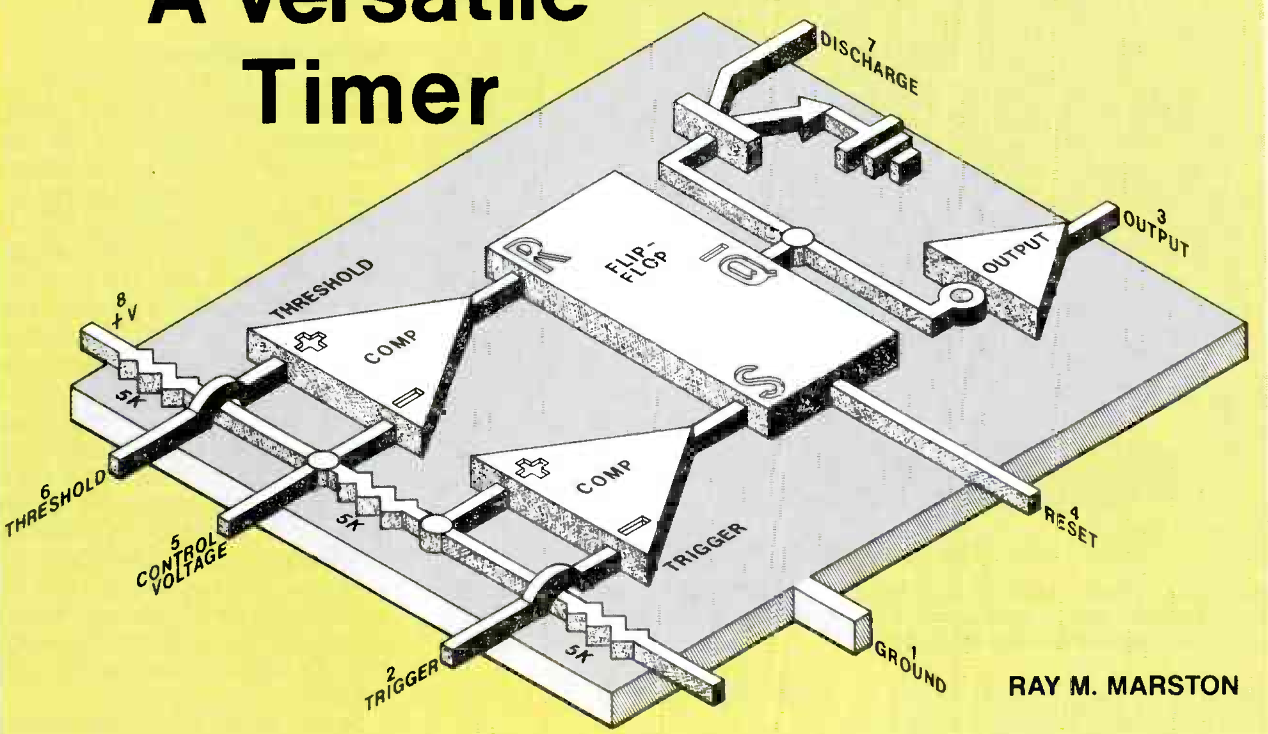
In the past, LAN cables were often pulled by electrical or telephone wiring contractors who might not have had proper tools and expertise. As a result, Ethernet cables may exceed recommended lengths, excess UTP cable may be left coiled in plenums over fluorescent fixtures, and so on. Those problems decrease LAN performance and, even worse, can serve to reduce reliability.

In response, major LAN vendors have devised performance tests to help ensure that LAN's meet standards for noise level, cable length, attenuation, and other factors that affect performance and robustness.

Without thinking out the problem the fanciest TDR in the world will be useless. Develop your ability to identify a problem and logically work your way through possible causes until it is solved.

Be sure to join us in Part III when we will roll up our sleeves and troubleshoot actual LAN's with the equipment and tools described here. **R-E**

The 555 A Versatile Timer



RAY M. MARSTON

FIG. 1—FUNCTIONAL BLOCKS OF THE 555 TIMER with its pinout identified.

Learn to use the 555 and 556 timer IC in practical circuits to obtain accurate time delays and square waves

IN ANY ASSOCIATION TEST FOR those who know integrated circuits, the three digits 555 will summon up the instant response "timer IC." It's the short form generic designation for progeny of the NE555, a popular monolithic timer/oscillator IC first introduced by Signetics many years ago. Still widely second-sourced because of its versatility, the 555 ranks as a standard "building block."

The 555 and its derivatives can be found in thousands of different circuits, and its possibilities for further applications appear limitless. Although classed as a linear IC, it is often used in digital or "quasi-digital" applications because its inputs and outputs are essentially square waves rather than sine or other complex waveforms. This article explains how the 555 works and shows you how to apply the IC in various practical control circuits.

A 555/556 overview

Figure 1 is a simplified block diagram of the 555 showing its principal functional blocks: threshold comparator, trigger comparator, R-S flip-flop, low-power complementary output stage, slave discharge transistor, and a voltage-reference potential divider. Both halves of a dual version of the 555 (two 555's on a single chip), the 556, have identical electrical characteristics. The 555/556 will run from 4.5 to 16 volts DC, although a typical supply will be +12 volts DC or less.

The outstanding features of the 555/556 include:

- Timing adjustable from microseconds to hours
- Duty cycle adjustable
- Ability of output to source (supply) or sink (dissipate) 200-milliampere current
- Output can drive TTL logic circuits
- Temperature stability exceeds 0.005%/°C
- Normally "on" and normally "off" output

The 555 and 556 were designed for precision timing applications, with the timing interval controlled by an external resistor and capacitor (RC) network. The devices contain voltage dividers consisting of three 5000-ohm resistors in series between the supply voltage and ground so that one-third of the supply voltage is developed across each resistor. The internal flip-flop circuit provides a definite "on" or "off" response. Its timing intervals are independent of the supply voltage.

The 555 has two basic operating modes: *monostable* (one-shot—a single pulse is emitted), and *astable* (a stream of output pulses is generated). In the monostable mode when functioning as timers, time is precisely controlled by the external RC network. In that mode the 555 produces output pulses with rise and fall times measured in microseconds.

In the astable mode, the 555 can be an oscillator. It can maintain an accurately controlled free-running frequency and duty cycle with only two external resistors and one capacitor. In either monostable or astable modes, timing accuracy is essentially independent of variations in supply voltage or ambient temperature. The device can be triggered and reset on falling waveforms.

Typical applications for the 555 include precision and sequential timing, pulse generation, pulse-width and pulse-position modulation, and linear ramp generation. Moreover, it can directly drive loads such as relays, solenoids, low-power lamps, and high-impedance speakers.

The 555 is packaged in plastic and metal DIP's and 8-pin metal cans for operation in the commercial temperature range of 0 °C to +70°C. Some plastic DIPs can operate in the –40°C to +85°C extended temperature range.

Alternate-sourced 555's can usually be identified by the inclusion of the numbers 55 or 555 in their designations. Examples include Harris' CA555, Motorola's MC1455, and National Semiconductors' LM555C. Other sources include Exar, Goldstar, Raytheon, Samsung, SGS-Thomson, and Sharp Electronics. CMOS versions of the 555, such as Texas Instruments' TLC555 are also available. In addition to their low power consumption compared to standard 555's, their outputs are compatible with CMOS as well as TTL.

Table 1 presents some basic electrical characteristics for the 555. The 556 is housed in a 14-pin DIP package but the block diagram of each circuit is identical to that of the 555 shown in Fig. 1. The 556 is also alternate-sourced by many of the same firms that offer the 555. Examples are Motorola's MC3556 and Texas Instruments' TLC7556.

How the 555 works.

Figure 2 is a representative circuit schematic for the 555. It contains 21 transistors, 4 diodes, and 15 resistors. The voltage divider consisting of three 5000-ohm resistors (shown in Fig. 1) appears to the right of Q10 in the trigger comparator. It applies one-third of the supply voltage to the non-inverting input terminal of the trigger comparator and two-thirds of the supply voltage to the inverting input of the IC's threshold comparator.

The output of the two comparators controls the R-S flip-flop, which in turn controls the states of the complementary output stage and the slave transistor Q6. The flip-flop's state can also be set by signals at RESET pin 4.

When organized as a monostable timer, the TRIGGER pin 2 is held high by external resistor R_T in series with the DC supply voltage. Under that condition, Q6 is saturated, shorting external timing capacitor C_D to ground, and OUTPUT pin 3 is driven low. Timer action is started by applying a negative-going trigger pulse to pin 2. As this pulse falls below one-third of the DC supply voltage, the output of the trigger comparator changes state. That causes the R-S flip-flop to switch, turning Q6 off, and driving OUTPUT pin 3 high.

As Q6 turns off, the short is removed from the external capacitor C_D. The capacitor charges through the external resistor R_D until the voltage across C_D rises to two-thirds of the supply voltage. Then the threshold comparator changes state and switches the R-S flip-flop back to its original state, turning Q6 "on" and rapidly discharging C_D. At the same time, OUTPUT pin 3 reverts to its low state. The *timing cycle* is then complete.

A characteristic of the 555 is that, once triggered, it cannot respond to additional triggering until the timing sequence is complete. However, the sequence can be aborted at any time by feeding a negative-going pulse to RESET pin 4.

The output pulse is a square wave whose duration (time delay) depends on the values of R and C. The formula for this is: t_D (time delay) = 1.1 (value of R × value of C)

Simply stated, time delay is directly proportional to the

TABLE 1—ELECTRICAL CHARACTERISTICS

Characteristics	Symbol	Min.	Typ.	Max.	Unit
DC Supply Voltage	V_{CC}	4.5	—	16	V
DC Supply Current (V+ = 5V)	I_{CC}	—	3	6	mA
(V+ = 5V)		—	10	15	mA
Power Dissipation		—	—	600	mW
Threshold Voltage	V_{th}	—	⅔	—	V
Trigger Voltage (V+ = 5V)	V_T	—	1.67	—	V
(V+ = 15V)		—	5	—	V
Reset Voltage	V_R	0.4	0.7	1.0	V
Reset Current	I_R	—	0.1	—	mA
Timing Error (Monostable)		—	1	—	%
Frequency Drift with Temperature		—	50	—	ppm/°C
Drift with Supply Voltage		—	0.1	—	%/V
Output Rise Time	t_r	—	100	—	ns
Output Fall Time	t_f	—	100	—	ns

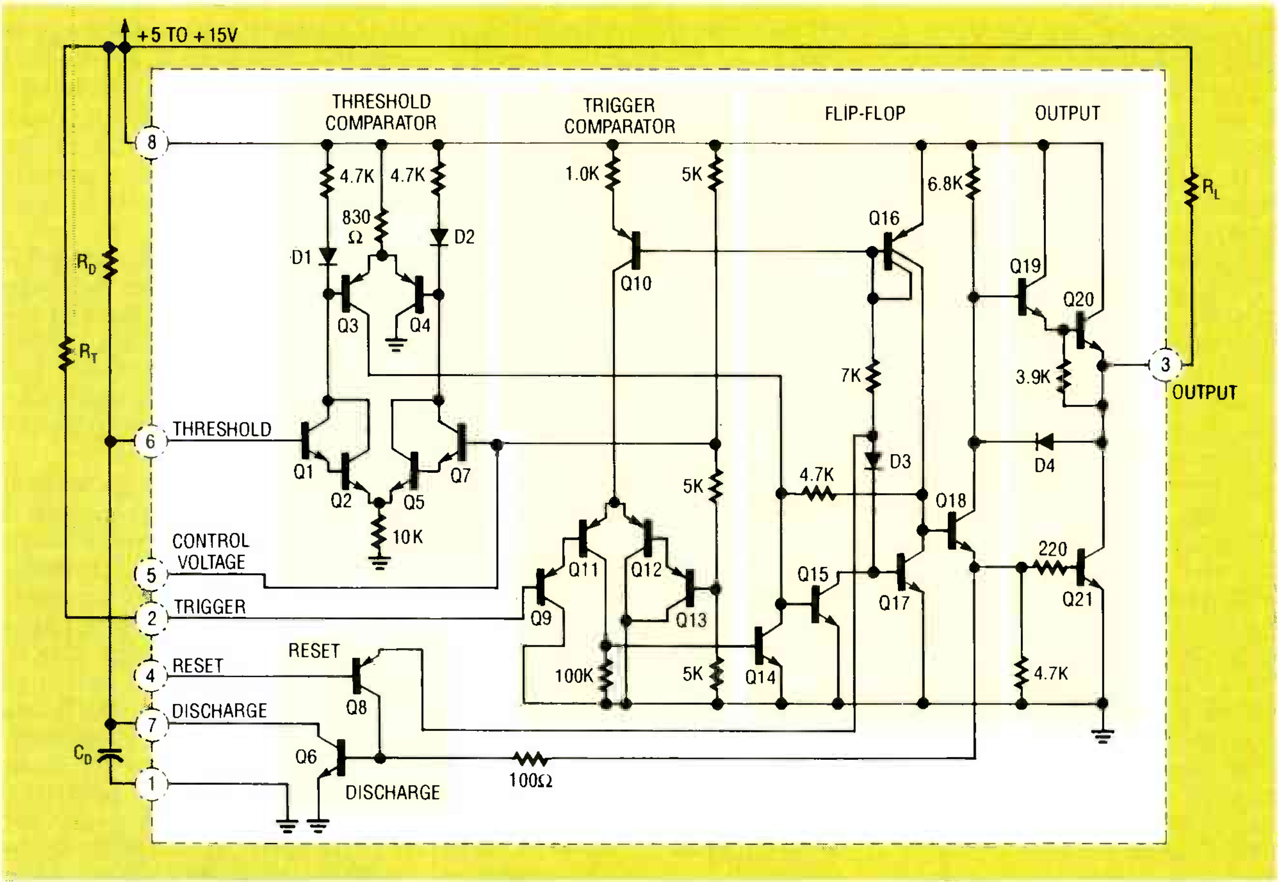


FIG. 2—REPRESENTATIVE CIRCUIT SCHEMATIC FOR A 555 timer with external resistive and capacitive components.

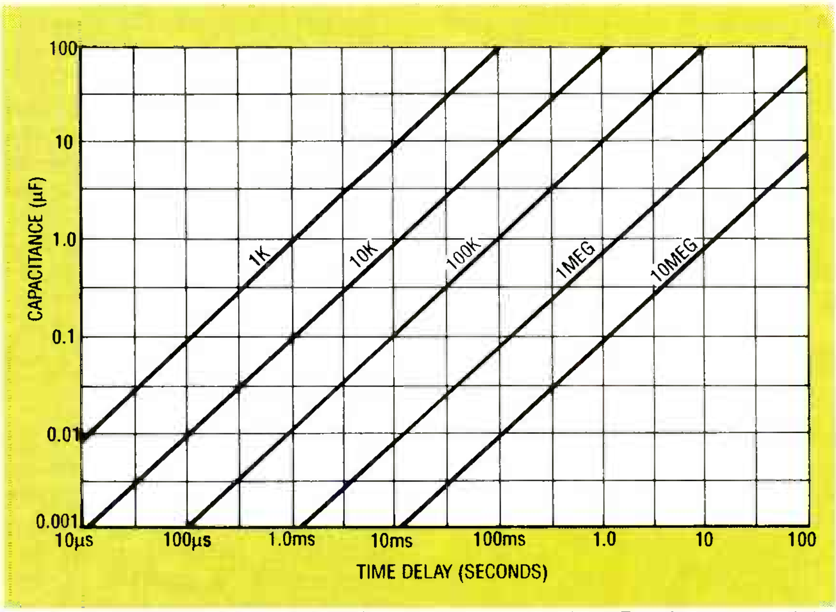


FIG. 3—COMBINATIONS OF RESISTANCE AND CAPACITANCE yield a range of time delays. The trigger pulse width must be less than the timing period.

product of R and C. Figure 3 is a plot of time delay vs. resistance and capacitance based upon the time-delay formula where t_D is in milliseconds, R is in thousands of ohms, and C is in microfarads. Figure 3 gives a family of time delay curves with variations in R_T and C_T. Delays from 10 microseconds to 100 seconds can be obtained by selecting suitable values of low-leakage capacitors from 0.001 μF to 100 μF and resistors from 1 thousand ohms to 10 megohms.

Figure 4-*a* is a simple fixed-period (approximately 50-second) manually-triggered time delay circuit, and Fig. 4-*b* shows the waveforms as they would appear on an oscilloscope. The sequence of events in Fig. 4-*b* is initiated by grounding TRIGGER pin 2 with momentary START switch S1. The CONTROL VOLTAGE pin 5 is decoupled by C2, and the output state can be determined by observing whether LED1 is illuminated or not. A square output pulse (whose fixed-period is determined by R1 and C1) appears at OUTPUT pin 3, while an exponential sawtooth (with the same period as the square wave) appears at DISCHARGE pin 7.

The fixed-period output of the circuit in Fig. 4 can vary from 1.1 to 120 seconds by making the changes shown in Fig. 5. Resistor R1 is replaced with a 10K fixed resistor and 1-megohm potentiometer R5 in series, as shown. A reset feature can be added by installing RESET switch S2, permitting

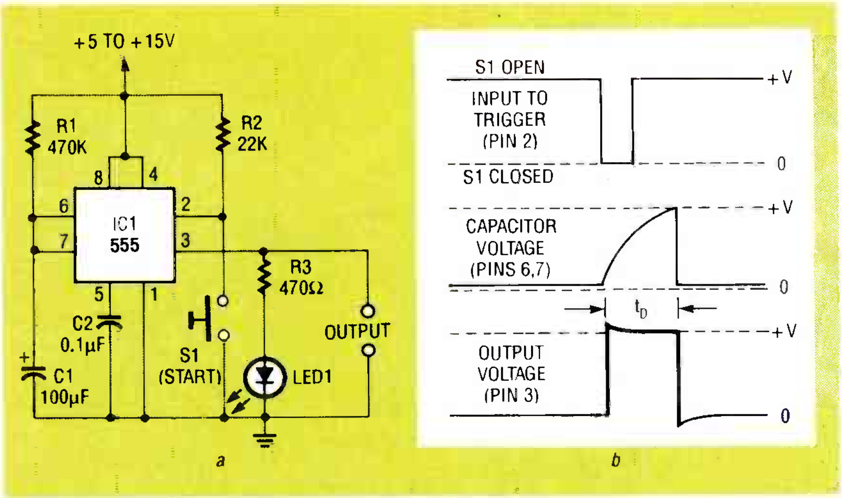


FIG. 4—FIXED-PERIOD TIMER produces a 50-second time delay (*a*). The waveforms at three pins are shown (*b* + *a*).

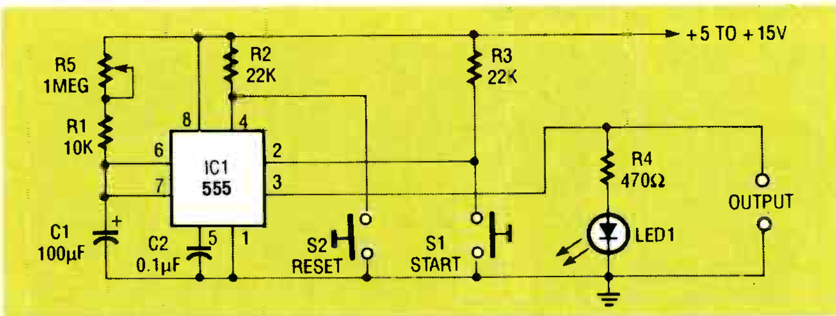


FIG. 5—VARIABLE-PERIOD TIMER CIRCUIT with reset capability produces time delays from 1.1 to 120 seconds.

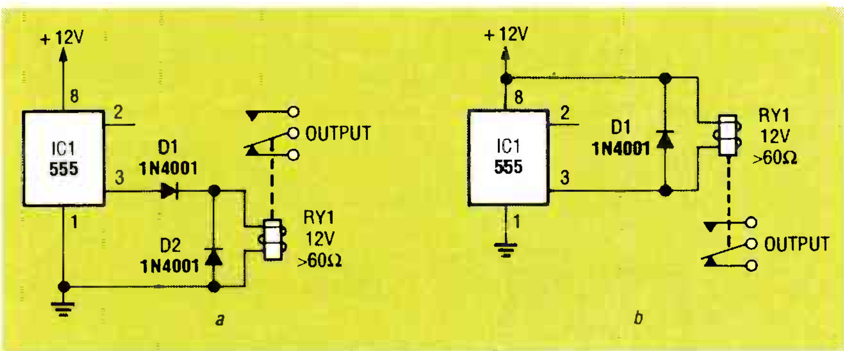


FIG. 6—ALTERNATE METHODS FOR ENERGIZING a relay from the output of a 555.

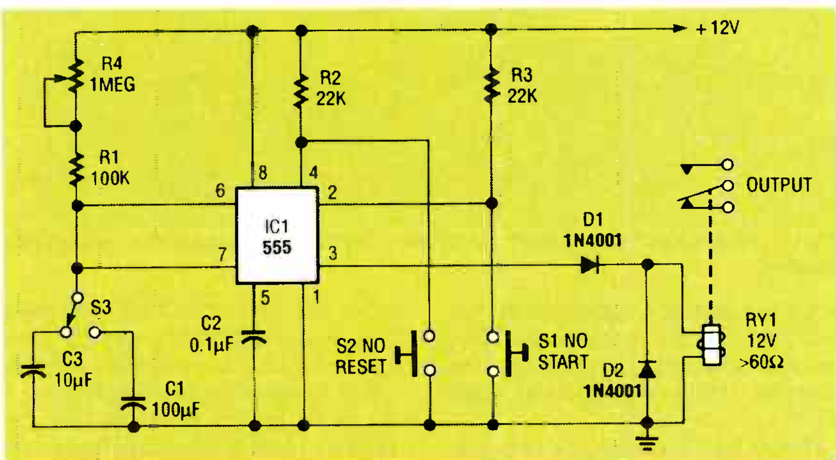


FIG. 7— TIMER WITH A RELAY OUTPUT provides time delays of 1.1 to 120 seconds.

premature termination of the timing period.

The 555 timer can drive non-inductive loads directly from pin 3 with currents as large as 200 milliamperes. However, if the circuit contains an inductive relay load, either of the schematics shown in Fig. 6 apply. In Fig. 6-*a*, the relay RY1 is normally off, but it goes on only when OUTPUT pin 3 goes high during the timing interval; in Fig. 6-*b*, RY1 is normally on, but it turns off during the timing interval. Diode D1 in both circuits protects the 555 against inductive-switching damage. The contacts of relay RY1 can control external circuits.

Figure 7 shows how a relay and a 555 can form a simple 1.1- to 120-second timer in two switch-selected decades. However, the general-purpose circuit has several drawbacks. First, it draws current continuously, even when the timer is off. Second, because of the wide tolerance variations in the electrolytic timing capacitors C1 and C2, potentiometer R4 needs two custom calibrated scales.

The schematic in Fig. 8 shows how to overcome these drawbacks. The RESET switch S2 and the set of relay contacts in parallel with the START switch S1, which are both normally open (N.O.) keep the circuit off so there is no current drain. The timing cycle is started by pressing momentary pushbutton switch S1, which connects power to the 555. At the instant of S1 closure, C3 is fully discharged. It therefore sends a start pulse to TRIGGER pin 2 through R4 and initiates a timing cycle.

As the timing cycle starts, RY1 is energized. The contacts in parallel with S1 close and keep the 555 powered even when S2 is released. At the end of the timing cycle RY1 is de-energized and its contacts re-open, disconnecting power from the 555.

The timing of the circuit in Fig. 8 is principally controlled by the values of resistor R1 and potentiometer R5, and either C1 or C2, which are switch-selected by S3-a. Note, however, that timing is also influenced by the setting of potentiometers R6 and R7. They are selected with switch S3-b and connected to CONTROL voltage pin 5 of the IC. Those potentiometers effectively shunt the internal voltage of the 555, thereby altering timing periods.

That feature allows the circuit to produce precise timing periods even when capacitors with loose-tolerance values are in the circuit. It also allows a single calibrated timing scale to cover the two switch-selected timing ranges.

To set up the Fig. 8 circuit, first set potentiometer R5 to its maximum value, set switch S3 to position 1 and push START button S1. Then adjust potentiometer R6 for a precise period of 10 seconds. Next, set 3 to position 2, push START switch S1, and adjust potentiometer R7 for a precise period of 100 seconds. With those adjustments complete, the timing scale can be calibrated over its full 100-second range.

Timers for car lights

Figure 9 is a circuit that automatically delays the turn-off of an automobile's headlights, permitting them to function as safety lights at night after the ignition switch is turned off. It is a useful circuit if you want your car's headlights to remain on for 50 seconds after you have parked, turned off the ignition, locked the doors, and walked away. The headlights will stay on long enough to illuminate your route until you can reach the safety of your home. The circuit does not interfere with normal headlight operation.

When the car's ignition switch S2 is turned "on," RY1 is energized (through diode D3) closing its contacts and connecting the 12-volt battery to the 555 and headlights switch S1. In this state the headlights operate normally. However, because both sides of capacitor C2 are connected to the positive supply, it is fully discharged.

When S2 is turned "off," the voltage across R3 goes to zero, de-energizing the relay. However, at that time C3 applies a

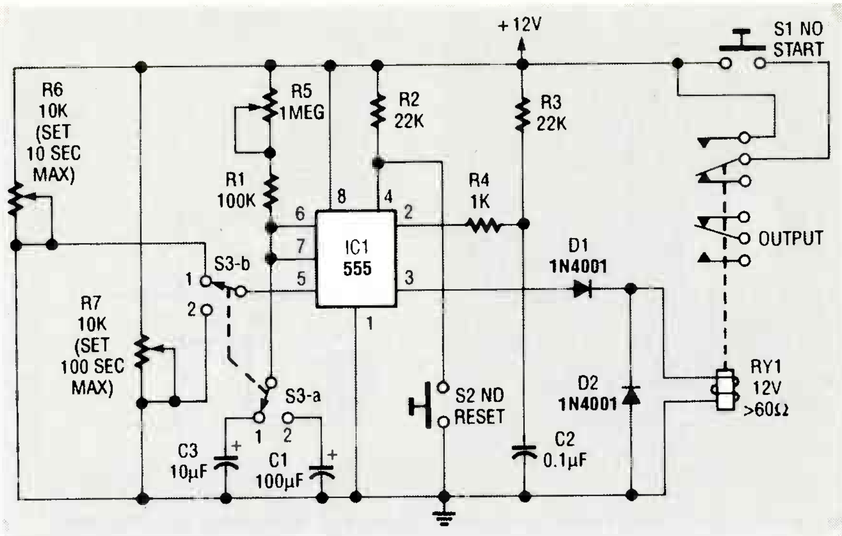


FIG. 8—PRECISION (COMPENSATED) TIMER with a relay output has two ranges: 0.9 to 10 seconds and 9 to 100 seconds.

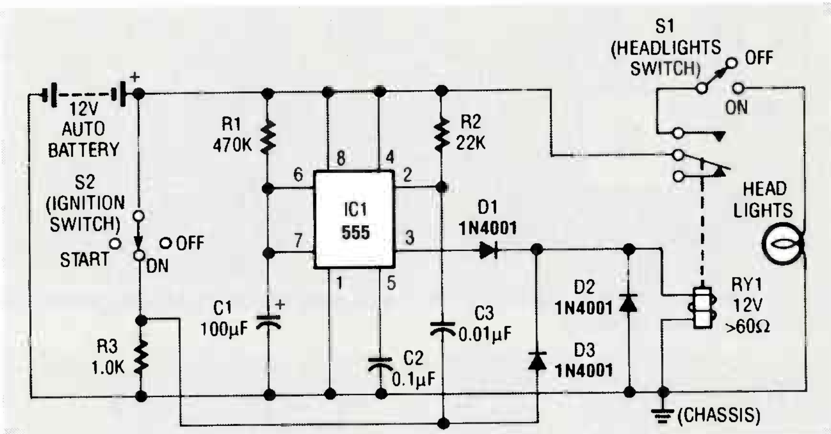


FIG. 9—HEADLIGHT TURNOFF CONTROL with automatic delay for automobiles.

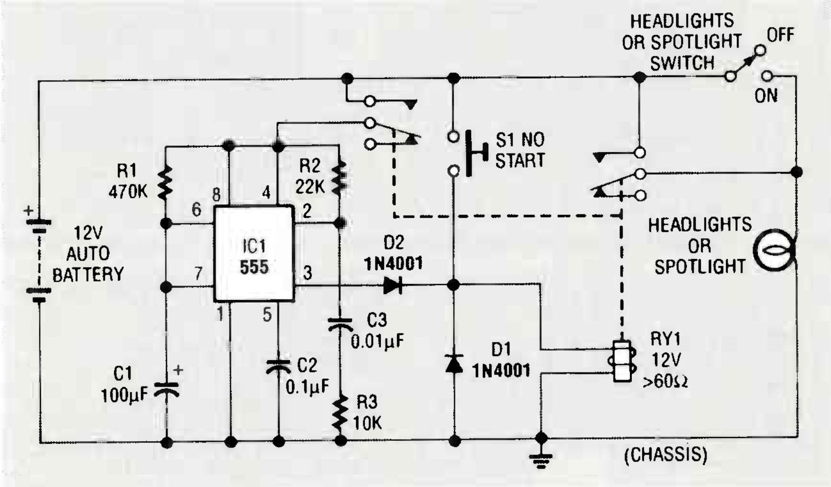


FIG. 10—HEADLIGHT/SPOTLIGHT TURNOFF CONTROL for automobiles is manually actuated.

negative-going trigger pulse to TRIGGER pin 2, initiating a 50-second timing cycle that applies current to the relay coil through D1.

Relay RY1's contacts remain closed for about 50 seconds after S2 is turned off, keeping the positive battery supply connected to S1 during this period. That keeps the headlights on if S1 is in its ON position. At the end of that 50-second time delay, RY1 de-energizes, its con-

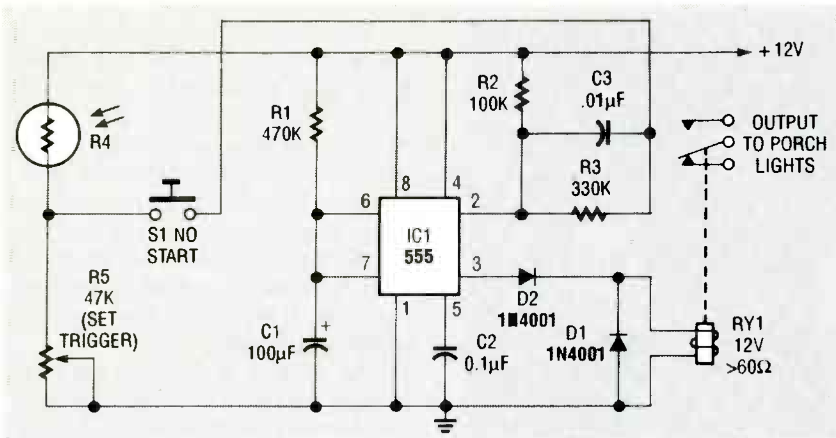


FIG. 11—PORCH LIGHT CONTROL AUTOMATICALLY turns on a light for a preset period only when triggered at night.

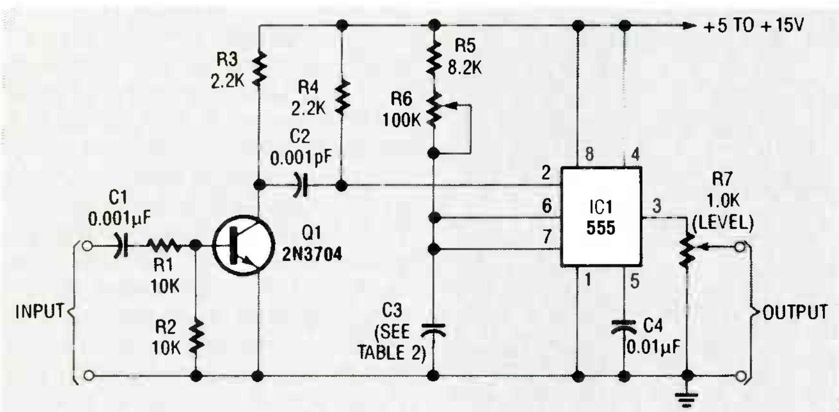


FIG. 12—ADD-ON PULSE GENERATOR can supplement a stand-alone pulse generator. It is triggered by rectangular input signals. Table 1 gives output pulse widths for various values of C3.

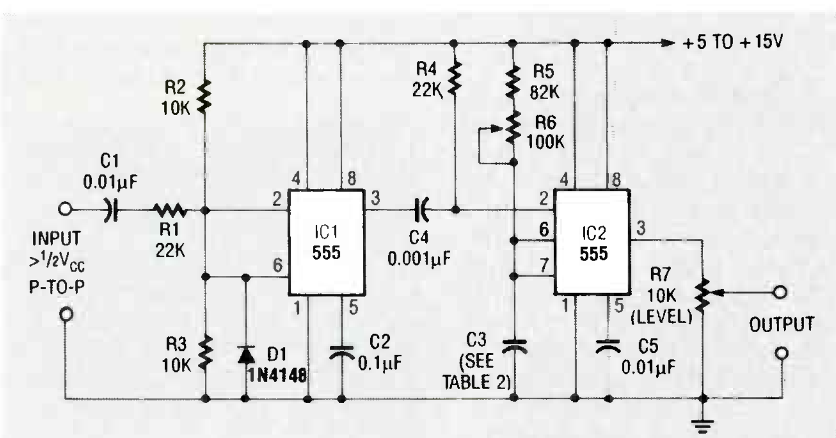


FIG. 13—MODIFIED ADD-ON PULSE GENERATOR can be triggered by any kind of input waveform including sine waves.

tacts open, and battery supply is disconnected from the 555 and S1.

The circuit in Fig. 9 is compatible with modern practice for powering the headlights switch S1 with ignition switch S2 so that headlights work only when the ignition switch is on. However, the circuit shown in Fig. 10 is applicable to older vehicles whose headlights or spotlight are independent of the ignition switch. The circuit illustrates a manual delayed turn-off light control.

That circuit works if the vehicle is parked with its lights off. They will be turned on for a preset 50-second period as soon as momentary pushbutton START switch S1 is pressed. When the delay period times out, the lights will be turned off again automatically.

The Fig. 10 circuit includes relay RY1 with two sets of normally-open contacts. The timing sequence is started with the momentary closure of pushbutton switch S1. Normally, both S1 and the relay contacts are open, so the timer circuit is not powered and the lights are off. Capacitor C3 is discharged under this condition.

When S1 is momentarily closed, RY1's coil is energized. That action closes its first set of contacts, applying power to the car's lights while also closing its second set of contacts, applying power to the 555. However, TRIGGER pin 2 of the IC is briefly grounded through C2, so a negative trigger pulse is fed to it, and a timing cycle is begun.

Consequently, OUTPUT pin 3 of the 555 switches high when the relay contacts close, locking the relay into its "on" state (regardless of the subsequent state of S1), keeping the lights on for 50 seconds. At the end of the timing cycle, pin 3 of the IC switches to its low state, de-energizing RY1. Then both sets of relay contacts open, disconnecting power from the 555 and the lights.

Automatic porch light

Figure 11 is an automatic control circuit for a porch light. It will turn a porch light on automatically for a preset 50-second period when its sensor detects the presence of a person. However, it performs that function only at night or under conditions of reduced visibility such as might occur during a storm. The circuit is activated with switch S1, which can be a microswitch triggered by a porch gate. It might also be a pressure-switch hidden under a porch mat and triggered by a person weighing perhaps 50 pounds or more.

Circuit operation depends on a negative-going pulse that falls below the internally controlled

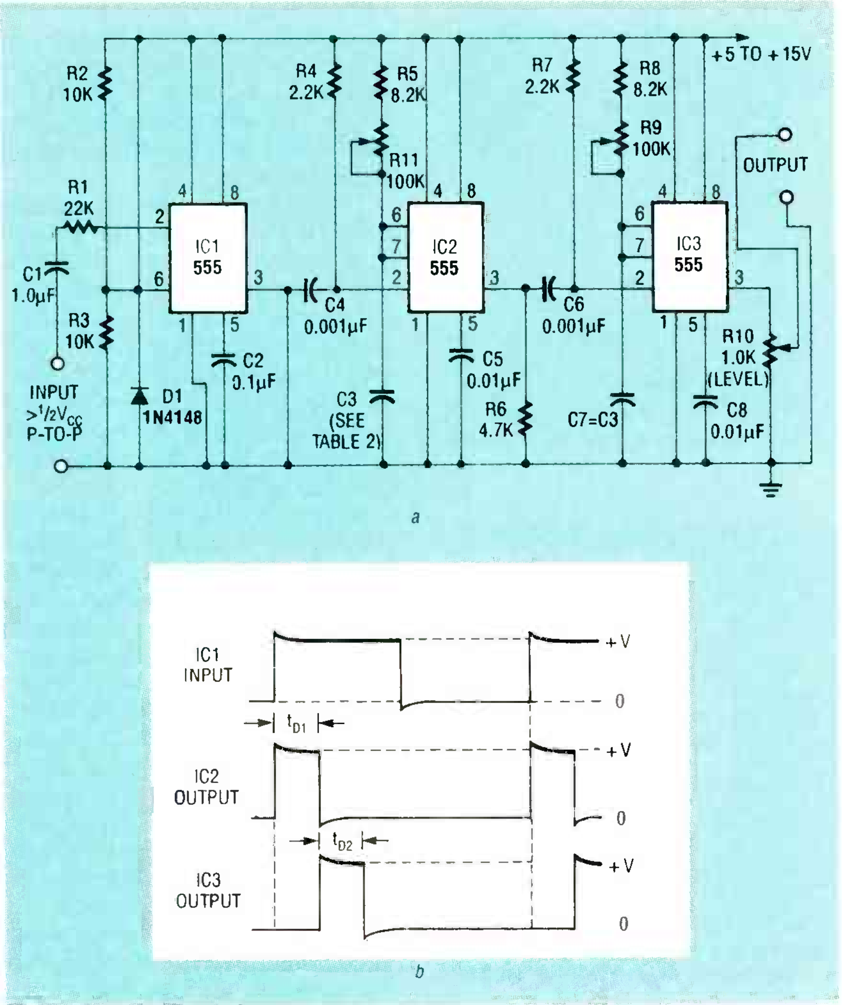


FIG. 14—ADD-ON DELAYED PULSE GENERATOR can be triggered by any input waveform (*a*). Waveforms at input to IC1 and those at the outputs of IC2 and IC3 based on different values of R and C (*b*).

one-third supply voltage being fed to TRIGGER pin 2 of the 555. If the trigger pulse does not fall below that value, the timing cycles cannot be initiated.

In Fig. 11, the photocell (resistor R4) and potentiometer R5 are in series as a light-dependent voltage divider. One side of S1 is connected to the junction between R4 and R5, and the other side is connected to pin 2 through a the network of C2 and R3. In normal daylight the photocell's resistance is low, so a high voltage appears at the junction of R4 and R5. As a result, closing S1 sends a voltage pulse to pin 2 whose value is too low to pull pin 2 below one-third of the supply voltage. Thus, the timer cannot be triggered with S1 under those conditions.

However, the photocell's resistance value increases at night or under reduced visibility, causing a low voltage to appear at the R4-R5 junction. Under that condition, closing S1 generates a voltage pulse that pulls pin 2 below the one-third supply voltage value, triggering the timer.

The cadmium-sulphide (CdS) photocell (resistor R4) should have a resistance of 1000 to 47,000 ohms under "dark" turn-on conditions. Potentiometer R5 can be adjusted to preset the minimum "dark" level for circuit triggering. The trigger signal is fed to pin 2 of the 555 through the C3 and R3, a network that shapes the trigger pulse and effectively isolates the DC component of the photocell-potentiometer network from pin 2.

Pulse generators

In all of the circuits presented so far, the 555 functions as a monostable (one-shot) pulse generator. Suitable trigger signals are fed to TRIGGER pin 2 and output pulses are taken from OUTPUT pin 3. The 555 can generate well formed output pulses with periods from 5 microseconds to hundreds of seconds. The maximum usable pulse repitition frequency is approximately 100 kHz.

The signal reaching TRIGGER pin 2 must be a carefully shaped negative-going pulse. Its amplitude must switch from an "off" value greater than two-thirds of the supply voltage to an "on" value less than one-third of the supply voltage. (Triggering actually occurs as pin 2 drops through the one-third supply voltage value.) Trigger pulse width must be greater than 100 nanoseconds but less than that of the desired output pulse. That condition assures trigger pulse removal by the time the monostable period times out.

Suitable trigger signals for the 555 in the monostable mode can be formed by converting the input signal to a good square wave that switches between the full positive supply voltage and ground. The square wave is then coupled to pin 2 with a resistor-capacitor differentiating network having a short time constant. That network converts the leading or trailing edges of the square wave into suitable trigger pulses.

Figure 12 shows a timing circuit that accepts input signals already in the form of square waves or pulses. Transistor Q1 converts a rectangular input signal into a form that switches between the positive supply and ground. The output signal is

TABLE 2—CAPACITOR VALUES FOR PULSE-WIDTHS

Capacitors C3 (Microfarads)	Pulse Width Range (Time in Seconds)
10.0	90 ms - 1.2
1.0	9 ms - 120 ms
0.1	900 µs - 12 ms
0.01	90 µs - 1.2 ms
0.001	9 µs - 120 µs

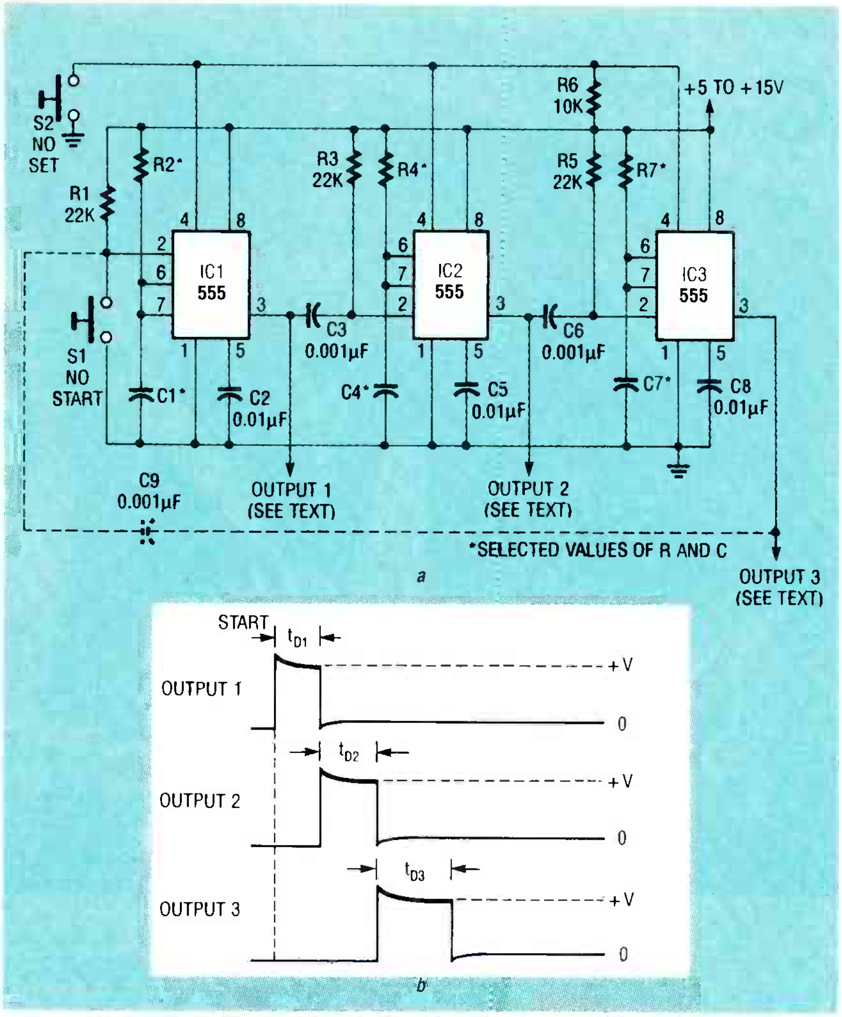


FIG. 15—THREE-STAGE SEQUENTIAL TIMER or pulse generator (*a*) and waveforms at three different output pins (*b*).

then fed to TRIGGER pin 2 through differentiating network C2-R4. The circuit can become an add-on pulse generator in combination with a separate square-wave or pulse generator. Variable-amplitude output pulses can be obtained from potentiometer R7.

The output pulse widths of the Fig. 12 circuit can be varied over more than a decade range with potentiometer R6, and they can be switched in overlapping decade ranges with the values of C3 listed in Table 2. With the component values shown, output pulse width is variable from 9 microseconds to 1.2 seconds. Capacitor C4 decouples CONTROL VOLTAGE pin 5 to improve circuit stability.

Figure 13 shows a modification of the circuit in Fig. 12 that can be triggered by any kind of input waveform, including sine waves. Here the first 555 (IC1) is configured as a Schmitt trigger to convert all input signals into square-wave output signals. Those square waves trigger the second 555 (IC2) in the monostable mode in the same way as described earlier. The circuit can also become an add-on pulse generator in combination with any kind of stand-alone waveform generator that produces output signals with peak-to-peak amplitudes greater than one-half the IC's supply voltage.

Figure 14-*a* shows how two monostable circuits can be connected in series to make a delayed-pulse generator. As in Fig. 13, the first 555 (IC1) is configured as a Schmitt trigger. The second 555 (IC2) controls time delay width, while the third 555 (IC3) determines the output pulse width.

As shown in Fig. 14-*b*, the output pulse at pin 3 of IC3 appears at a time interval after the initial application of the trigger signal. This time delay width T_{D1} is determined by the product of the value of capacitor C3 and the sum of the values of resistor R5 and potentiometer R6, in accordance with the time delay formula given earlier. Similarly, output pulse width t_{D2} is determined with the values of C7, and R8 and R9.

This circuit can become part of a stand-alone pulse delay generator by building it into a square-wave generator case. The square-wave generator will provide the initial trigger signals needed.

A number of monostable pulse generators can be placed in series to operate in sequential form. Figure 15-*a*, for example, shows a three-stage sequential generator circuit. It can control lamps or relays in a pre-programmed time sequence after pushbutton switch S1 is pressed to give the START command. Note that the RESET pins (pin 4) of all three 555's are shorted together and positively biased by R6. Those pins can be shorted to ground with SET switch S2. When power is applied, S1 should be closed, ensuring that none of the 555's in the circuit are falsely triggered.

Figure 14-*b* shows the waveforms from the output pins of all three 555's (IC1 to IC3). The time delay t_{D1} is determined by the values of C1 and R2, t_{D2} is determined by the value of C4 and R4 and t_{D3} is determined by the values of C7 and R7 when inserted in the time delay formula given earlier.

Finally, three or more monostable circuits can be connected with capacitor C9 (shown in a dashed connection line) between S1 and pin 3 of the third 555 (IC3). This loop feeds a signal back from the OUTPUT pin of IC3 to the input TRIGGER pin of IC1, permitting infinite repetition of pulse sequence. The circuit can drive LED's and digital logic. The circuit also has the reset capability provided by S2 that clears the circuit when power is first applied.

Set up a versatile sloping-vee antenna for your shortwave receiver of ham rig to improve your transmission and reception at low cost.

SLOPING V ANTENNA

RICHARD A. FORMATO

THE SLOPING-VEE ANTENNA IS ONE of the most versatile broadband antenna designs available to amateur radio enthusiasts and shortwave listeners. It is structurally simple, inexpensive, easy-to-build, and easy to set up in the field if you want to take your rig with you on vacation. The sloping vee can achieve moderate and occasionally even high gain over a frequency span of 5 to 1, 10 to 1, or more. The antenna is functional over the high-frequency (HF) into ultra-high- frequency (UHF)-range from about 3 MHz to about 800 MHz.

The most common configuration for the sloping-vee antenna is shown in Fig. 1. It consists of two sloping, radiating elements (wires) fed by a radio-frequency source at their vertex. The source is located at a height H above the ground, and the elements are terminated by two equal resistors, R, located at or near the Earth's surface. Technically it is an *inverted-vee* sloping antenna.

The *true* sloping-vee antenna has a vertex height, H, that is actually less than the height of its terminations. The radiating elements slope up from the ground, not down as shown in Fig. 1, making this configuration more difficult and expensive to build because two masts are required. However, both forms are called sloping vee's because they resemble a tilted letter "V."

This article presents a systematic design procedure that takes into account the unique characteristics of this antenna. A typical design for an HF/VHF 10- to 60-MHz sloping-vee antenna is discussed in detail, and measured performance data for the actual antenna is given. A frequently overlooked feature of the sloping-vee antenna at HF and a major advantage is that it combines the features of horizontal and vertical antennas, which results in virtual polarization diversity.

In a careful design, the characteristics of the communication links to be supported by the antenna must be considered. For example, the take-off angles at which the antenna must have adequate gain are determined by the transmitter-to-receiver distance and by the virtual ionospheric reflection height.

Another design constraint is the antenna's required bandwidth which is determined by the operating frequencies. For some amateur radio operators, only the HF band (3 to 30 MHz) is of concern; others want to cover the upper HF range and the 6-meter (50 kHz) band as well. High-gain antennas such as Yagis exhibit a bandwidth of a few percent of the center frequency. A well designed sloping vee, by contrast, will cover the entire HF spectrum and even exceed it.

Antenna siting is another important consideration in the design of a sloping vee. From HF well into the VHF range, the Earth's electrical characteristics (ground conductivity and dielectric constant) have a dramatic effect on antenna performance. Ground effects are especially important at low take-off angles (close to the horizon).

Shallow take-off angles are necessary for long-range transmission. For very long distances, the take-off angle could

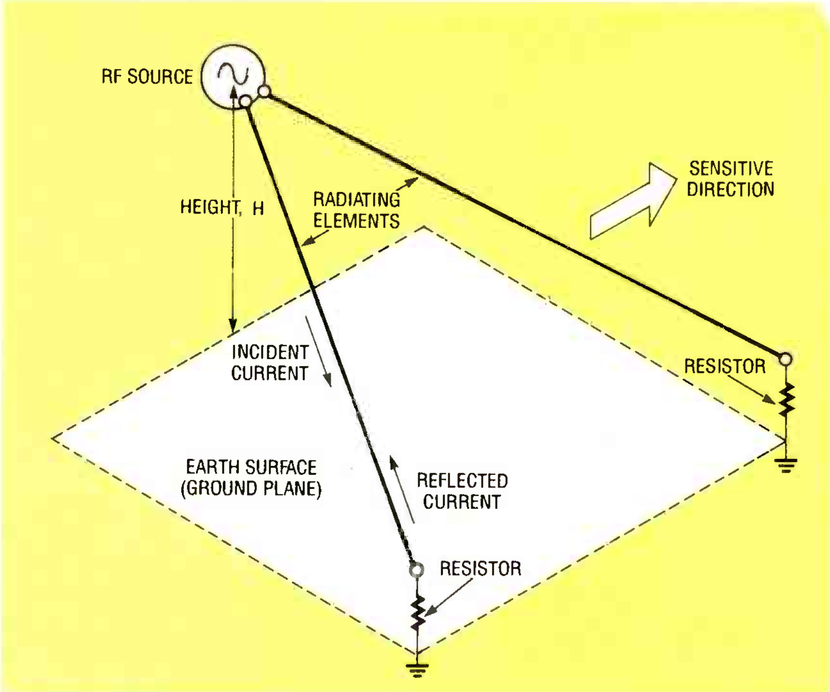


FIG. 1—A SLOPING-VEE ANTENNA is simple, inexpensive to build and erect, and provides excellent broadband performance from HF well into VHF.

be so low that mountains or other terrain features block signal transmission. Those obstructions limit the minimum take-off angle which, in turn, limits the range.

Sloping-vee operation

As shown in Fig. 1, the RF source excites current waves on the vee's radiating elements. The total current consists of two components: an incident wave propagating from the source toward the end of the element, and a reflected wave propagating from the terminating resistor back toward the source. In an ideal vee, the reflected component is zero because the terminating resistor absorbs any incident energy that would otherwise be reflected. In practice, there is a only a slight reflected component. The incident and reflected waves combine point-by-point along the element length to form a weak standing-wave pattern. An unterminated antenna, such as a center-fed, half-wave dipole, propagates a reflected wave with a large amplitude that creates a strong standing-wave pattern.

The half-wave dipole is a resonant, narrow band, standing-wave antenna. By contrast, a properly designed vee is a nonresonant, broadband, traveling-wave antenna. Broadband operation is obtained from the vee antenna by eliminating as much of the reflected current wave as possible. The terminating resistors are capable of absorbing most of the incident energy that is not radiated from the elements. If the terminating resistor is conjugate-matched to the characteristic impedance of the radiating element, there is no reflected signal because all of the power is absorbed.

This situation is the same as the maximum power transfer condition for a transmission line feeding a load. The load absorbs maximum power when its internal impedance is equal to the complex conjugate of the transmission line's characteristic impedance Z_0. Because Z_0 for well-designed transmission lines is nearly a pure resistance, the matched load is a resistance of equal value. The most common coaxial cable impedance is 50 ohms, and the corresponding matched load is a resistive 50 ohms. The load could be a 50-ohm dummy (essentially a resistor), or it could be an antenna with an input impedance of 50 +j0 ohms.

The frequencies at which the vee exhibits near traveling-wave behavior determine its useful bandwidth. The precise definition of *impedance bandwidth* is the range of frequencies at which antenna input voltage standing-wave ratio (VSWR) is less than or equal to some threshold value, typically 2 to 2.5:1 for transmitters and up to 5:1 for receivers. There are different thresholds because transmitter circuits cannot tolerate high VSWR without reducing output power or shutting down; by contrast, a receiver is not limited by VSWR.

For receive-only operation, increased antenna VSWR causes higher mismatch loss into the receiver front-end, which reduces the available signal level. There is a point at which the mismatch loss is so high that receiver sensitivity (minimum detectable signal) becomes unacceptable low. Figure 2 is a plot of mismatch loss as a function of VSWR with one end of the transmission line matched . At a VSWR of 5:1, receiver sensitivity is reduced by only 2.5 dB; but at 21:1, the reduction approaches 8 dB.

An objective for the design of a vee antenna is to maximize the range of frequencies in which VSWR is less than 2.5:1 for transmission and less than 5:1 for reception. An antenna meeting the transmission criterion between 3.5 and 30 MHz, for example, could be loaded directly on all bands from 80 to 10 meters without a tuner or matching network! The same antenna could receive over an even wider bandwidth.

Design procedure

The design of a good vee involves three steps. The first is to evaluate the kinds of communication links for which the antenna is intended. The designer must answer the following questions: What are the distances and operating frequencies involved, and what is the propagation mode? The second step calls for the selection of the vee's apex angle based upon the intended operating frequency and antenna size. The third

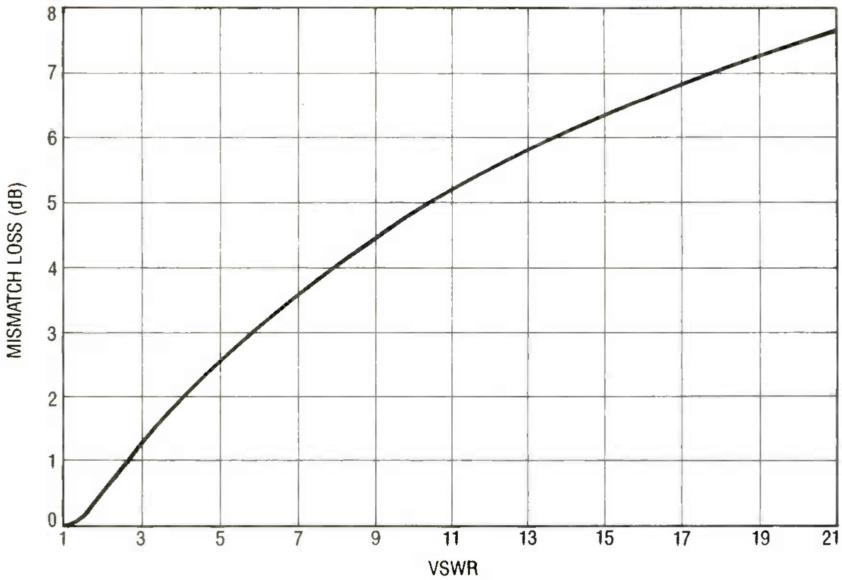


FIG. 2—PLOT OF MISMATCH LOSS in decibels vs. VSWR with one end of the transmission-line matched.

step is the computation of the antenna radiation patterns for the desired distances.

The assumed specifications for the design of a vee antenna are:

- Frequency range—15 to 50 MHz (continuous)
- Propagation mode—meteor trails at 100 kilometers
- Link distances—400 to 1200 kilometers (250 to 750 miles
- Antenna siting—limited to an area 100 × 100 feet and a height 25 feet
- Main lobe gain—0 dBi, minimum value

Step 1—Link evaluation

Three transmission-path factors influence vee design: distance between transmitter and receiver (determines antenna take-off angles); operating frequencies (determines required bandwidth); and propagation mode (determines take-off angles). Each of those factors must be known or estimated to design an antenna matched to the path.

Signals propagating between points on the Earth's surface are bent by the ionosphere or other scattering mechanism such as a meteor reflection. The most common (but not the only) propagation mode at HF is the skywave. The transmitted signal is bent back toward the Earth's surface by the ionosphere's changing refractive index. This process is equivalent to a specular reflection from a virtual reflection point. The simplest model of HF skywave propagation is a straight-line signal ray from the transmitter to a location near the reflection point where it is bent back as another straight line ray from the reflection point to the receiver as shown in Fig. 3.

The attainable distance in a communication path depends, in part, on the reflection height, with higher reflections providing greater distances. HF skywave propagation is caused by reflections from the ionosphere's layers: D layer (about 50 kilometers high), E layer (about 120 kilometer high) and F layer (200 to 500 kilometers high). Meteor-trail reflections are of growing interest because of the increased availability of high-speed packet data equipment. Those reflections occur at altitudes of about 100 kilometers.

The path geometry (reflection height and transmitter-to-re-

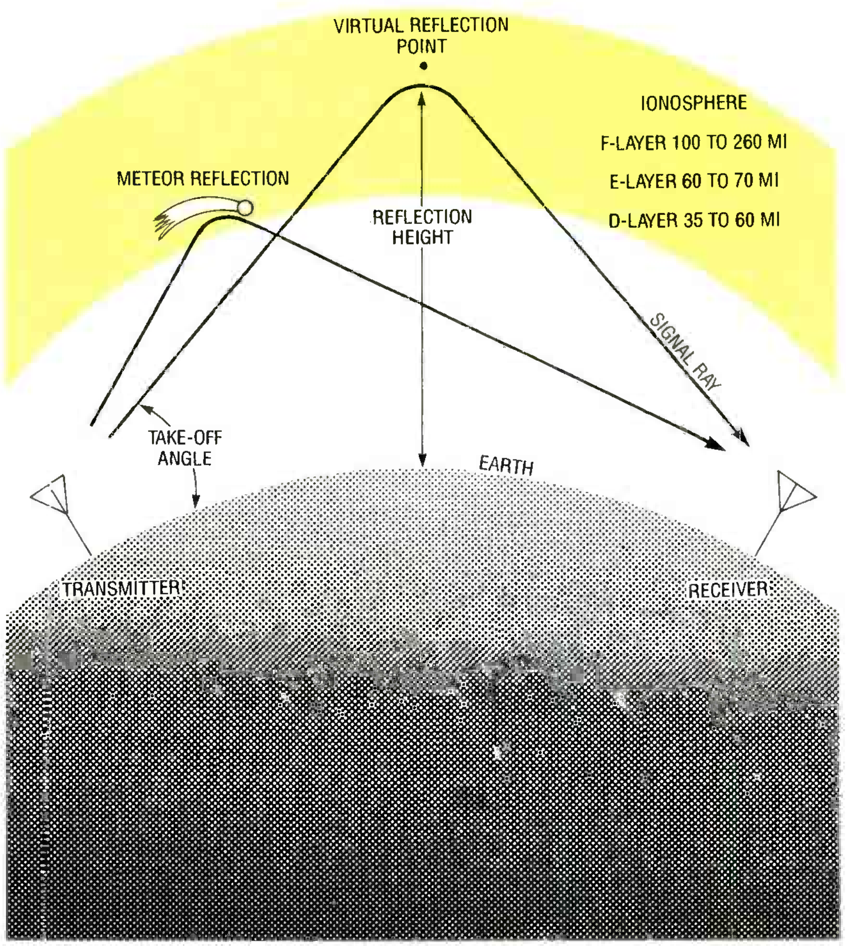


FIG. 3—DIAGRAM SHOWING RELATIONS between take-off angle, virtual reflection point, and signal range.

veiver distance) determines the range of required take-off angles for the antenna. Signal rays transmitted at too high an angle fall short of the receiver, while those transmitted at too shallow an angle can overshoot the receiver.

Figure 3 shows two important angles in vee design. The take-off (or elevation) angle is measured upward from the earth's surface to the ray direction. The polar (or zenith) angle is measured down from the vertical to the ray direction. Both angles are important because path requirements are usually described in terms of the take-off angle, but antenna performance is usually referred to a coordinate system based on the polar angle. The sum of the polar angle and the take-off angle is 90°, so the polar angle can always be determined by subtracting the take-off angle from 90° and the take off-angle can be found by subtracting the polar angle from 90°.

Figure 4 is a communication-range plot. The left vertical axis is the maximum range in kilometers for a specific take-off angle in degrees, while the right vertical axis is the maximum obstruction height in feet vs. take-off angle. Three range vs. take-off angle curves are plotted for different reflection heights, and each curve is labeled with the height (100, 300, and 500 kilometers). These curves were computed for an Earth spherical radius of 6371 kilometers. A "4/3-Earth" correction factor (Earth radius increased by 1/3) is sometimes used at HF. Applying that correction would modify the curves shown somewhat.

Either the maximum path distance for a given take-off angle or the appropriate take-off angle for a specified distance can be determined from Fig. 5. At a take-off angle of 20°, for example, the maximum range is about 2100 kilometers (1300 miles) for 500-kilometer reflections in the F2 region. The range increases to 4000 kilometers (2500 miles) at about a 5° take-off angle.

If the path length were 3200 kilometers, the appropriate

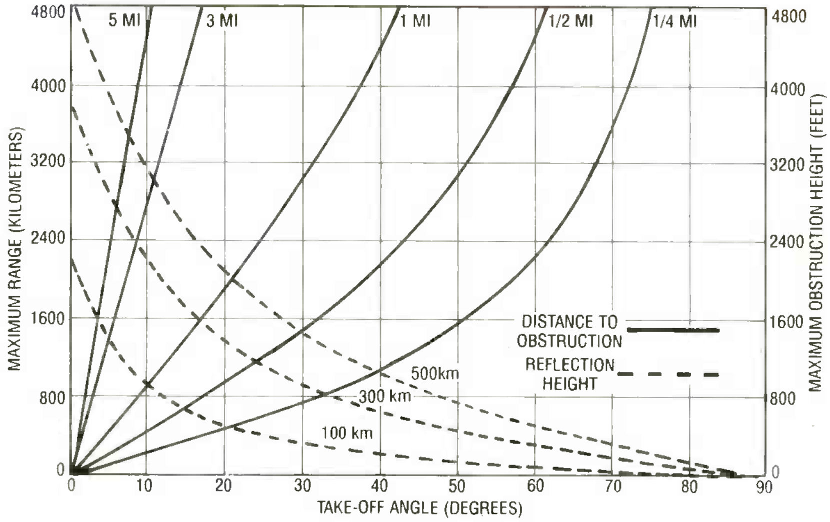


FIG. 4—COMMUNICATION RANGE PLOT: maximum range and maximum obstruction height vs. take-off angle

take-off angle for 500-kilometer reflections is about 10°, and it's about 3° for 300-kilometer reflections. Also plotted in Fig. 5 is a family of five obstruction height curves. They are important in antenna siting, especially for very shallow take-off angles (long paths).

Figure 5 shows the transmitted-ray geometry for a signal obscured by a hill or mountain. The obstruction with height H is located at a distance R from the antenna. The minimum take-off angle corresponds to the ray that just grazes the obstruction as shown. Transmitted or received signals at smaller take-off angles are blocked by the obstruction.

The curves related to the right vertical axis in Fig. 4 show the maximum allowable obstruction height in feet vs. the take-off angle. For example, if the path requires a take-off angle of 20°, a land-mass or structural obstruction 1/4 mile away must be less than 500 feet high if the ray is to pass without being blocked. A 500-foot hill 1/4 mile away would obscure all signals with take-off angles below 20°. Higher obstructions can be tolerated if they are further away. At a distance of 1/2 mile, for example, the obstruction could be as high as 1000 feet before obscuring a ray with a 20° take-off angle.

The curves in Fig. 4 also show maximum range in kilometers vs. take-off angles in degrees for the vee. For 100-kilometer reflections, the most effective angles are between about 8° and 25°. The objective in designing a vee antenna is the placement of this lobe in this angular range. The the 8° minimum take-off angle requires that the antenna be carefully sited to avoid lobe blockage by a nearby

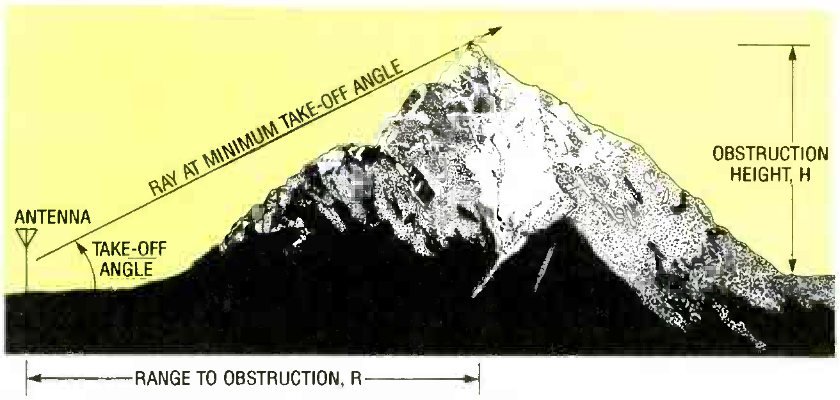


FIG. 5—DIAGRAM SHOWING MINIMUM TAKE-OFF angle to avoid a nearby signal-blocking obstruction.

hill or structure. The maximum height of that obstruction can be only about 200 feet if the antenna is to be located ¼ mile away. This requirement might easily be exceeded in hilly terrain or near tall buildings.

Step 2—The apex angle

Figures 6 and 7 plot the optimum vee apex angle in degrees as it changes with frequency and antenna element (radiator) length. The apex angle is inversely related to both frequency and element length. Thus, short elements at low frequencies must have wide apex angles while long elements at high frequencis can have small angles. The curves in Fig. 6 are for frequencies of 10, 30, and 50 MHz with respect to element lengths in meters, while those in Fig. 7 are for element lengths of 20, 40 and 60 meters with respect to frequency. Our example vee must operate over a wide frequency range (15 to 50 MHz).

It turns out that a given apex angle is optimum at only one frequency, not over a range of frequencies. Therefore, the selection of an *optimum* apex angle calls for both judgment and compromise. The objective is to select an angle that provides good performance at all frequencies over the stated range.

The design example calls for a vee antenna that will fit in a 100 × 100 foot square plot. Therefore, 40- or 60-meter elements are too long; only the 20-meter length will fit. By referring to both Figs. 6 and 7, it can be seen that for a 20-meter element the optimum apex angle at 10 MHz is 116°, but at 50 MHz it is 54°. It can also be seen that a good compromise for apex angle with a 20-meter element over the 15- to 50-MHz band can be reached by finding the apex angle for 30 MHz—69°. That angle will now become the trial value, and it will be retained unless the gain or pattern fails to meet the design objectives. In that case, the selection process must be repeated with another choice for the apex angle.

Now look at the vee input resistance at the design apex angle. Figure 8 is a plot of input resistance in ohms (R_{in}) vs. frequency for apex angles of 40°, 70°, and 100°. The input resistance value for a 70° apex angle at 30 MHz is about 690 ohms. (The vee is generally considered to be a 600-ohm antenna, so this is close to a match). The value of input resistance increases to 780 ohms at 15 MHz but drops to 630 ohms at 50 MHz. For design purposes, 690 ohms can be selected as a representative average value of R_{in} over the 15- to 50-MHz band.

The value of R_{in} is needed to specify the vee input balun. Because the vee is a balanced radiating system, feeding it with an unbalanced coaxial cable requires a balun (a *bal*anced to *un*balanced transformer). Matching a 50-ohm transmitter to 690 ohms requires a 14:1 balun, which can be made by winding magnet wire on a ferrite core or purchasing the component complete.

A value for R_{in} is also needed in the specification of each terminating resistor. Those values are $R_{in}/2$ (345 ohms for the design example). Select the standard value closest to 345 ohms. That value is not critical because R_{in} changes with frequency.

The tentative geometry for the

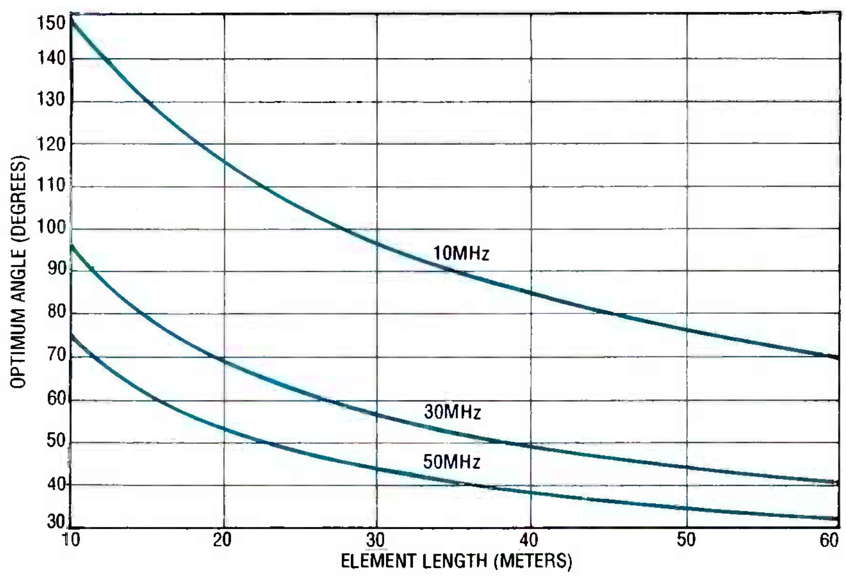


FIG. 6—OPTIMUM APEX ANGLE for sloping-vee antenna: plot of optimum angle vs. element length at three different frequencies.

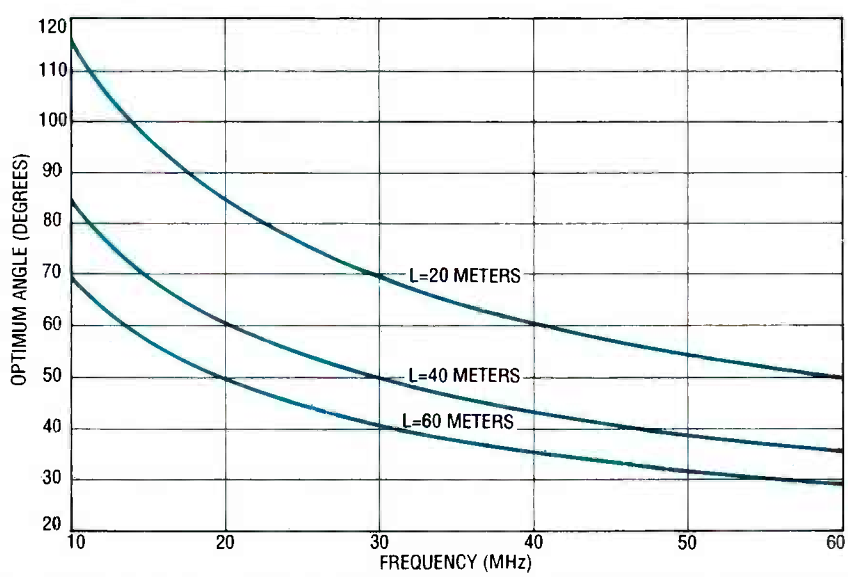


FIG. 7—OPTIMUM APEX ANGLE for sloping-vee antenna: plot of optimum angle vs. frequency for three different element lengths.

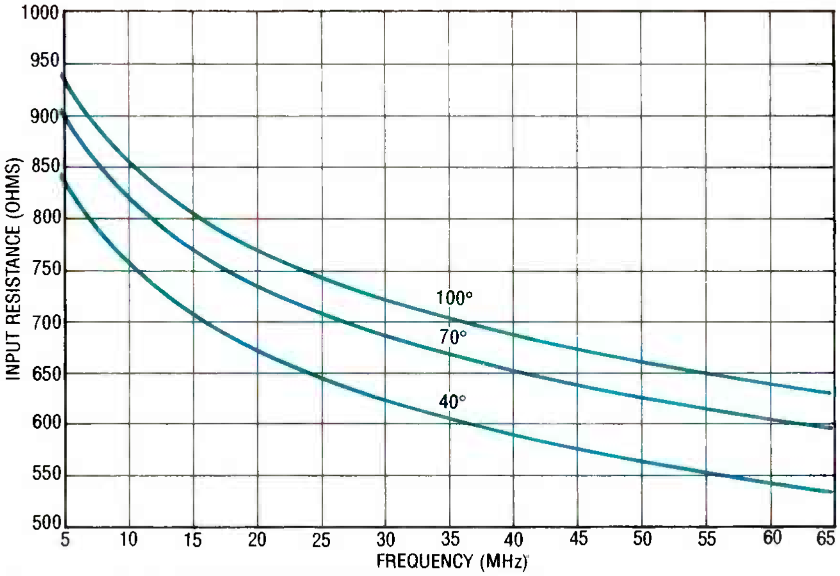


FIG. 8—PLOT OF INPUT RESISTANCE vs. frequency for a sloping-vee antenna.

15- to 50-MHz vee is shown in Fig. 9. Each radiating element is 62 feet (20 meters) long, and the apex angle is 69°. The required separation at the ends of the elements can be calculated with trigomometry or plotted to scale on paper with a protractor. For the 69°-apex angle, the ends of the elements must be 72.5 feet apart.

Step 3—Radiation Patterns

An antenna is efficient only if it radiates signals with adequate gain in the desired direction. The final step in the design of the vee is to compute its radiation patterns to verify that they meet the gain requirements. Software compatible with personal computers is available for this purpose from the source listed in Sources of Materials.

Certain parameters such as feed-point height, termination height, and element length should be varied before writing a final antenna specification. Changing any of those parameters will modify the radiation patterns. The design process is complete when the antenna radiates acceptable patterns. If a specific design doesn't meet requirements, the process should be repeated with new design values until they are met. A repetitive approach ensures a good design, and also gives the designer insight into how an antenna's performance changes with parameter differences.

For the design example, an element length of 20 meters was determined from the siting criterion. Missing are the design heights for the feed point and terminating resistors. Because the maximum height cannot exceed 25 feet, it is convenient to start by assuming a feed-point height of 6 meters (19.5 feet) and a termination height at ground level. The effectiveness of those choices will become clear as the radiation patterns are studied.

Radiation patterns were calculated every 5 MHz from 15 to 50 MHz, the intended operating range, with the tentative design values and element lengths of 20, 40 and 60 meters. Although only the 20-meter element meets the 100 × 100 foot site limit, it's instructive to see how the pattern changes with longer elements. Figures 11, 12, and 13 show the patterns at 15, 30, and 50 MHz. Those frequencies mark the endpoints and mid portion of the desired band. In all three figures the mast height is 6 meters, the apex angle is 69°, the diameter of the element is ⅛ inch and the termination is 689 ohms.

Results at intermediate frequencies are not included here. The patterns were computed with the sloping-vee antenna located on rocky ground with a conductivity of 0.001 siemens/meter and a dielectric constant of 4. The patterns change if different ground constants are assumed, so sensitivity to ground constants was also examined, although those results are not included here.

Figure 10 shows the pattern at 15 MHz. The left vertical axis is the antenna power gain in dBi (decibels relative to an isotropic radiator, an antenna that radiates in all directions). The horizontal axis is the polar angle in degrees. Note that the polar angle, not the take-off angle, is used on the horizontal scale. A polar angle of zero is a vertical with respect to the Earth

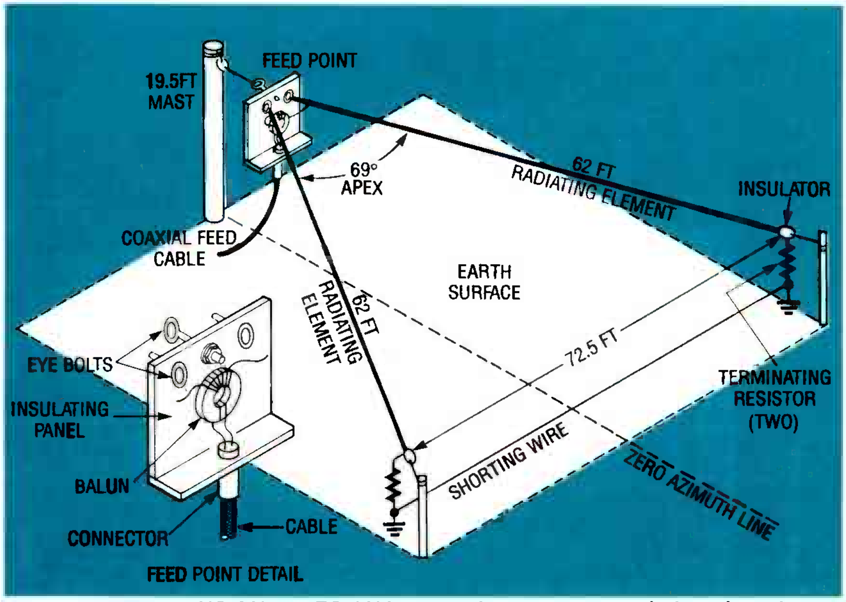


FIG. 9—FINAL DIMENSIONED DESIGN for a sloping-vee antenna that can be set up on a 100 × 100 foot plot.

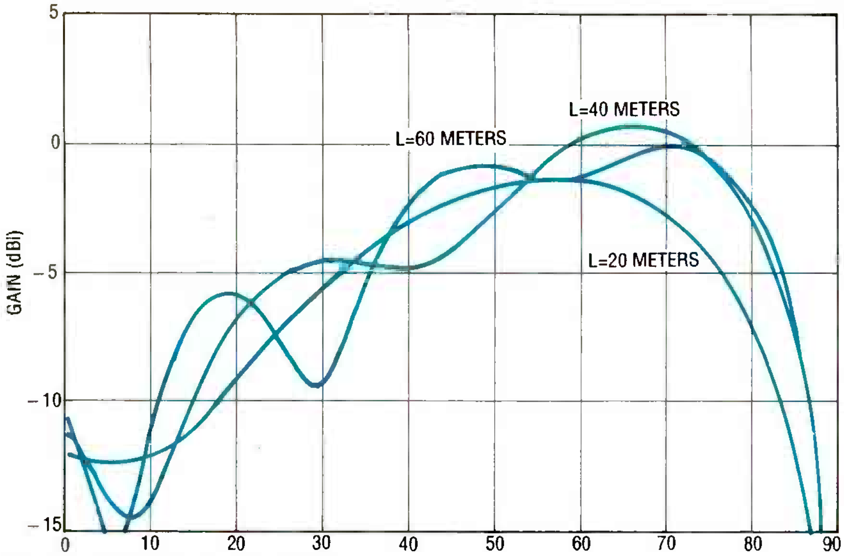


FIG. 10—GAIN VS. POLAR ANGLE for a sloping-vee antenna above rocky ground at a frequency of 15 MHz for various element lengths.

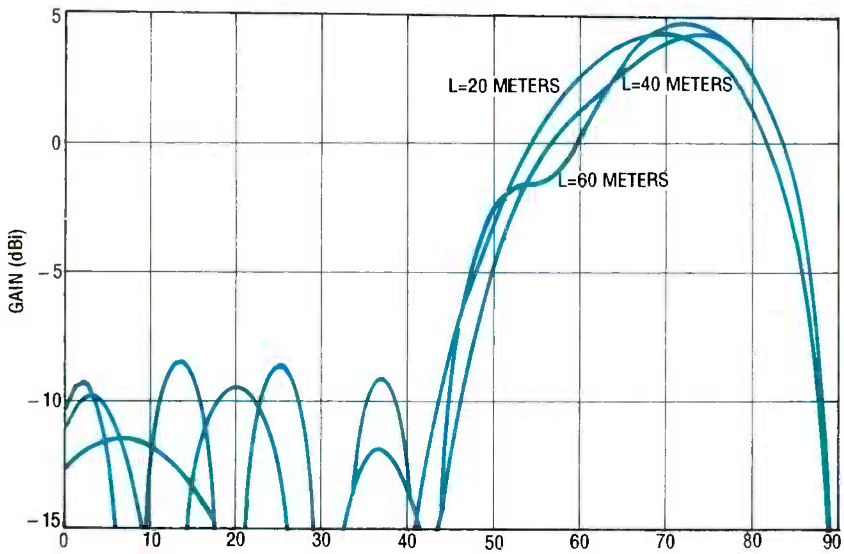


FIG. 11—GAIN VS. POLAR ANGLE for sloping-vee antenna above rocky ground at a frequency of 30 MHz for various element lengths.

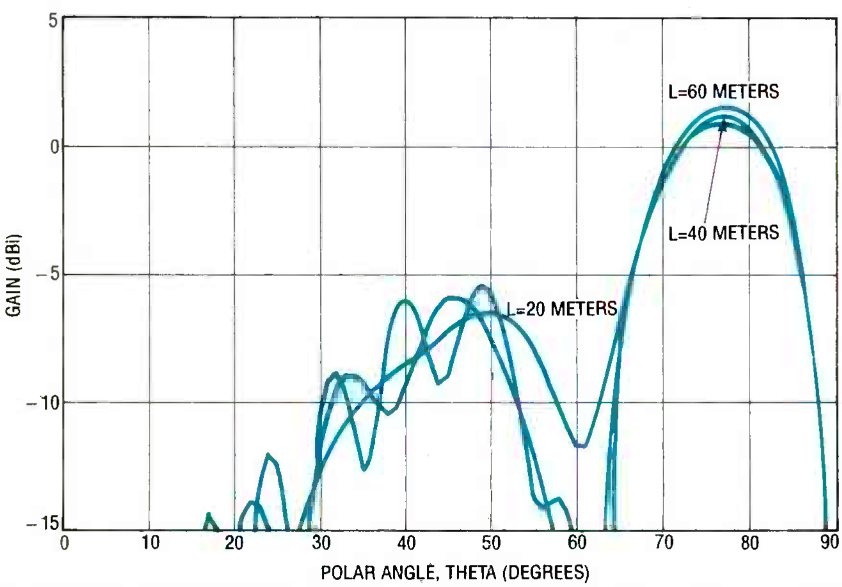


FIG. 12—GAIN VS. POLAR ANGLE for sloping-vee antenna above rocky ground at a frequency of 50 MHz for various element lengths.

(zenith), while 90° is parallel to the Earth's surface (horizon). Take-off angles of interest, 8° to 25°, correspond to polar angles of 82° to 65° in the figure. The design objective is to obtain at least 0 dBi gain in a main lobe propagating generally between polar angles of 65° to 82°.

The main lobe maximum gain at 15 MHz is -1.5 dBi at 57° for the 20-meter element. The lobe is broad, and the gain rolls off slowly on either side of the maximum. The -3 dB points are at about 32° and 74°. The highest gain, 1.5 dBi, is obtained with the 40-meter element in a broad main lobe that shows minor scalloping (sidelobing) near 40°. The pattern for the 60-meter element shows signs of breaking up—a significant secondary lobe is forming near 18°.

The 30-MHz pattern (Fig. 11) is interesting because all three elements produce a maximum gain of about 4 dBi, and their main lobe structures are very similar. The lobes are broad and smooth between 40° and 88° and the -3 dB points are near 55° and 82°. The 40- and 60-meter elements show considerable pattern scalloping between 0° and 40°, but the 20-meter element is electrically too short to develop a highly structured pattern.

Scalloping is due to constructive and destructive interference between direct rays from the antenna and rays reflected from the Earth's surface. Electrically long antennas (measured in wavelengths) are more susceptible to scalloping than shorter ones. Sidelobes waste energy by radiating it in undesired directions. Good antenna designs, therefore, minimize sidelobes as much as possible.

The 50-MHz vee pattern is shown in Fig. 12. The main lobe is again similar for the three element lengths. Maximum gain is about 6.5 dBi near 77° (13° take-off), and the -3 dB points are at approximately 70° and 83°. The main lobes are smooth and narrower than they are at the lower frequencies. The 20-meter element is beginning to show some scalloping. It has a peak sidelobe gain of -2 dBi at 50°).

However, the 40- and 60-meter antenna elements show more scalloping and even higher sidelobe gains.

An assessment of the patterns supports the conclusion that a vee antenna with 20-meter elements fed at a 6-meter height with a 69° apex and ground-level terminating resistors meets the objectives. Gain could be improved at the low end of the band with a longer radiating element, but that could violate the site limit.

The actual dimensions selected for the vee antenna are those of Fig. 9. A shorting wire connects the terminating resistors (which might or might not be connected to actual Earth ground). That wire, a current path between the resistors, is very important. In an ideal vee, the resistors are connected to a perfect ground plane that provides the current path. Omitting the shorting wire in a vee mounted on poorly conducting ground degrades performance significantly.

Antenna Construction and Measured VSWR

The antenna shown in Fig. 9 was built and tested on rocky ground in New England. It was fed through a 14:1 balun wound with 18 AWG magnet wire on a 2-inch outside diameter toroidal ferrite core. The turns ratio is the square root of the impedance ratio (in this case 3.75:1). The balun was wound with 2 turns in its primary and 7.5 turns in its secondary. If the sloping-vee is to transmit, the balun should be tested for power handling by operating at full power for several hours. Any problems that might develop such as transmitter overheating and arcing will show up.

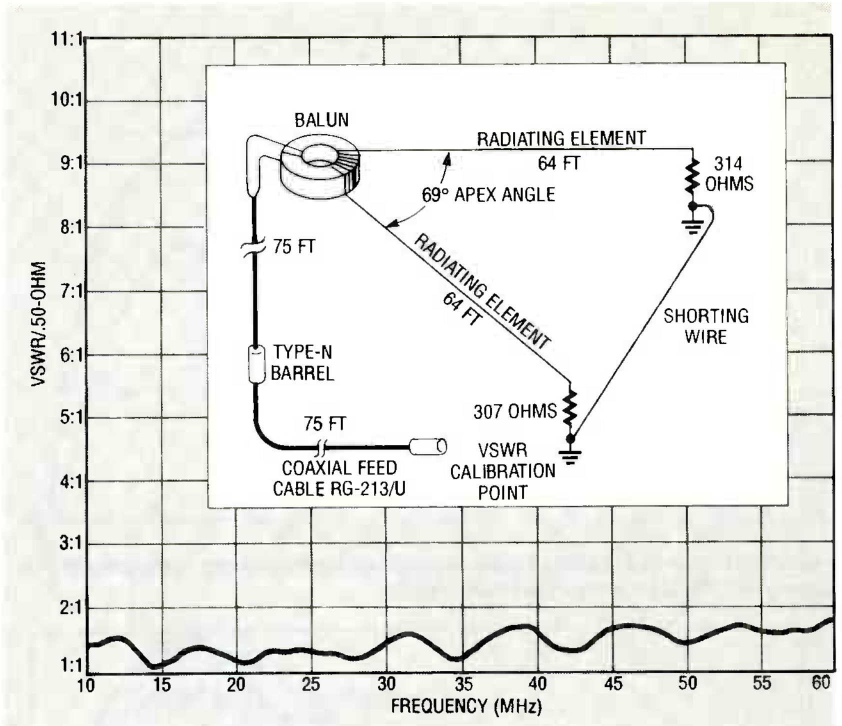


FIG. 14—PLOT OF VSWR VS. FREQUENCY for sloping-vee antenna with characteristics shown.

SOURCES OF MATERIALS

The following companies are sources for materials and computer software for this project:

- **Toroidal ferrite cores (Part No. FT240-43)—Radio Kit, Inc., P.O. Box 973, Pelham, NH 03076, (603) 635-2235**
- **Film power resistors—Power Film Systems, Inc., Yellville, AR 72687, (501) 449-4091**
- **Antenna design software—Phadean Engineering Co., Inc., P.O. Box 611, Shrewsbury, MA 01545, (508) 869-6077**
- **Phosphor-bronze wire—Astro Industries, Inc., Dayton, OH 43432, (800) 543-5810**
- **Fiberglass tubing—J. T. Ryerson Co., P. O. Box 1111, Boston, MA 02103, (617) 782-6900**

The simplest way to test a balun is to build two and connect them back-to-back as in Fig. 13. One balun is connected to the transmitter and the other is connected to a 50-ohm dummy load. This setup can also test for insertion loss by measuring the input and output power. The insertion loss in decibels for one balun is 5 $\log_{10}$ (output power/input power). The measured insertion loss of the balun in this this vee was a low 1.5 dB.

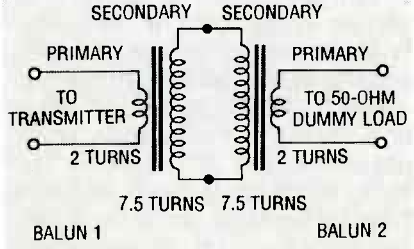


FIG. 13—BACK-TO-BACK INSERTION LOSS TEST of baluns for sloping-vee antenna.

The 6-meter antenna mast was a single 20-foot section of round 2-inch diameter Extren 500 fiberglass tubing with ¼-inch wall thickness. This material is strong, durable, and easy to machine. Extren 500 is available as round and square tubing, right-angle stock, flat stock, and I-beams in various sizes. A suitable base for a self-supporting mast can be made from those materials.

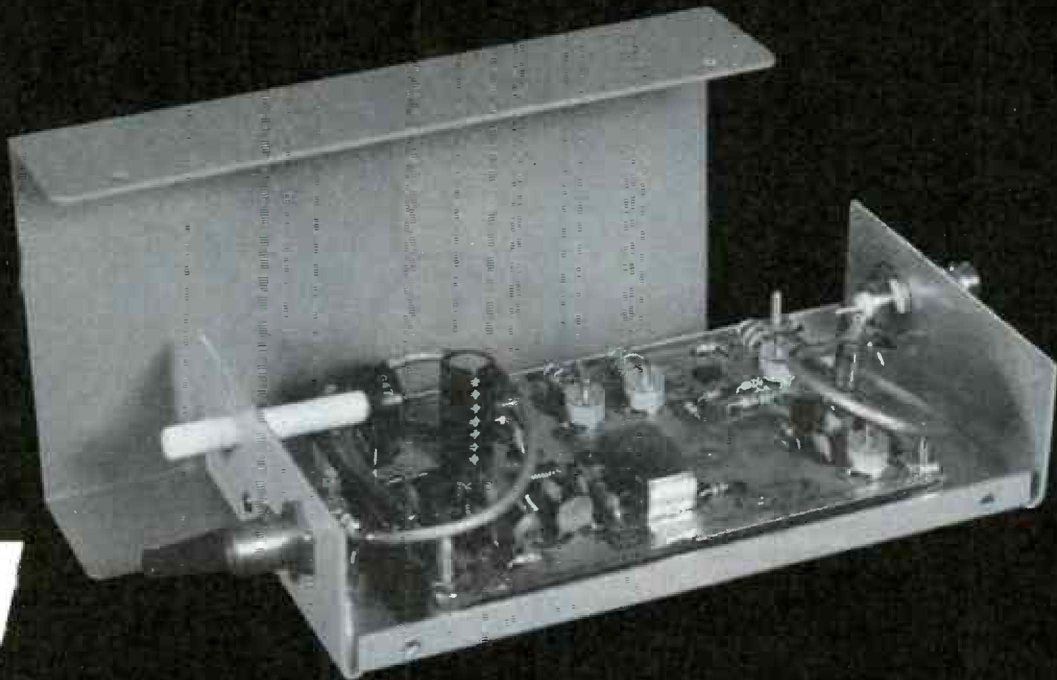
Alternatively, the fiberglass mast can be guyed at several points. The balun, eye-hook strain reliefs for the vee radiating elements, and the input coaxial connector were mounted as shown in Fig. 9. If fiberglass tubing for the mast is not readily available or it costs more than you want to spend (about $4 per foot), other suitable insulating materials such as thick-wall polyvinyl chloride (PVC) tubing is a good substitute.

Other less expensive mast alternatives include wood beams or even living trees.

The antenna radiating elements were 62-foot lengths of uninsulated 7 × 19 stranded phosphor-bronze wire with a diameter of ⅛-inch. Stranded

continued on page 100

Receive amateur TV signals on a standard TV with our low-noise downconverter.



ATV Downconverter

WILLIAM SHEETS and RUDOLF F. GRAF

YOU CAN RECEIVE AMATEUR TV SIGnals on a standard TV receiver with our inexpensive ATV downconverter. The downconverter converts the 420–450 MHz ATV band, which is several channels below the lower limit of the UHF band, to channel 3 or 4 for viewing on virtually any TV. The downconverter has a low-noise preamplifier stage and a double-balanced passive mixer for good performance and a wide dynamic range. That is necessary with today's crowded UHF bands. The converter draws about 27 milliamperes from a 13.2-volt DC source, so it can be used in portable and mobile applications. An extra IF stage gives an overall gain of about 25 dB.

Circuitry

Figure 1 is a block diagram of the downconverter. It consists of three active stages and a passive diode double-balanced mixer. The input signal is first filtered so that only signals centered around 430 MHz are fed to Q1, an RF amplifier with a 20-dB gain and a noise figure of 1.5 dB. Q1 is an NEC 25137 gallium-arsenide field-effect transistor, or GaAsFET. The amplified signal in the 420–450 MHz range is fed to a double-tuned bandpass filter. The overall bandwidth of the RF stage is about 12 MHz, which is sufficient to cover the most frequently used part of the ATV band (426–439 MHz) without retuning. For operation over the entire 420–450 MHz band, you may have to repeak the filters to tune in weak signals.

The amplified signals are mixed by a diode double-balanced mixer with an oscillator signal (generated by Q2) that is nominally 60–70 MHz lower than the received frequency. A 2-dB pad is used between the oscillator and mixer to reduce interaction. The IF output from the mixer is fed to a low-pass filter that cuts off at about 100 MHz. That reduces UHF signal feedthrough. Amplifier Q3 boosts the IF signal at 60 or 66 MHz (channel 3 or 4) by about +15 dB. The output of Q3 is fed to the TV receiver being used as an IF amplifier.

Figure 2 shows the schematic of the downconverter. The input signal from J1 is applied to a tap on L1, the input (antenna) coil. L1 is nominally a 3-turn coil and the tap is at ¾ turn so that the voltage applied from J1 is stepped up four times. Capacitor C1 tunes L1 to resonance, and is also connected to gate 1 of Q1.

Capacitors C3 and C4 provide

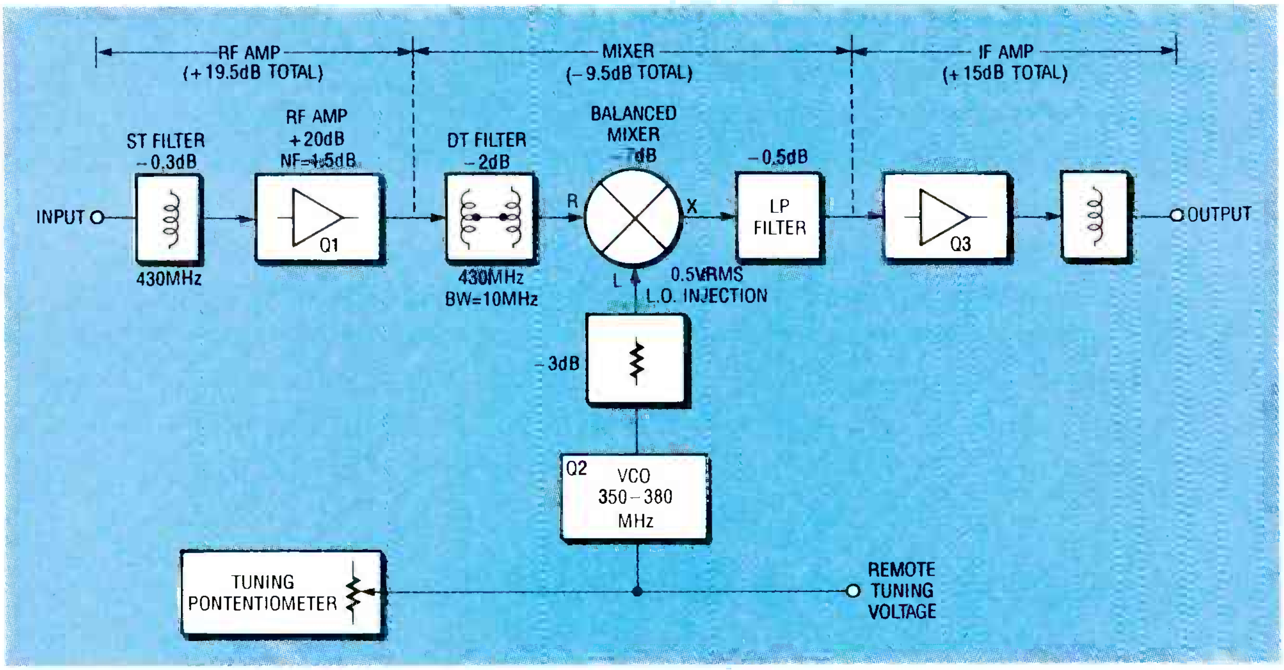


FIG. 1—DOWNCONVERTER BLOCK DIAGRAM. It consists of three active stages and a passive diode double-balanced mixer.

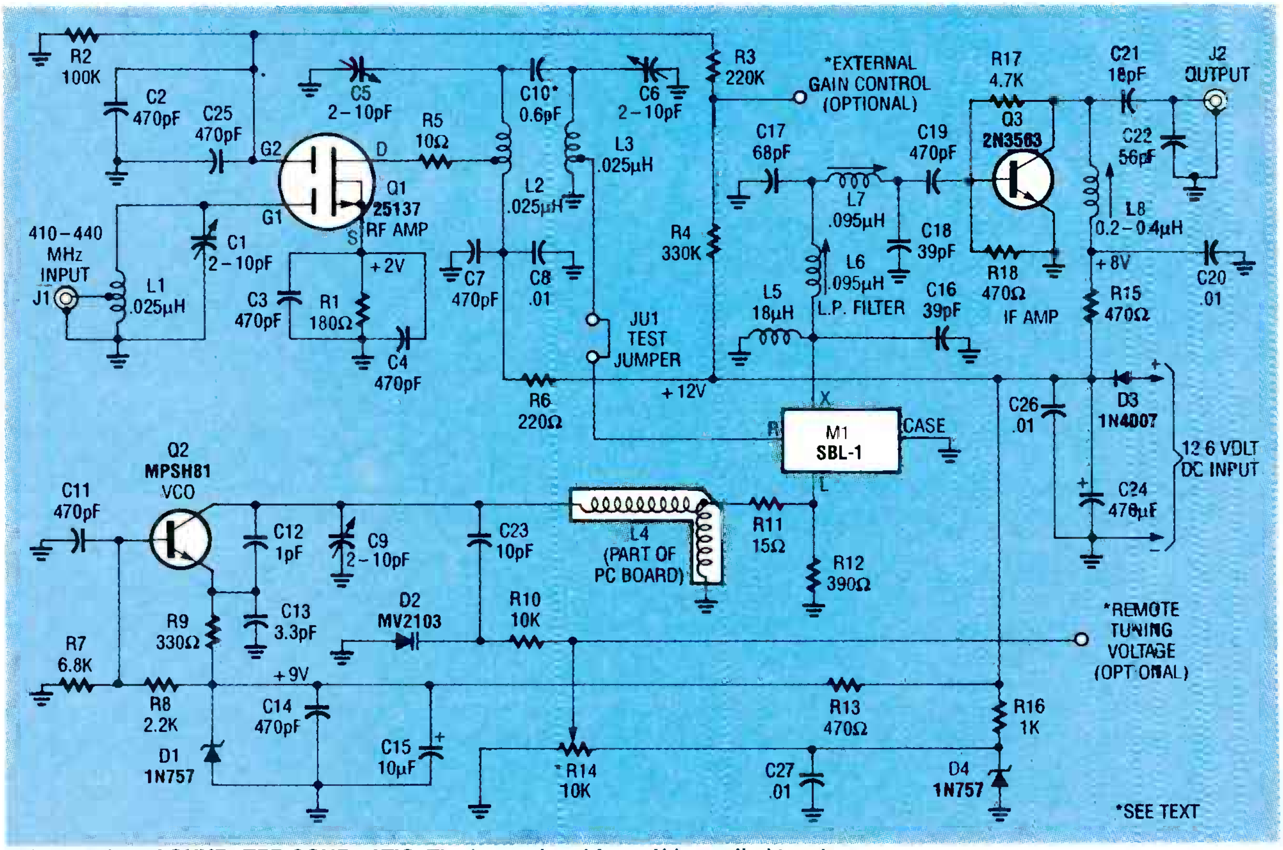


FIG. 2—DOWNCONVERTER SCHEMATIC. The input signal from J1 is applied to a tap on L1. Capacitor C1 tunes L1 to resonance and passes the signal to Q1, an NEC 25137 GaAsFET.

RF bypassing for the source of Q1, and R1 provides self-bias for Q1. Gate 2 of Q1 is biased by network R2, R3 and R4. An external gain-control signal (which is usually not required) can be applied to the junction of R3 and R4 if it becomes necessary to reduce the gain of the converter on very strong signals. A DC voltage of +6 volts will cause full gain, and −6 volts will cause nearly a −40-dB reduction in gain. The voltage can be derived from an AGC circuit, if necessary, but a potentiometer can also be used. Capacitor C2 provides RF

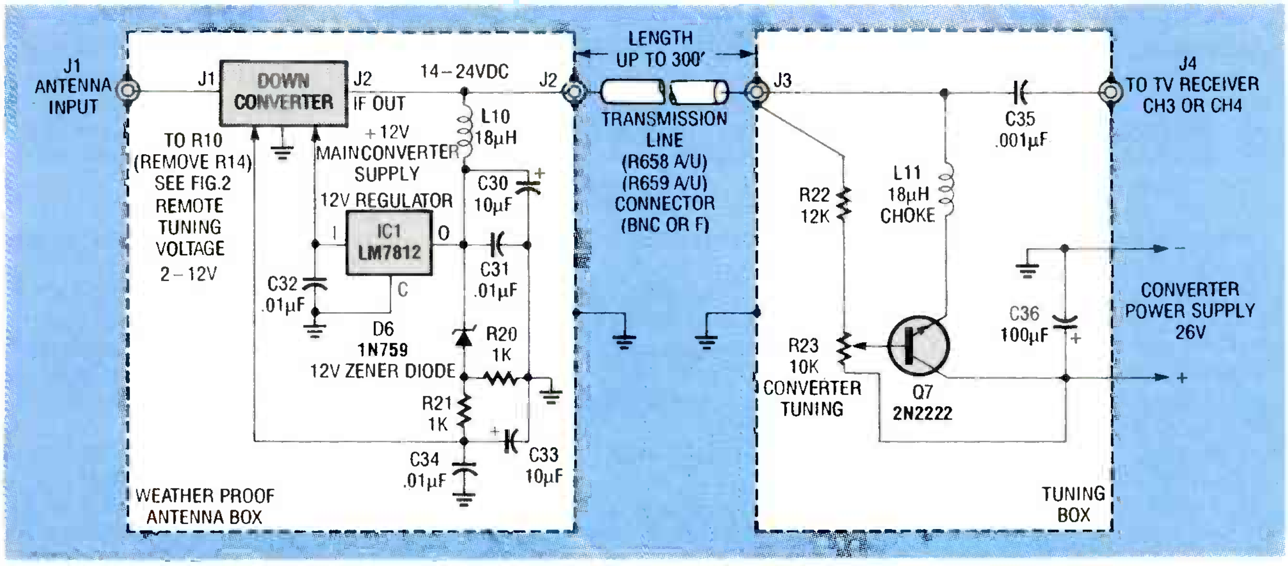


FIG. 3—THE DOWNCONVERTER can be supplied with an external DC voltage for remote-control tuning.

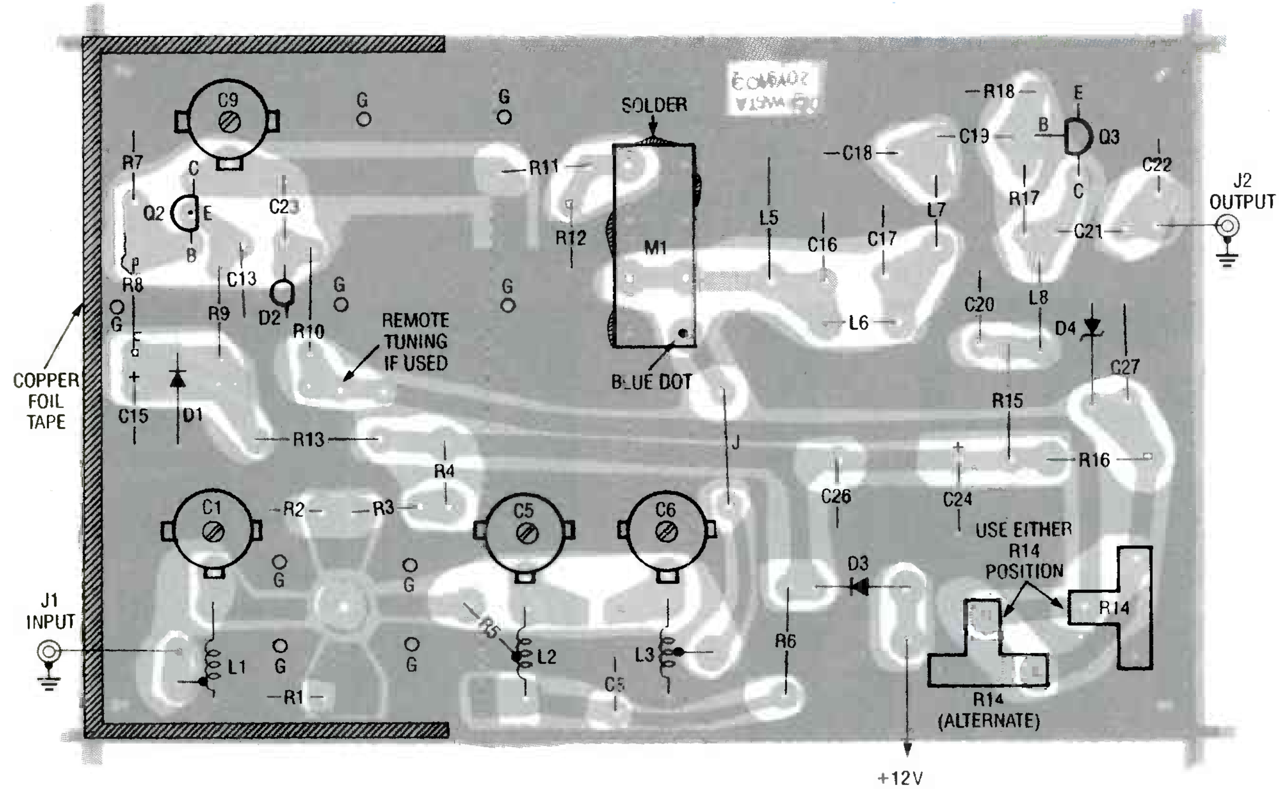


FIG. 4—PARTS-PLACEMENT DIAGRAM. This layout must be followed exactly to duplicate the performance of the downconverter. Some components mount on the solder side of the board as shown in Fig. 6.

grounding for gate 2 of Q1, and R5 reduces any UHF parasitic oscillations. The drain of Q1 is connected to a tap on L2, which is part of the bandpass filter network. Capacitors C7 and C8 provide RF grounding for the cold end of L2. DC bias is fed through R6. Under normal conditions, the drain pin of Q1 will be at +10 to +11 volts DC.

Capacitor C10 couples the signal from the first tuned circuit (C5-L2) to the second tuned circuit (C6-L3). The value of C10 is very small (0.6 pF); it determines the degree of coupling between L2 and L3. It is made from a small piece of PC board material and is mounted on the bottom of the main board. A signal from a tap on L3 is fed via test jumper JU1 to mixer M1. The local oscillator (L.O.) signal from Q2 is also fed to the mixer.

Transistor Q2 is the local oscillator, for which R13, D1, C14, and C16 provide a stabilized 9 volts DC. Because Q2 is a PNP transistor, it allows the collector to be DC grounded, which is an advantage in this type of oscillator circuit. Resistors R7 and R8 provide base bias for Q2, C11 provides a solid RF ground

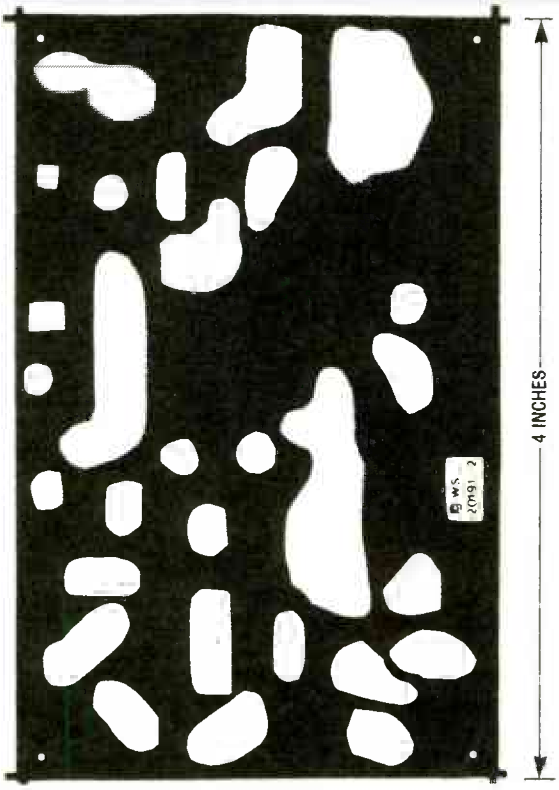
PARTS LIST

All resistors are ⅛-watt, 5%, unless otherwise noted.
R1—180 ohms
R2—100,000 ohms
R3, R4—220,000 ohms
R5—10 ohms
R6—220 ohms
R7—6800 ohms
R8—2200 ohms
R9—330 ohms
R10—10,000 ohms
R11—15 ohms
R12—390 ohms
R13, R15—470 ohms, ¼-watt
R14—10,000 ohms, potentiometer with shaft
R16—1000 ohms
R17—4700 ohms
R18—470 ohms
Capacitors
C1, C5, C6, C9—2–10 pF trimmer
C2–C4, C7, C11, C14, C25—470 pF, chip
C8, C20, C26, C27—0.01 µF, disc
C10—0.6 pF (must be handmade, see text)
C12—1 pF, NPO disc or chip
C13—3.3 pF, NPO disc or chip
C15—10 µF, 16 volts, electrolytic
C16, C18—39 pF, NPO disc
C17—68 pF, NPO disc
C19—470 pF, disc
C21—18 pF, NPO disc
C22—56 pF, NPO disc
C23—10 pF, NPO disc
C24—470 µF, 16 volts, electrolytic
Semiconductors
D1, D4—1N757A Zener diode
D2—MV2103 varactor diode
D3—1N4007 diode
Q1—25137 GaAsFET (NEC)
Q2—MPSH81 NPN transistor
Q3—2N3563 NPN transistor
Other components
L1–L3—3 turns of 20 AWG tinned wire (approx. 0.025 µH, see Fig. 5)
L4—part of PC board etching, see text
L5—18 µH RF choke
L6, L7—8 turns of 22 AWG enameled wire wound on No. 8 screw (approx. 0.095 µH, see Fig. 5)
L8—9½ turns of 22 AWG enameled wire wound on No. 8 screw, with ferrite slug (see Fig. 5)
M1—MCL SBL-1 mixer
J1, J2—F connector
Miscellaneous: PC board, 3⁄16-inch copper-foil tape, coaxial cable, project case, 12.6-volt DC power supply, solder, etc.

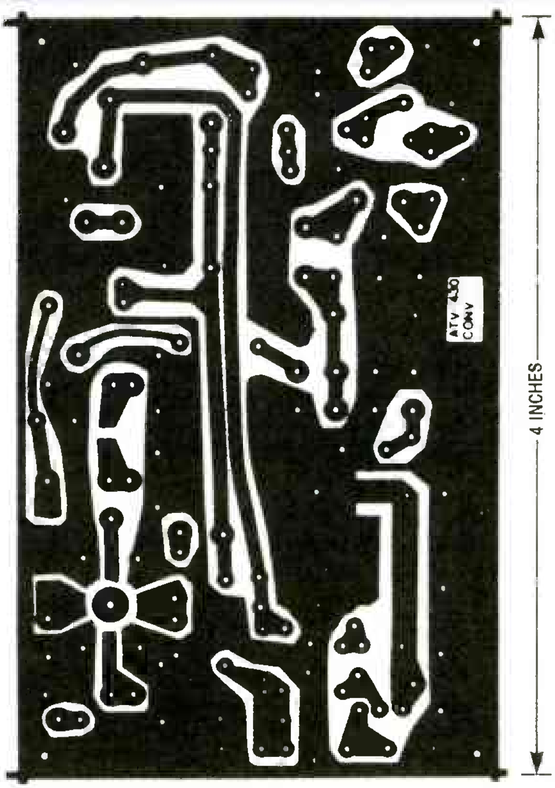
Note: The following items are available from North Country Radio, P.O. Box 53, Wykagyl Station, New Rochelle, New York 10804:

- **A kit of parts to build the downconverter (includes PC board and all parts that mount on it, J1 and J2, and wire to wind all inductors (metal case and power supply not included)—$59.50 + $3.50 S&H (Note that none of the parts shown in Fig. 3 are included with the downconverter kit.)**
- **Metal case as shown—$12.50**
- **2-watt ATV transmitter kit with a 439.25-MHz crystal (see Radio-Electronics, June and July 1989)—$110 + $3.50 S&H**
- **A 0.5-watt, 9-volt transmitter kit with a 439.25-MHz crystal—$112 + $3.50 S&H**
- **Linear amplifier kit to boost the output of ATV transmitter to 15 watts (see Radio-Electronics, August 1992)—$79.50 + $3.50 S&H**
- **Crystals for channels 14, 15, 16, 17, or 18 (for test purposes only)—$7.50 each**

New York residents must add sales tax.



COMPONENT SIDE FOIL PATTERN.



SOLDER SIDE FOIL PATTERN.

for the base of Q2, and R9 provides emitter bias. Nominal current through Q2 is about 5 to 6 milliamperes. Capacitors C12 and C13 provide a feedback network for Q2.

Components C9 and L4 (a length of microstrip line etched on the PC board), together with

C23 and varactor diode D2, form a circuit that can be tuned via the bias on D2 over the range of 350 to 390 MHz, depending on the setting of C9. Therefore, Q2 will oscillate over that frequency range, because positive feedback is provided by C12 and C13, and Q2 acts as a grounded-base amplifier. Oscillator output is taken through R17 and R12 to mixer M1. The level at terminal L of the mixer is about 0.3 volt RMS. Resistor R11 is connected to a tap on L4, which also provides bias return for the collector of Q2, because it is at DC ground.

The output from mixer M1 at 60 to 70 MHz (the difference frequency between received signal and L.O. frequency) appears at mixer terminal X. There is about a 7-dB loss in the mixer. Coil L5 provides a DC return for the mixer IF port. A low-pass filter made up of C16, L6, C17, L7, and C18 eliminates any remaining UHF signal components appearing at terminal X. Transistor Q3 is an IF amplifier stage, which is biased by R13, R14, and R15 to a V_{CE} of 8 volts and a collector current of about 8 mA. Tuned circuit L8, C21, and C22 can be tuned to either channel 3 or 4. The signal from the low-pass filter is coupled to Q3's base via C19. Transistor Q3 provides about a 15-dB gain; its output signal appears at J2. Power for the downconverter is supplied through D3, which protects against reverse voltages, and C24 and C26, which bypass RF and noise.

Resistor R10 couples DC bias to D2 supplied from tuning-potentiometer R14. Components R16, D4, and C25 provide 9-volts DC for that purpose. If desired, R10 can be supplied with external DC for remote-control tuning, or to allow the downconverter to be mounted close to the antenna. That is commonly done to reduce transmission-line losses between the antenna and converter—losses run high at 450 MHz unless very expensive transmission line, such as ½-inch hard line, is used. If you are planning on remote-controlling the converter, install R14 so it's easy to move.

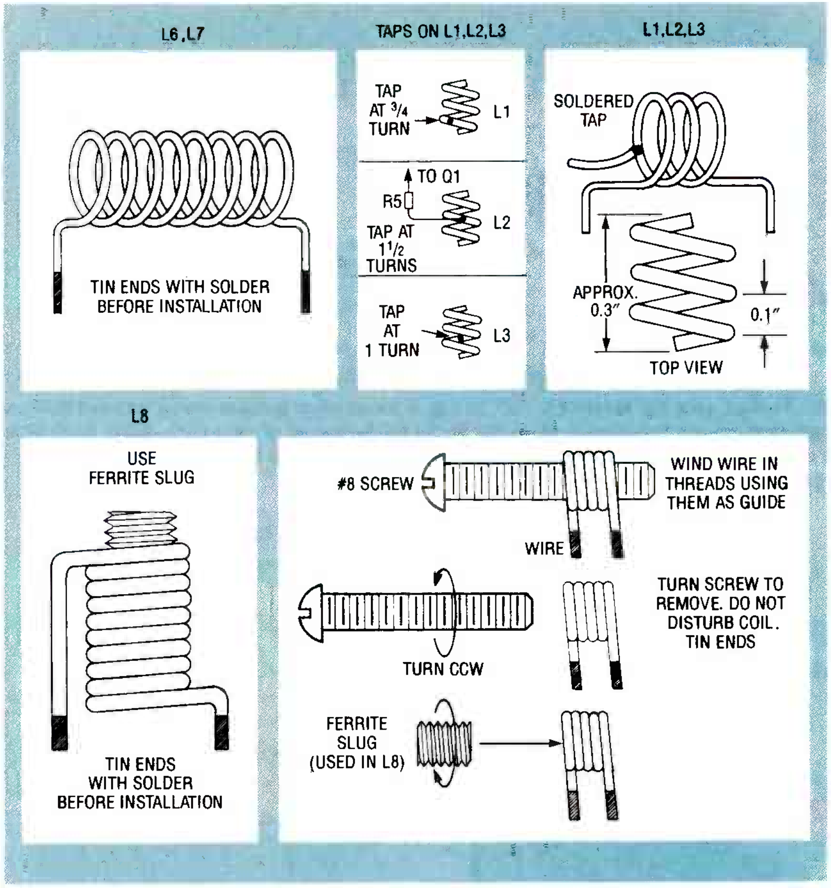


FIG. 5—COILS L1, L2, AND L3 are three turns each of 20 AWG tinned wire wound around a No. 8 screw and stretched to 0.3 inch. The lead from J1 has its center conductor soldered to L1 at ¾ turn from the grounded end. Resistor R5 is soldered 1½ turns from the end of L2 that connects to R6, C7, and C8. Coil L3 is tapped at 1 turn from the grounded end. Coils L6 and L7 are 8 turns each of 22 AWG enamelled wire wound on a No. 8 screw. Coil L8 is 9½ turns of 22 AWG enamelled wire wound on a No. 8 screw with a ferrite tuning slug added.

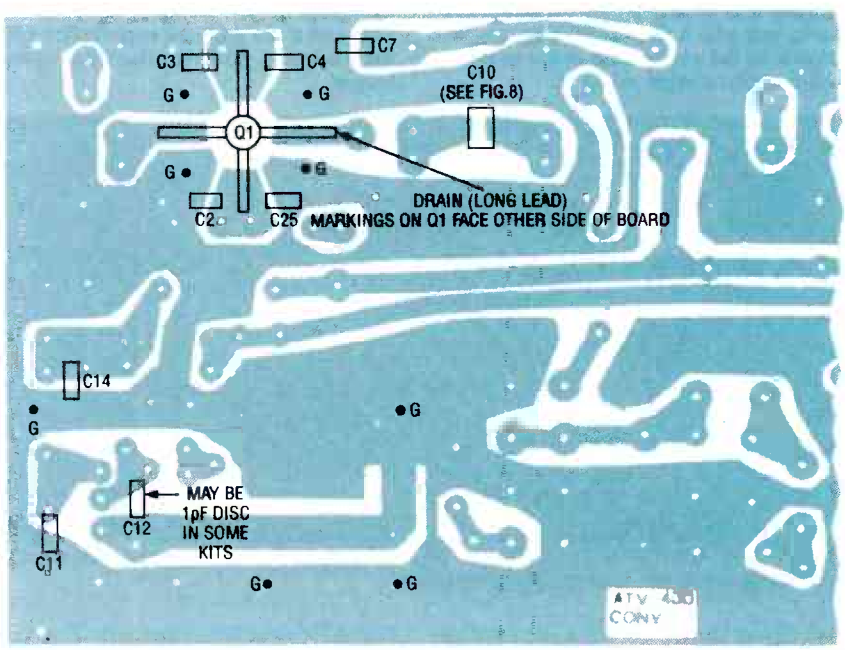


FIG. 6—ALL CHIP CAPACITORS, C10 (see Fig. 8), and Q1 mount on the solder side of the board. The markings on Q1 face the component side of the board.

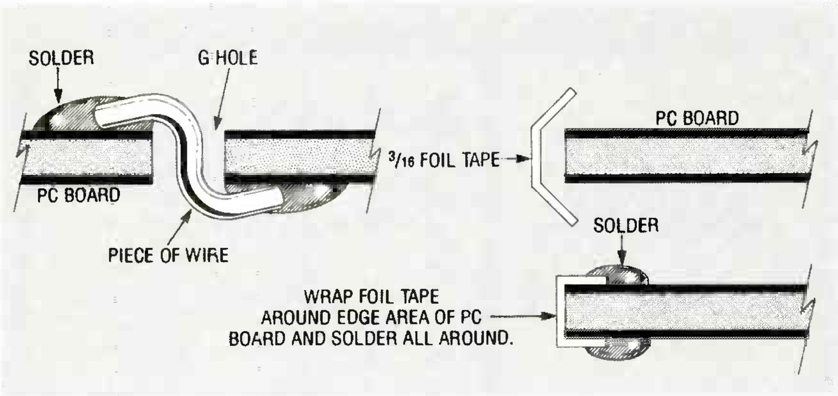


FIG. 7—ALL HOLES MARKED "G" in Fig. 4 must have jumper wires passed through them that are soldered on both sides of the PC board as shown here. Also, both sides of the board must be grounded together with copper-foil tape as shown.

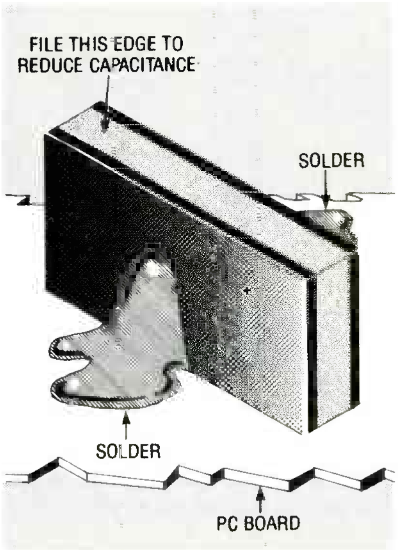


FIG. 8—TO MAKE C10, take a small square of G-10, 0.062-inch PC board material and trim it to a 3/16-inch square. Install it on the solder side of the board in the location shown in Fig. 6.

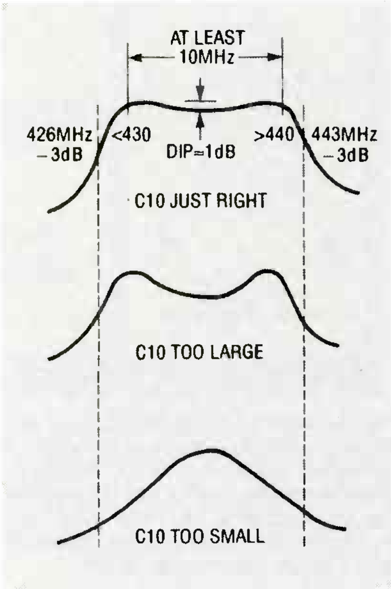


FIG. 10—PEAK THE CONVERTER for a response as shown here. By trimming C10 with a file you can experiment with the coupling and resultant bandpass shape.

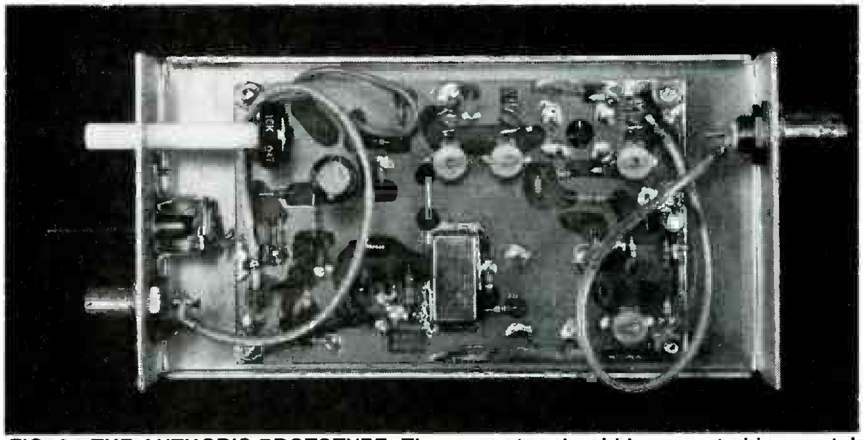


FIG. 9—THE AUTHOR'S PROTOTYPE. The converter should be mounted in a metal box, weatherproof if outdoor use is intended.

Figure 3 shows how J2 can be connected to a long coaxial transmission line that runs to the ATV receiver station. The cable is isolated from ground and can therefore carry a DC voltage. The DC voltage is impressed on the cable as follows: A nominal 26-volt power source at the ATV receiver station is connected to Q7, a 2N2222 NPN transistor used as an emitter-follower. Resistors R22 and R23 produce a variable voltage of 14 to 26 volts at the base of Q7, whose emitter will follow the voltage. Power is supplied to the cable through L11, and by varying potentiometer R23, the voltage applied via R22 to the cable at J3 can be adjusted between 14 and 24 volts. Capacitor C35 prevents any DC voltage from appearing at J4.

The DC voltage is taken off the cable via the 18μH RF choke L10. Capacitors C30 and C31 remove noise from the DC voltage and provide an RF ground. Positive voltage is fed to the downconverter via the cable's center conductor and the outer shield serves as the negative supply lead; it is grounded to the case and ground foil.

The DC input is fed to D6, a 12-volt Zener diode (a 1N759 can be used). Capacitors C33 and C34 filter any noise from the voltage which will be 12 volts less than the voltage on the coaxial transmission line (+14 to +24 volts), or +2 to +12 volts DC. That is fed to R10, which feeds the tuning voltage to the downconverter varactor. By varying the DC voltage on the transmission line between +14 and +24 volts, not only can the downconverter be powered, but it can be remotely tuned to a desired frequency as well.

Note that the components shown in Fig. 3 are not part of the downconverter board, and they are used only if remote operation is required.

Construction

The PC board material (G-10, 0.062 inch thick glass epoxy) and layout must be followed exactly to duplicate the performance of the downconverter. The stray capacitance, coupling between elements, and L4 are all integrated into the design of the board. Any layout deviations can change those specifications. The foil patterns are

continued on page 109

HARDWARE HACKER

Apple's PhotoGrade, electronic halftones, consultants network, marketing your ideas, and two great new books.

DON LANCASTER

Oh, the times, they are a-changing. We seem to have a mix of really bad and really awesome stuff coming down lately. Let's start off with some of the sadder vibes...

Heathkit has recently discontinued production on most of its electronic kits. It's the end of an era for sure.

But a funky little outfit called *Musty Manuals* is setting out to stock and make available all of those older Heath assembly books and instruction manuals. And lots of exciting hacker kits are being made available from such outfits as *PAIA*, *Old Colony*, and *Micro Mint*. Plus, of course, through several of the advertisers in this magazine.

The technical paperback book field (especially the non-computer titles) is clearly not well. *Sams* is essentially gone, bought out by Macmillan and triaged into an ethereal shadow of what once was the most respected and diversified technical book publishers in the world. *TAB* has been purchased by McGraw-Hill and become a subsidiary. I have been getting plenty of helpline complaints about several sources that offer dated and inaccurate titles. Believe it or not, your IRS is now *paying publishers to shred books*, especially old technical paperbacks, through an obscure inventory ruling that has totally decimated long-term back lists and older technical titles.

But—an incredibly exciting new opportunity called *Book-on-demand* publishing is emerging in which you can produce first-quality paperback and hardback books literally on your kitchen table *when and as they are ordered*. With a "forever" backlist, no IRS inventory penalties, and no lower limit to the total number of sellable volumes needed. And it also includes such exciting possibilities as a 90-percent author's royalty and rapid CD-ROM distribution. Much more on this on *GEnie* PSRT.

Very alarmingly, some community colleges are cutting back on or outright eliminating their electronics departments. And many electronic service and repair trade journals have vanished without a trace.

But—we now have got the richest and most incredible variety of cheap new chips to play with. Anywhere. Ever. We have major breakthroughs in hacker direct-toner printed circuits. We have a brand-new **Electronics Now** format with new features and fresh ideas that continues the oldest ongoing electronics magazine publishing house. And we are something like a scant eight years away from hardware that can surpass the human brain in logic and analysis capabilities.

Right now is certainly the greatest time *ever* to be getting into hardware hacking in a *very* big way.

Electronic halftones

I've recently been playing around with the new *LaserWriter G* and am *very* impressed with its new ability to print medium- to high-quality photo halftones. So, I thought we might review what is involved in the laser printing of photos in general, and see just why Apple's neat *PhotoGrade* process seems to beat out brute-force methods—and how we can do even better.

Many of those previous-generation laser printers were 300-DPI devices, capable of placing or not placing 300 whole dots per inch uniformly along any one selected laser scan line. That translates to 90,000 dots per square inch, or a tad over 8 million dots on a standard page. If a dot is only black or white, it can usually be represented on the *page bitmap* or in your *frame device* as a single bit. Thus, around a megabyte worth of memory must be reserved for your full-page bitmap at 300-DPI resolution.

The obvious big dilemma in raising your laser-printer resolution is this: As you go from 300 DPI to 1200 DPI, you could end up requiring *sixteen* times the memory! And your page makeup times could end up *sixteen times* as long! Yet "more" resolution is perceived to be a big user need. Or is it?

Actually, laser-printing resolution is pretty near as highly overrated as *Peterbilt* trucks or teenage sex. But that's another story for another time. I strongly feel that higher resolution is not worth losing genuine Adobe Level II PostScript, duplex printing options, low per-page printing costs, mainstream technology, good third-party supply sources, local hard-disk support, or any sleep.

A poorly scanned photo (or one that's not properly *histogram equalized*) will end up looking even *worse* on the premium machines.

One zero-cost way to increase your printer's resolution when you'd like "camera ready" art for conventional printing: Just work oversize and then photoreduce. Most of my *Hardware Hacker* figures are printed at 133 percent normal size and are then reduced here for an effective resolution of a scant 400 DPI. Yet I feel they look as good as most of the other technical figures.

An easy way of making a 300-DPI

NEED HELP?

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

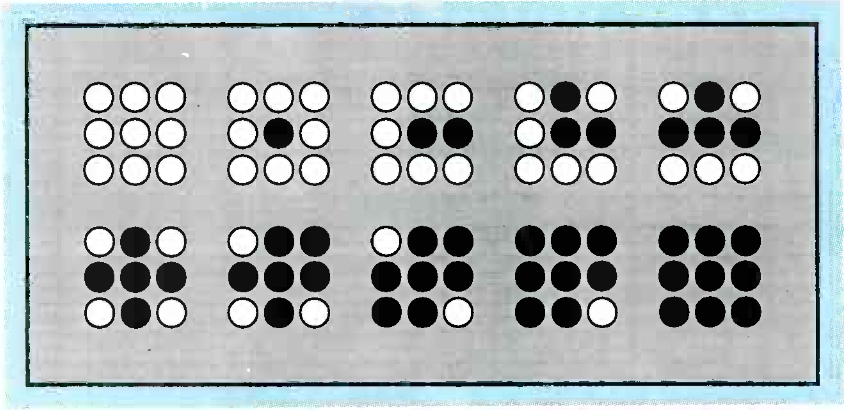


FIG. 1—A LASER PRINTER can fake a halftone by grouping dots into a larger "cell." In this example, a 3 × 3 pixel array forms a cell that can have ten gray levels, including black and white. On a 300-DPI printer, this would form a "100 line, 0 degree" halftone screen.

printer look better is to do a plain old smoothing job. That concept was pioneered by *Hewlett-Packard* as *Resolution Enhancement Technology*.

Apple (and many also-rans) have copied this idea. On the LaserWriter G, Apple calls it *FinePrint*.

The smoothing is done by a custom integrated circuit that intercepts and stores a few of the scan lines on their final way out to the laser scanner. By analyzing a matrix formed from the nearby dots on earlier and later lines, certain dot positions are delayed by one-half a dot, following a smoothing algorithm. The result is a really big improvement in most typography and some graphics, especially for reproducing slanted lines.

Despite all the hype, the circuitry involved is simple and cheap. And it can end up totally independent of the imaging model or language in use.

But plain old smoothing can't help halftone photos, and it may even

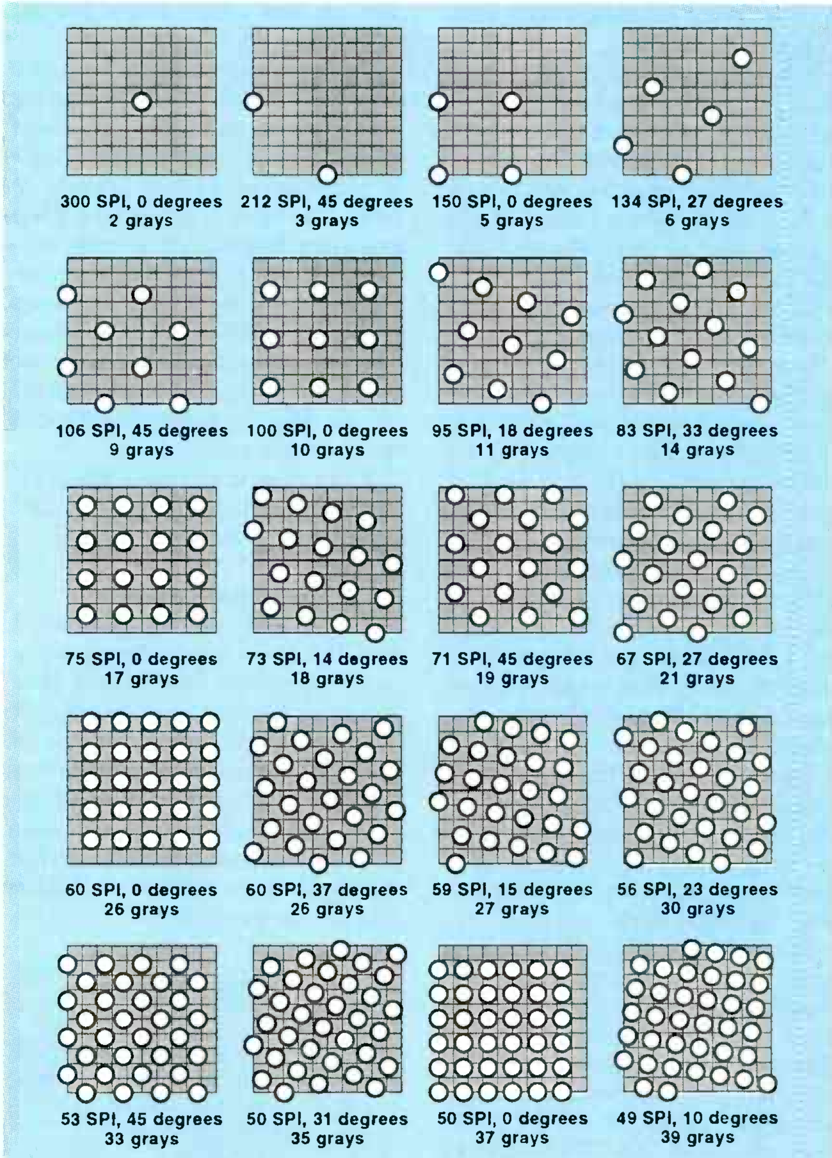


FIG. 2—THE AVAILABLE SPOT PATTERNS for a typical 300-DPI PostScript printer. Note that these are the *ONLY* dense patterns available. You'll get one of these regardless of what you ask for. Note the perfect tiling.

hurt. Let's look further at...

The halftone process

There is only one method to print something that is truly gray on the page. And that is to use gray ink. And each *different* shade of true gray will need a *different* gray ink and another pass through the printing press. Since this is clearly not good, printers have long used a *halftone* process instead.

The halftone process consists of printing lots of different-sized *black* dots very near to each other. The dots are carefully spaced to be less than the eye's angular resolution. Instead of seeing the individual dots, your eye averages out the black dots and the white background and perceives an average gray level. The higher the ratio of white to black, the lighter the gray, and vice versa. Let's try it out. Look at a gray portion of any black and white photograph or tint box in this magazine. While it looks gray with the naked eye, under a magnifying glass you'll see all the little dots that make up the *halftone*. The dots are all black.

To print any photograph, a special screen is used on the litho camera to convert gray values into collections of black dots of varying size.

Traditional printers will spec their *screen size* as the number of halftone spots per inch. Some popular ones include 85 spots per inch for tabloid news and the 120 spots per inch for most magazines of **Electronics Now** quality.

Even higher spot densities are used on premium magazines. But they require special inks, coated papers, and extreme attention to detail. *Note that even the highest spot densities used are nowhere near 300 spots per inch!*

A second halftone parameter is called the *screen angle*. It turns out that the human eye is very good at picking out horizontal and vertical lines, but rather poor on resolving diagonals. Since the halftone process introduces *visual artifacts*, it is often best to set your black-and-white screens on a 45-degree angle. In color printing, the halftone screen angles become even more critical if they are to eliminate objectionable *Moire* patterns.

Several methods can be used to fake halftone screens on laser printers. One method is to group all the possible laser dot positions into larger spots that I'll call a *cell*. Figure 1 shows you how a 300-DPI printer can use nine dots to make cells of 100 spots per inch. This particular cell has a screen angle of zero. As you can see, there are ten possible gray levels here, including black and white.

We can immediately see that we could use 36 dots to form 50-spot-per-inch cells. And those cells would give us 37 possible grays. Clearly, we have a tradeoff between the number of cells per inch and the number of available grays. Use too few cells per inch, and you'll end up with the "Sunday Funnies" effect with very grainy dots. Use too few grays, and you will *solarize* with obvious (and often objectionable) steps between each possible gray level.

The gray-level resolution of your eye depends on context and contrast, but a number slightly over 256 gray levels is possible. But, because of the stupendous costs of exceeding 256 grays, most experts agree that eight bits of gray scale resolution is enough even for premium images. Television sometimes might get by with as few as six bits, good for a mere 64 gray levels.

The obvious next question is "How good can our halftones image at an unenhanced resolution of 300 DPI?" Ignoring the obvious answer of "Not good enough," we'll then go on to ask "What can we do about it?"

PostScript to the rescue

I have found that the *PostScript* general-purpose computer language has some really great approaches to electronic halftones. Those involve their *setscreen* and *image* operators, among many others. PostScript uses some imaging *tiles* that determine the screen angles and frequencies. Since these screen tiles must all abut each other perfectly and still must obey integer (whole numbers only) math, there are very definite limits to which 300-DPI tiles are and are not possible. If you ask for some halftone cell angle or frequency that is simply not physically possible, PostScript will substitute the nearest handy one.

Figure 2 shows you the available denser halftone cells as used on most popular 300-DPI PostScript printers. Figure 3 shows you the *secret gray map* for all of the "hidden" PostScript grays.

Typical PostScript users and most applications packages blindly insist on using the *seventeenth* most putrid PostScript gray available. While this is often incorrectly called a 60-DPI screen, its effective resolution is only 53 dots per inch. There are 33 grays with this default screen.

That sort of explains the "Sunday Funnies" effect of most poorly done PostScript screens. And one of the biggest reasons why people feel they need "more" resolution. When in fact, their grays can all get instantly and dramatically improved by using a few dozen keystrokes!

Ferinstance, the best PostScript 300 DPI halftone screen for typical graphics is a 106 DPI, 45-degree one which gives you absolutely beautiful grays. Sadly, you'll only get ten of those grays, but the lightest ones are very good for graphics.

Two other quite useful 300 DPI secret PostScript grays of interest are the 85-line and 35-degree "reprogray" useful for oversize camera-ready art, and the 135-line, 25-degree "india ink wash" gray. The latter gives you only six gray levels and requires a careful selection of toner and paper. But the results are stunning.

One way to do a best PostScript gray is to enter these keystrokes as PostScript commands...

106 45 dup mul exch dup mul
add 1.0 exch sub setscreen

The first number is your cell frequency; the second is your angle. The details of where and how you enter these code lines depend on

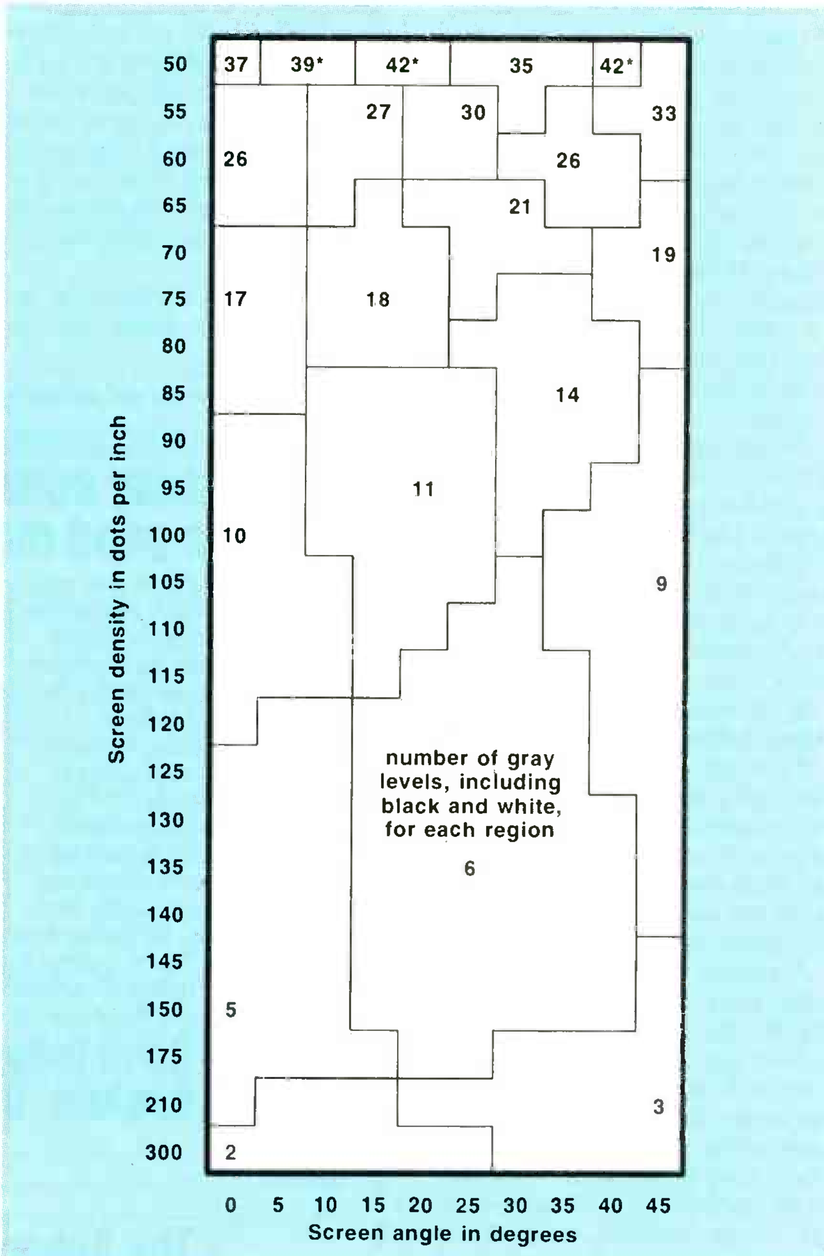


FIG. 3—THE TOP SECRET GRAY MAP for a 300-DPI PostScript printer. Most users and most application packages insist on using the seventeenth most putrid of the available grays. The best graphics gray is 106 DPI at 45 degrees.

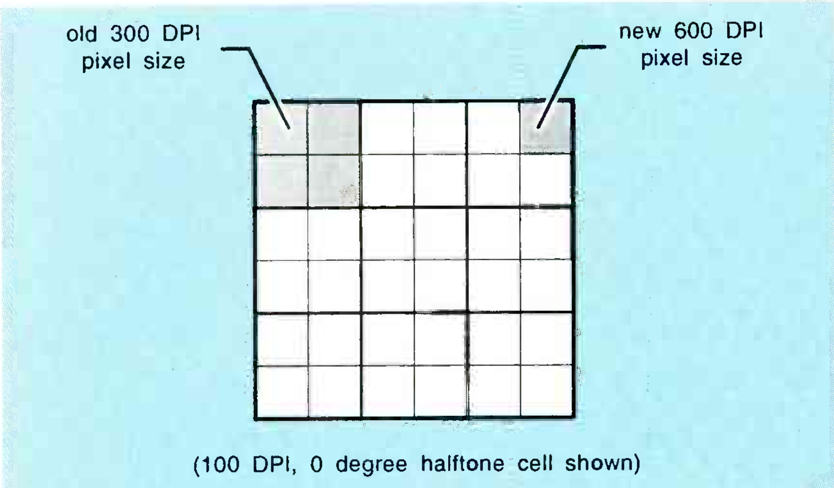


FIG. 4—BOTH QMS AND IBM/LEXMARK chose the "brute force" 600-DPI method to improve their PostScript photo halftones. The original 100-DPI spots allowed 10 gray levels; the new ones allow 37. There is a 4× speed and 4× memory penalty for the modest (but certainly welcome) improvement.

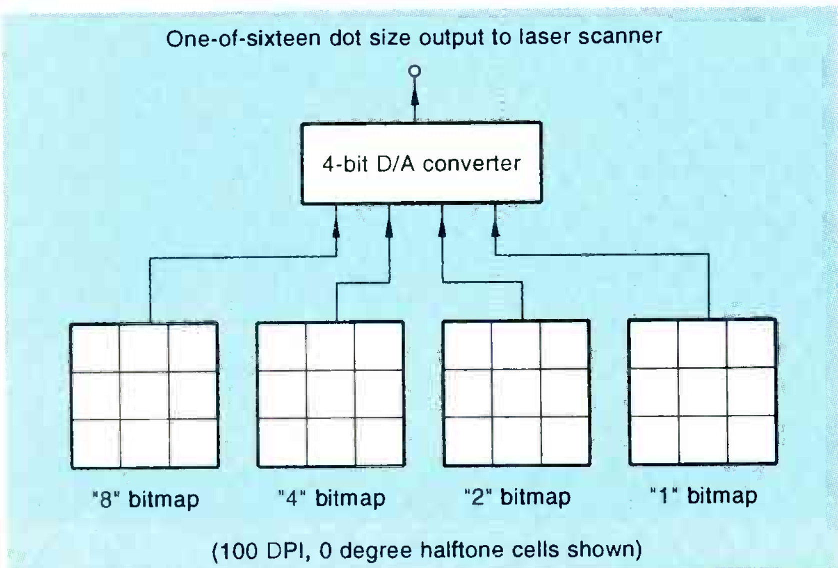


FIG. 5—THE APPLE LASERWRITER G remains at 300 DPI, but it uses four bitmap memory planes that allow one of sixteen pixel dot sizes. That permits 144 gray levels at 100 DPI for good- to better-grade photo halftones. Or 128 gray levels at the more popular 106 DPI and 45 degree screen.

your PostScript programming style or the applications package you have. Call me if you need any further help on this.

No, none of those screens can give you any high-quality halftone photos. But the 75-line screen can give you a recognizable "auto shopper" quality photograph. Especially if the scanned image has been properly histogram-equalized.

Three key points: The halftone dots used in everyday printing are *much coarser* than 300 DPI. Some excellent graphic PostScript grays are available at 300 DPI. They need only a few dozen simple keystrokes for their activation. And our halftone photo quality, *when given any properly image processed input*, doesn't miss by that much.

So we can potentially add only a little to 300 DPI and gain enormously on halftone photo quality. Both *QMS* and *IBM/Lexmark* picked the brute force method. As Fig. 4 shows us, they switched to a 600-DPI double resolution and then swallowed the 4:1 speed and memory penalties. At 100 cells per inch, you now have 37 gray levels. Or 50 gray levels at an 85-cells-per-inch

NAMES AND NUMBERS

Addison-Wesley
Jacob Way
Reading, MA 01867
(617) 944-3700
CIRCLE 316 ON FREE INFORMATION CARD

Apple Computer
20525 Mariani Avenue
Cupertino, CA 95014
(408) 996-1010
CIRCLE 317 ON FREE INFORMATION CARD

Fistell's Microelectronics
7023 East Colfax
Denver, CO 80220
(303) 393-6000
CIRCLE 318 ON FREE INFORMATION CARD

Hewlett-Packard Company
PO Box 10301
Palo Alto, CA 94303
(415) 857-1501
CIRCLE 319 ON FREE INFORMATION CARD

IBM/Lexmark
1221 Alverser Drive
Midlothian, VA 23113
(800) 438-2468
CIRCLE 320 ON FREE INFORMATION CARD

Keyboard Systems
3637 East 7800 South
Salt Lake City, UT 84121
(801) 943-7888
CIRCLE 321 ON FREE INFORMATION CARD

Magazine of Service Management
PO Box 12901
Overland Park, KS 66282
(913) 341-1300
CIRCLE 322 ON FREE INFORMATION CARD

Musty Manuals
645 Wheeling Road
Wheeling, IL 60090
(708) 634-6467
CIRCLE 323 ON FREE INFORMATION CARD

Navtech Information Service
2775 South Quincy St #610
Arlington, VA 22206
(800) NAV-0885
CIRCLE 324 ON FREE INFORMATION CARD

Old Colony Audio
PO Box 243
Peterborough, NH 03458
(603) 924-6371
CIRCLE 325 ON FREE INFORMATION CARD

QMS
PO Box 81250
Mobile, AL 36689
(205) 633-4300
CIRCLE 326 ON FREE INFORMATION CARD

Spread Spectrum Scene
PO Box 2199
El Granada, CA 94018
(510) 278-3157
CIRCLE 327 ON FREE INFORMATION CARD

Texas Instruments
PO Box 809066
Dallas, TX 75380
(800) 336-5236
CIRCLE 328 ON FREE INFORMATION CARD

Vox Humania Press
150 Locust Street
Macungie, PA 18062
(215) 966-2200
CIRCLE 329 ON FREE INFORMATION CARD

density. That could make the difference between lousy and not half bad photo halftones. Especially given a proper digital image processing.

Apple has chosen the more elegant *PhotoGrade* method shown in Fig. 5. They remained at 300 DPI, but added three extra bitmap memory planes for a total of four. Then they modulated their laser dot size to one of sixteen values. You now can have *sixteen* times as many potential gray levels as you did at 300 DPI with only a single memory plane. At 106 DPI, you now have a much better 129 gray levels available. That is equal to a brute force resolution of 1200 DPI!

There is only a negligible speed penalty, since all four memory planes are written in parallel by custom-designed LSI chips. And while you retain the same 4 × memory penalty as a brute force 600 × 600, you'll get *four times* the effective resolution!

The result? Good to better photo halftones out of any plain old 300-DPI laser-printer engine. Especially with premium toner and properly scanned image processing. The PhotoGrade is also upgradable on older NT and NTX printers with a simple plug-in board.

Can we do better?

I think we can. At least in theory. For any 100-spot-per-inch tile at plain old 300 DPI, we are using *nine* bits to call out only 10 different spot values. Since nine bits could represent 512 different state values, the *memory use efficiency* is a tad un-

PRODUCT MARKETING RESOURCES

DesignTech International
7401 Fullerton Road
Springfield, VA 22153
(703) 866-2000
CIRCLE 330 ON FREE INFORMATION CARD

Encyclopedia of Associations
835 Penobscot Building
Detroit, MI 48226
(313) 961-2242
CIRCLE 331 ON FREE INFORMATION CARD

GEnie
401 North Washington Street
Rockville, MD 20850
(800) 638-9636
CIRCLE 332 ON FREE INFORMATION CARD

Inventor-Entrepreneur Network
1683 Plymouth Road
Ann Arbor, MI 48105
(313) 663-8000
CIRCLE 333 ON FREE INFORMATION CARD

Micro-Mint
4 Park Street, Suite 20
Vernon, CT 06066
(203) 875-2751
CIRCLE 334 ON FREE INFORMATION CARD

Midnight Engineering
111 E Drake Road Suite 7041
Ft Collins, CO 80525
(303) 491-9092
CIRCLE 335 ON FREE INFORMATION CARD

PAIA Electronics
3200 Teakwood Lane
Edmond, OK 73013
(405) 340-6300
CIRCLE 336 ON FREE INFORMATION CARD

Redmond Cable
17371-A1 NE 67th Court
Redmond, WA 98052
(206) 882-2009
CIRCLE 337 ON FREE INFORMATION CARD

Synergetics Consultants Network
Box 809
Thatcher, AZ 85552
(602) 428-4073
CIRCLE 338 ON FREE INFORMATION CARD

Whole Earth Review
27 Gate Five Road
Sausalito, CA 94965
(415) 332-1716
CIRCLE 339 ON FREE INFORMATION CARD

der two percent. Wowie gee!

The *PhotoGrade* does ridiculously worse. Here we are asking *36* bits to call out a mere 144 different gray levels. Since thirty-six bits can yield us up to 68,719,476,736 different states, our memory use efficiency is essentially *zero*! Thus, *virtually all of that Apple PhotoGrade memory bitmap is totally wasted!*

Instead, let's go back to, say, 100 spots per inch at a plain old 300 DPI. Once in the *center* of every desired halftone spot, put out a *single* laser dot having 512 possible size values. Presto. A mind-blowing total of 512 grays at 100 DPI; Or a *perfect* 256 grays up at the usual 106 DPI! This is for photo halftone dots only; you would still be able to do special screens and weird spot functions the old way. Patterns, too.

For us to make full use of what seems theoretically designable, you would need some special automatic mode sensing for the halftone areas. And a diamond-shaped laser beam whose diameter could be controlled over a 25-decibel or 16:1 range. Down from a maximum slightly under three times *larger* than is now used. None of those needs seems a really big deal.

Thus, it should be theoretically possible to build a 300-DPI PostScript laser printer with outstanding photo halftones. A 1697 DPI equivalent. At *zero* speed or memory penalties. Hmmmm...

I have posted lots of halftone and secret gray study examples to *GEnie* PSRT, especially my files 129, 141, 144, 179, 180, 231, and 239. I've also uploaded some high-quality images that you can play with, either inside or outside PostScript. In particular, check out LENA.PS, MANDRILL.PS, and my enhanced LENAHIST.PS.

Marketing your products

I was pleasantly surprised to find that the leading invention marketing firms are now publishing their track records—up front in their initial mailings. One of the oldest and largest discloses: Of the ideas submitted and contracted, the odds of getting a royalty license are 100:1 against,

continued on page 93

AUDIO UPDATE

Format future shock

LARRY KLEIN

Are we lost in a forest of new audio formats? Is there a future for DAT, DCC, and the mini disc—not to mention recordable CD's?

I have always considered myself relatively immune to the effects of "Future Shock." As you may recall, the dreaded FS Syndrome describes the disturbed and disoriented behavior of those suffering input overload brought on by too many life changes happening too fast.

Students of sociology are aware that the organization of any society roughly reflects the way that the people in it make their living. And the kind of work that people do, in turn, derives from the technological level of the society. Since technology is cumulative, it follows that change, for better or worse, is inevitable. (I could cite historical data for all this, but for the sake of argument, just take my word for it). It has been suggested in other contexts that the way to deal with the inevitable is to relax and, if possible, enjoy it. But for many audiophiles, their fun is threatened by the proliferation and confusion of many competing formats.

All this is by way of a psycho-historical introduction to the present state of home audio electronics. In past articles I've looked at the question of new formats and examined the factors that make them into hits or misses. As I see it, the majority of audio consumers are most interested in a format's convenience and only secondarily in its fidelity. Although I certainly don't discount the very low distortion and noise-free qualities of the CD format, its obvious attractions—for the average consumer—mostly reside in its durability and convenient handling. My evidence for all this is the fact that several years ago the compact, convenient-to-use, and relatively rugged prerecorded cassette started to outsell LP's despite the LP's superior sound quality and lower price. For the same reasons, the latest figures show that CD's are now outselling cassettes in dollar volume. Next year's figures will probably show superior sales in absolute numbers as well.

What does all this tell us about the relatively sudden proliferation of new audio formats—and consumer reactions to them in the past several years? Are the Japanese (and others) engaging in a strange rite of mutual commercial throat-cutting? For example, no sooner did the CD format establish itself than digital audio tape (DAT) was introduced. Although the two formats were not really competitors any more than LP's and open-reel tapes were, consumer confusion was rampant. And consumers stayed away from the DAT format in droves!

Then, in 1986, the word was out that various companies were working on a recordable CD. About four years ago one company held a press conference during which it was claimed that their digital recorder/player would be on the market in about two years—and would cost less than $500! It didn't happen then, but recently Carver and Philips announced the imminent release of a new breed of compact-disc recorders. A clue to the target market for the machine is given in the Carver press release: "Professional user net price of the PDR-10 is under $8,000." In truth, I don't have a feel for the professional in the recording industry, but audio consumers are not likely to be waiting in line to invest so heavily in an unproven product with (for them) somehwat obscure advantages.

Planned obsolescence?

Over the years, I've occasionally defended the hi-fi industry against the recurrent charge of engaging in "planned obsolescence." The conversion from 78's to LP's, tubes to transistors, mono FM and records to stereo all struck me as worthwhile advances in the audio art rather than nefarious plots to sell new products. With today's technologies I'm not so sure.

Is Japan so filled with technologically obsessed marketers that they compulsively create new audio formats oblivious to consumer needs and reactions? Is their guiding philosophy something like the classic advertising agency approach, "Let's run it up the flagpole and see if anyone salutes."? If so, it's an expensive and frequently self-defeating way to run an industry.

Several years ago, the consumer-electronics trade publication *Twice* ran an interview with Hiroki Shimizu, general manager of JVC's Personal Audio Products Division. Mr. Shimizu's comments were so startlingly different from the usual self-serving presentations heard at new-product press conferences that they are worth quoting. Shimizu was troubled by what he called the ethical (!) aspects of today's proliferation of formats. He suggested that the industry was coming out with too many products too fast without considering the interest—or best interests—of the consumer. DAT technology, according to Mr. Shimizu, came too fast and the application came later; as a result the market has not taken off. The application should come first, he said. In his view the most important thing is how the new product will fit into the market.

Other voices of discontent are heard in the land. A writer in *The*

PHILIPS' DCC900 will be one of the first Digital Compact Cassette decks on the market.

New York Times suggested that the proliferation of competing formats is part of a conspiracy involving Sony (CBS Records), Matsushita (MCA Records), and Philips to somehow protect their record-company royalties from the predations of rabid home recordists. (If the recording machines don't sell because of consumer confusion, they won't be used to copy copyrighted material.) However, it seems improbable to me that the music and audio-product divisions of a company would play those sort of internal games with so much cash and prestige on the line.

Future formats

Do I have any advice to offer those seeking to keep their heads above water in the flood of new audio products? For one thing, read the articles extolling the virtues of this or that new format with a critical eye. Remember that most writers and editors believe that readers are automatically turned on by the *New!* Experience has shown, however, that large numbers of excited words devoted to the advent of a new audio format don't reliably predict its success.

Given the snowballing of technology, it's hard to make predictions, but certain developments seem inevitable. In a science-fiction story I wrote in 1977, I predicted that the turn of the century would see a fiber-optic cable that linked most homes in America. Among its many services would be the ability to call up any musical composition, pop or classical, from the world's recorded library. Separate musical software as such would be obsolete, as would, of course, the players that deliver it. I think such a development is inevitable, and it would finally put an end to all the format shenanigans. Or would it? **R-E**

HARDWARE HACKER

continued from page 91

and the odds of any positive cash flow that exceed costs are 600:1 against!

Those figures sound about right to me. Sometimes I've done almost that well on my own. And sometimes not. Selling an idea is a real rough row to hoe. One that could become a near impossibility if you are not a fully trained and well experienced insider knowledgeable about what is going on in trade journals, politics, economics, and the tech literature of the target field.

An invention-marketing firm is just a hired gun, similar to an ad agency or a resume-typing service. You pay them for their time and effort for such services as patent searches, listings in product newsletters, and participation in invention fairs—cash up front.

As we've seen a number of times in the past, the core problem lies in the absurd mythology surrounding today's patent system. Very simply, patents have little or nothing at all to do with the selling or marketing of an idea. For most individuals and most small-scale technical startups, *any involvement whatsoever with the patent system is virtually certain to end up as a net loss of time, energy, money, and sanity.*

Just about all hackers will tend to grossly overvalue a new idea. At one time way back in the golden age of inventing, ideas were occasionally worth as much as a dime a dozen. Today, they are worth less than ten cents a bale in ten-bale lots. Ideas gain value *only* when you can clearly demonstrate your end users actually getting off on them. And then *only* when those ideas are *already* in some saleable, competitive, promotable, and distributable form.

The key secret to selling an idea is very simple: *The buyer must come to you.* For our special resource sidebar this month, I have gathered together some ideas that can help you to profit from your ideas.

Two essential magazines are that *Midnight Engineering* and the

continued on page 108

continued from page 52

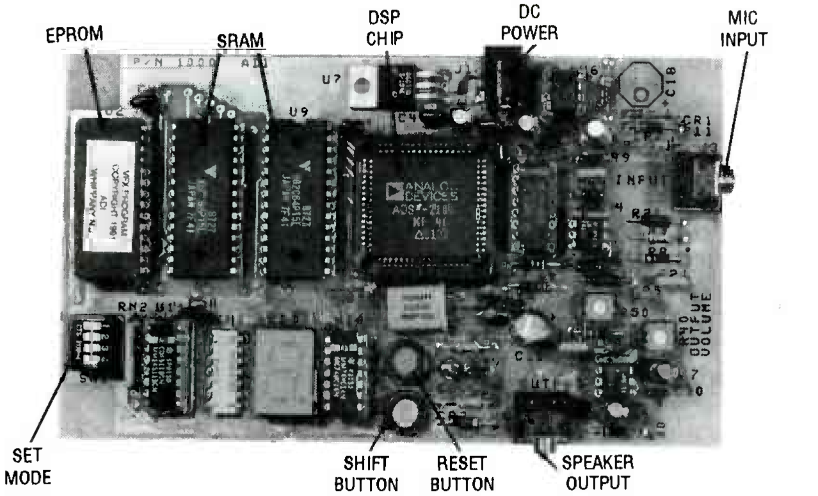


FIG. 9—THE VFX PROTOTYPE. Carefully check the board for solder splashes and bridging before applying power.

button and the LED display should count fast enough so that all the segments (an "8") appear dimly lit.

Remove power from the board and install the two RAM's (IC8 and IC9). Apply power to the board. The LED should again display "6." Press the SHIFT button and the LED should display "0." If any RAM errors occur, they will cause the LED display to increment.

Next install IC3 and IC5. Connect your speaker or headphones to J2 and reapply power. Press the SHIFT button twice and a tone should be heard in the headphones or speaker. Install IC4 and connect a microphone to J3. Apply power and press the SHIFT button three times. Then speak into the microphone and your voice should be heard through the headphones. Adjust potentiometers R50 and R40 for minimum distortion. Now that your VFX board is working, you can change the DIP switches according to Table 1 for the other three effects.

As mentioned before, there is a test mode that can help troubleshoot the VFX processor. It is activated by setting the DIP switches as shown in Table 1 and pressing the reset button. The test mode individually tests the system RAM, the CODEC, and the LED display.

In the test mode the external SRAM is constantly written to and read, and the number of errors are displayed on the LED. If the LED display is blank and all the power supplies are normal, there is something wrong with the LED or the driver. If the LED has a number other than zero, there might be a problem with the SRAM.

The CODEC data is received and immediately retransmitted, so the microphone input is echoed back the headphones. If there is no output or if the output doesn't sound like the input, there is a problem. If there are no other fault indications and the microphone and speaker are working, there might be a problem with the CODEC. If nothing happens and the power supplies are normal, there might be a problem with the digital signal processing chip or the EPROM.

Where to go from here

The VFX processor is intended to demonstrate in, an enjoyable way, the capabilities of digital signal processing. The four applications programmed into the VFX board are just four out of many possible applications. The VFX processor hardware is capable of being reprogrammed to perform other functions as well. Some of the possibilities are speech recognition, active noise cancellation, voice compression/recording, and a spectrum-shifting hearing aid.

For example, the VFX processor could easily recognize the numbers from 0 to 9 and display them on the LED indicator. That requires that the speech be converted into the frequency domain and the spectral peaks of the sound be compared with pre-stored templates. The closest matching sound is selected and displayed on the LED. The processor could then generate the DTMF signals for that number to make a voice-activated telephone dialer.

A voice compressor/recorder converts an audio input into the frequency domain, picks out the most prominent spectral energies, and stores them in data memory as frequency and amplitude. The technique can reduce the amount of data that must be stored compared to that from conventional digitizing processes from 6.5K words per second to 650 to 300 words per second. The VFX board with 8K words can record approximately 12 to 25 seconds of compressed speech.

Active noise cancellation is being developed for applications ranging from muffling the sound of automobile engines and industrial machines to eliminating the background hissing noise in fighter-aircraft intercom-system headphones. Similar applications for the VFX board are being developed. Let us know if you have any other applications you would like programmed into the VFX processor. If you are interested in programming your own applications, look into the EZ-LAB system sold by Analog Devices that has been referenced in this article. It is an affordable way to implement small- to medium-sized algorithms.. **R-E**

DRAWING BOARD

Video scrambling.

ROBERT GROSSBLATT

Looking at a line of video on an oscilloscope or waveform monitor can be a real eye opener. As we discuss the various factors involved in video scrambling, you'll need a good understanding of video to follow along. You'll also need some equipment to view the waveform, other than on a TV set. For a good background on video, get your hands on the series of Drawing Board columns I did on video from January to November 1990. You'll probably be able to find them in your library if you don't have the back issues.

The starting point for any would-be unscrambler (hereinafter referred to as "us") is that scramblers (hereinafter referred to as "them") start out with a signal that's exactly the one we want to wind up with. Video originates in the clear, gets messed up one way or another by them, and is sent to us. Our job is simply to undo what they've spent a lot of money doing.

You don't have to be a rocket scientist to mess up video—that is true both aesthetically and scientifically. The hard part is to do it in such a way that you can put it back together again. This means that there has to be a rigorous approach—almost a mathematical one—to tearing the signal apart.

Take a look at—and get intimately familiar with—the typical line of video shown in Fig. 1. While most of the time on the line is devoted to the picture area, it's the control area where the real work is done. The signal in the picture area determines what you'll be seeing on the screen but the stuff in the control area is what tells your TV where to put the picture and how it's supposed to appear.

The control area is blown up in Fig. 2, and the information in it is a graphed function of time and voltage. By the way, most video people like to talk about "units of video" rather than voltage for the same reason that audio people like to talk about decibels rather than voltage.

When the NTSC video standard was established, the two most basic decisions made were that it would range from 0 to 1 volt peak-to-peak, and that one voltage range would be reserved for picture and one would be reserved for control. As we go through our discussion on scrambled video, I'll talk sometimes about video in terms of IRE units and other times about voltage. The two are directly related as shown on the Y axis of Fig. 2.

The bottom line of the picture is 0 IRE units which is about 0.3 volts up the IRE scale. That point is important because it's both the defined level for black video (no picture on the screen) and the upper limit for any control signals. (There's a slight ambiguity here when you examine the colorburst but we'll get to that later.) For the moment, we can consider everything above 0.3 volts as picture and everything below that as non-picture.

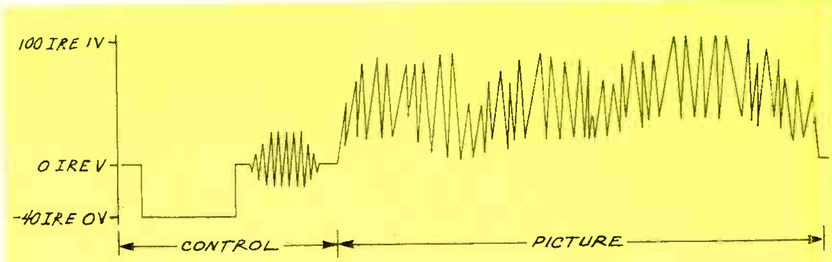


FIG. 1—TYPICAL LINE OF VIDEO. Most of the line is devoted to the picture area, but it's the control area that we're interested in.

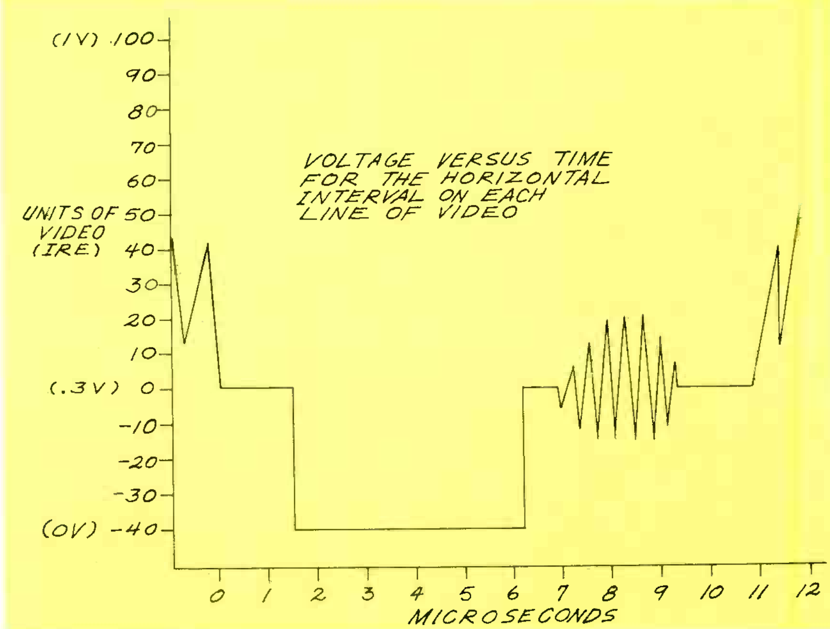


FIG. 2—THE CONTROL AREA. The NTSC video standard says that the signal can range from 0 to 1 volt peak-to-peak.

That signal definition is the basis for most of the hardware in every NTSC-compatible TV ever made. Your TV contains circuitry that expects control information to be below 0.3 volts and picture information from 0.3 to 1 volt. That's important because it is the starting point for scramblers; when you get rid of some of the control information, a standard TV can't display the picture. Remember that the horizontal sync pulse defines the end (or, depending on your point of view, the beginning) of a line of video. If the TV doesn't see it, it won't know how to display the line on the screen, and the result will be that the TV will end one line and start another one at some random point on the screen.

The freewheeling retrace frequency of the TV will come close to the one sent by the broadcaster, but it won't match exactly. What you'll see on the screen will be something like Fig. 3. The curved line running down the center of the screen is the horizontal interval sent by the broadcaster.

Three things are happening in Fig. 3. The first is that the line is curved because the horizontal circuitry in your TV runs at a frequency that's not exactly the same as the broadcast horizontal frequency. The TV can accept a certain amount of drift in the horizontal frequency. Once upon a time a horizontal control was built into on the TV so you could hand tune the TV to the received signal. Although that control isn't around any longer (except sometimes as a trimmer on a circuit board inside the TV), the tolerance is still there. Modern TV's can automatically lock onto the broadcast horizontal frequency so there's no reason for the horizontal control to be accessible.

The second thing that's happening is that the line is in the center of your screen. The reason for that is simple. The TV's horizontal circuit uses the received horizontal pulse as an instruction to move the beam back to the left side of the screen. Because the scrambled signal has anything but a recognizable horizontal sync pulse, the TV zips the line back to the left side of the screen whenever it reaches the right side.

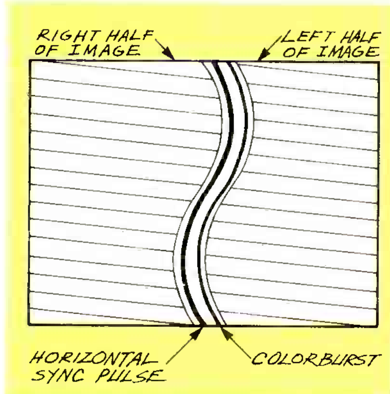


FIG. 3—A FREEWHEELING RETRACE won't match the frequency sent by the broadcaster. The curved line running down the center of the screen is the horizontal interval sent by the broadcaster.

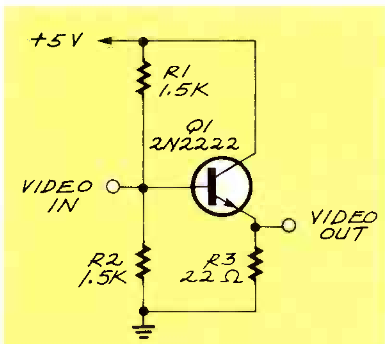


FIG. 4—A VIDEO BUFFER isolates one stage of hardware from another. The transistor is set up as a buffer and the level of the video can be controlled by the value of R2.

Because that has nothing to do with the signal it's receiving, the line usually shows up at some random spot on the screen. The TV's freewheeling frequency is close to the broadcast horizontal frequency, so the TV will start a new line at about the same point in the broadcast line. That means you'll see the broadcast horizontal interval on each line at more or less the same horizontal location on the screen. The result is a curved line down the screen.

The third thing happening on the TV screen is that the colors are messed up. Because the horizontal sync is missing, the TV circuitry isn't seeing the colorburst in the right place, so there's no reference for either the intensity or color of the picture. The TV then uses whatever it sees in the colorburst location as a reference for both the intensity and color of the image.

You can see now that by simply getting rid of horizontal sync, the resulting video signal will be completely messed up. The best way to appreciate that, and a good way to get into video hardware, is to build something to demonstrate how all this stuff really happens. That's right, our first piece of hardware is going to be something that will let you scramble video. And, as far as the law is concerned, I'm pretty sure that nobody's going to become very upset.

We'll need a source of real video. That can be anything from an NTSC generator to a line-level video signal from the back of a VCR. You'll also need a scope to look at the video waveform and a TV to look at the picture. You can do without the latter but the former is a must. I'm not going to beat you up any more about getting a scope, but if you don't have one, get one. If you don't get one, this series of columns, while informative, will be somewhat less than useful from a practical point of view.

To get started, because we're building circuitry that is going to use an external signal, the first thing we have to do is buffer it. That is done for two reasons. The first is that we have to be able to control the level seen by our video circuitry, and the second is so that a wiring error on the breadboard isn't going to send unpleasant voltages back to the signal generator or VCR. The results could be a bit nasty.

Video buffers are just like any other buffer—they're simple circuits that isolate one stage of hardware from another. Think of it as being like an electronic fuse. The easiest way to build a buffer is with a single transistor as shown in Fig. 4. The transistor is set up as a buffer, and the level of the video can be controlled by the value of R2. You can also put a potentiometer in series on the line feeding the video to the base of the transistor and trim the level that way.

Although the NTSC video standard calls for a signal that's 1-volt peak-to-peak, most VCR manufacturers don't strictly follow that standard when it comes to a video output signal. If you put the signal on a scope, you'll probably find that it's a bit higher than that. If that's the

continued on page 109

COMPUTER CONNECTIONS

The Cheshire Cat, multimedia, and vision.

JEFF HOLTZMAN

Vision, according to the American Heritage Electronic Dictionary, can be defined in five ways: 1. The faculty of sight. 2. Unusual foresight. 3. A mental image produced by the imagination. 4. Something, as a supernatural sight, perceived through unusual means. 5. One of extraordinary beauty.

In the business world, definition 2 is what people usually think of. Actually, definition 3 is most important. Persons with unusual foresight help bridge short-term gaps between today and tomorrow. Persons with imagination set long-term goals and directions, and inspire others to try to move in those directions to achieve those goals. Companies are typically founded by Type-3 people, and run by Type-2's.

Starting about 250 years ago during the dawn of the industrial revolution, technical vision and imagination in the western world focused on building tangible items to ease the time involved in producing, transporting, and defending necessities. After about 200 years of widespread social effort, most of those problems were solved, so persons with visionary imagination shifted focus to a different set of problems. From these origins was born the computer industry.

Early work in that field centered on doing the same kinds of activities people had been doing—e.g., accounting and typing—only faster. Things started to get interesting when Ted Nelson, Doug Englebart, and others realized that the computer had created a whole new world, a "virtual" world. Again the American Heritage, this time on virtual image: *An image from which rays of reflected or refracted light appear to diverge, as from an image seen in a plane mirror.*

There is a virtual world behind the CRT, from which *imaginary* light rays are diverging, rays that until recently were visible only to mathematicians, computer scientists, and software engineers. Now, thanks to Nelson and company, and more recently to video games and the Macintosh (and let's not forget Microsoft Windows), that Cheshire cat image is becoming accessible to more and more people.

Graphics editors let artists reach in and take hold of some of that virtual Play-Dough a proprietary term. On-line references let writers and researchers tap into the knowledge of the world. Three-D CAD programs let architects and product designers "build" prototypes without cutting wood or metal. Medical imaging devices let medical technicians and researchers non-intrusively create images of body parts. Serious and popular composers use synthesizers to create new musical forms.

Computer technology has penetrated many disciplines, but it still has a long way to go. Take video editing for one. The traditional method for editing videotape and film is to do a lot of physical fast-forwarding and rewinding. The efficient way to do the job is via random access, instantly jumping from any frame to any other. Due to the immense storage required for video information, effective random access completely dwarfs the storage and bus-bandwidth capabilities of today's most powerful personal computers and low-cost networks.

Multimedia

This is where Type-3 vision comes in. That vision centers around a topic of growing public interest: multimedia. Don't be misled by popular computer, video, and games magazines. Multimedia is not just putting a sound board in a PC, or adding a CD-ROM drive to a Nintendo. The real promise behind multimedia is twofold: 1) To bring the whole world into that virtual image behind the CRT, and 2) To connect your virtual image to mine and everyone else's.

The requirements for rich multimedia are simple: 16-bit audio, full-screen 30-frame-per-second video, 24-bit (photographic-quality) imaging, fast access to lots of textual and numeric data—all of which must be available on-demand, synchronously, instantaneously, at any time, and (eventually) anywhere in the world.

It would take a powerful mainframe to provide that kind of capability today. On the other hand, a run-of-the-mill 486 today exceeds the computational power of a mainframe of a decade ago. Assume then that within the next decade, "computers" that meet those requirements become available. Those "computers" will have built-in general-purpose digital signal processors (DSP's) for compressing and decompressing audio and video data, and for doing fax and modem chores as well. Semiconductor memory will be measured in the gigabytes, and permanent storage will be measured in the terabytes (on *personal* computers; mainframes will have even more). Optical storage may finally, after decades of promise, become cost effective.

Tomorrow's computers will have built-in connectivity to office systems, commercial databases, entertainment banks, and interactive educational courseware. Transmission speeds of these new networks will make Ethernet and Token Ring look like box turtles.

Those systems will have built-in docking technology (both hardware and software) for portable notepad/planner systems based on today's fledgling pen-input technology. They will have lightweight, flat, high-resolution, true-color displays—and printers—and will accept keyboard and pen input indiscriminately. They will communicate via a universal digital communications system that will probably come about as some sort of joint venture between AT&T, the cable TV companies, the independent networks (CNN, FNN, Fox), media giants like Time-Warner, and major computer companies.

There will be gobs and gobs of data flowing around, and lots of confusion about who owns rights to what. New kinds of copyright issues will keep lawyers busy for the next century. Students and researchers will have unprecedented opportunities to cheat. Illegal data tapping and decoding (akin to today's cable TV descramblers) will provide a data underground and new forms of law enforcement (the Data Police).

That technology will not replace today's TV, VCR, stereo system, video game, fax, telephone, or computer. However, those technologies will come to be seen as modular, interoperable pieces of a larger system in which all the pieces can plug and play—for those who want to.

From this perspective, multimedia begins to look like *everything* connected with computers, consumer electronics, and entertainment. Grandiose? Maybe. But ask yourself why IBM is contemplating a half-billion dollar deal with Time-Warner, why IBM and AT&T are both working like crazy to get fiber-optic data rates to work over copper cabling, and why Apple is partnering with Sharp and Microsoft with Sony.

Personal computers revolutionized typing, accounting, and publishing in the 80's. The 90's will see even more radical and pervasive changes.

That's the vision. Question: How will you participate?

Product watch

For years the phrase "reasonably priced tape backup" was a contradiction in terms, but that is no longer the case. Figure 1 shows one of the best deals around: the Jumbo 250 from Colorado Memory Systems. It's a high-quality 250-megabyte QIC-80 tape drive that can fit in a 3.5 inch or 5.25 inch bay, and it runs off a standard floppy-disk controller.

The Jumbo 250 includes a special cable adapter that runs from the drive to the floppy controller; the cable from the floppy drive(s) plugs into the Jumbo's cable. Other than mounting the drive and copying software to your hard disk, that's the extent of installation.

FIG. 1—COLORADO'S JUMBO 250 packs 250 megabytes of data on a $20 tape cartridge in less than two hours.

Backup software included with the drive runs in both menu-driven and command-line modes; the latter allows unattended backup via scheduled batch files. If hard-disk capacity exceeds that of a tape, the software will store additional data on additional tapes. In addition, the software has several options, including password protection, the ability to back up and restore Novell NetWare bindery (user access rights) files, and several types of software-based data compression. Using compression is faster than not using it; I have no trouble backing up about 170 megabytes of data on a single tape in less than an hour.

You can use the menu-driven mode to create a tag list, or list of files to back up, and then use the command-line mode to back up the files on the list. One nice feature is its ability to append multiple backup volumes to the same tape, which gives you the ability to perform daily backups simply and quickly. My main complaint with the software is that it forces you to restore files to their original locations. Sometimes, especially in a networked environment, it's helpful to be able to restore files elsewhere.

Many installation options are available, including a case for external mounting, numerous special cable and connector arrangements for special PC's (such as PS/2's), and several dedicated tape-controller boards that provide increased speed and hardware data compression. Colorado also sells software to control the drive under several varieties of Unix (SCO, Interactive, AT&T, and Intel).

The drive includes a one-year warranty, toll-free technical support, and access to a BBS. If you shop around, you can pick one up for $250 mail order. By way of comparison, just a few years ago my trusty 80-megabyte Irwin backup unit cost three or four times that amount. For small offices and Windows power users, this is a must-have item.

For more power and flexibility in tape backup software, check out Sytos Plus. It has several nice features, including the ability to work with multiple devices, including the Colorado, numerous digital audio tape (DAT) and 8mm formats, IBM's optical read/write disk, and hard and floppy disks; others are being added all the time.

Sytos also supports OS/2, whereas Colorado does not (yet). Sytos is routinely bundled with numerous high-capacity tape drives; the company claims more than a million users.

Probably the nicest feature is Sytos' more integrated way of creating backup sets. Whereas Colorado's TAPE.EXE forces you to create tag lists and then manually create batch files with numerous parameters, Sytos allows you (in the menu mode) to create "procedures" containing both tag list and configuration options, and then run various procedures from the command line.

Sytos also has more extensive

documentation than Colorado. It covers different kinds of backups, and methods for creating backup schedules.

Sytos will allow you to restore files from tape to new locations with new names; the only feature it lacks (and that Colorado supplies) is a gauge that indicates progress in formatting a tape.

News bits

What's larger than a calculator and smaller than a notebook PC? Better yet, what's the size and weight of a paperback book, has a 32-bit RISC processor, a multitasking, object-oriented operating system, and a 6- × 3-inch LCD screen for pen input and visual display? Easy: Apple's Newton, the first handheld device for jotting, sketching, scribbling, figuring, doodling, making lists, and subsequently moving that data to a larger computer or another user via fax, modem, or network. Initial specs include flash EPROM, 1 to 20 megabytes of RAM, PCMCIA expansion cards, sound output, an infrared data link to other Newtons and desktop Macintoshes, and wired links to both Macs and PC's. In addition to the text and graphics doodle pad, Newton will have an address book, scheduler, and an intelligent assistant that will understand and act on commands like "fax this story to Brian." Newton is scheduled for release around January of 93, and reportedly will cost $500–$1000. There are also rumors of another Apple-developed handheld, this one called Sweet Pea, with CD-ROM and the ability to play QuickTime scripts. It sounds a lot like the device Microsoft is developing with Sony.

IBM has publicly demonstrated FDDI running on copper shielded twisted pair (STP) cabling, thus paving the way for a potential ten-fold increase in bandwidth to desktop computers—and other devices. Not to be outdone, AT&T Paradyne has announced a similar technology, with claims that it could spur the nascent multimedia industry by delivering on-demand and interactive video services.

Nintendo and Sega are going at it neck and neck, and in the process, taking a pot-shot at the computer industry. Sega plans to introduce, two places by Thanksgiving a $300 CD-based game that delivers quality audio and live-action video; Nintendo plans to introduce a similar $200 unit early next year. Sega is working with Sony to produce games related to movies, e.g., Spielberg's *Jurassic Park*. Early reports indicate that Sega's device will include only half-speed, quarter-screen animation, whereas the Nintendo unit will do a full 30 frames per second. **R-E**

PRODUCTS DISCUSSED

- Jumbo 250, Colorado Memory Systems, 800 South Taft Ave., Coveland, CO 80537, (303) 669-8000.
- Sytos Plus, Sytron Corporation, 124 Flanders Road, P.O. Box 5025, Westboro, MA 01581-5025. (508) 898-0100.

Try the **Electronics NOW®** bulletin board system

(RE-BBS) 516-293-2283

The more you use it the more useful it becomes.

We support 1200 and 2400 baud operation.

Parameters: 8N1 (8 data bits, no parity, 1 stop bit) or 7E1 (7 data bits, even parity, 1 stop bit).

Add yourself to our user files to increase your access.

Communicate with other R-E readers.

Leave your comments on R-E with the SYSOP.

RE-BBS 516-293-2283

SLOPING VEE ANTENNA

continued from page 78

phosphor-bronze wire is preferred over stranded copper or aluminum wire because its spring qualities avoid kinks. It is almost impossible to tangle this kind of wire, especially important if you want a field-transportable antenna system. Nevertheless, if phosphor-bronze wire wire is too expensive (about $2 per foot) or difficult for you to obtain stranded copper or aluminum wire can be substituted. The shorting wire was 16 AWG bare, stranded-copper wire.

Solder all connections if the antenna installation is permanent. But if you plan to set up and take down the antenna frequently, be sure that there are clean metal-to metal mechanical connections between all conductive components.

The terminating resistors must be capable of handling a significant amount of power if the antenna is to be used for transmission. Non-inductive carbon-film power resistors, rated for 300 ohms ±10%, were specified for the test antenna. They had measured DC resistances of 307 and 314 ohms. As a general rule, the resistor power dissipation rating should be 10 to 20% of the maximum transmitter output power. Check the termination resistors for overheating.

For receiver-only applications, almost any low-power dissipating resistor with the correct resistance value will be satisfactory. The test sloping-vee antenna showed good VSWR performance and reception with 300-ohm, ¼- watt carbon resistors.

The measured impedance bandwidth of the 15 to 50 MHz vee is shown in Fig. 14. A network analyzer measured the input VSWR of about 150 feet of RG-213/U coaxial cable and it was below 2:1 at all frequencies between 10 and 60 MHz; it was particularly good between 14 and 30 MHz. The undulations in the VSWR curve shown in Fig. 14 were caused by the transmission line's frequency-dependent transformer action acting on the sloping vee-input impedance.

VSWR measured directly at the antenna input is slightly higher because cable loss lowers VSWR. This measurement was made, and the VSWR was just over 2:1 in the following bands: 38 to 40 MHz; 44 to 47 MHz; and 52 to 57 MHz. At all frequencies below 58 MHz, the sloping vee's input VSWR was less than 2.5:1. The test antenna easily exceeded the bandwidth design objective, and it provides very good broadband performance. In field tests the slope vee performed well as a transmitter antenna down to frequencies of about 4 MHz. **R-E**

BUYER'S MART

FOR SALE

CABLE Stealth: protect yourself from descrambler detection and stop the "bullet". Preset/tested, only $24.99, $4.00 S&H, **BALDWIN ELECTRONICS**, Box 9291, Baltimore, MD 21222-0291.

CABLE TV converters: Jerrold, Oak, Scientific Atlantic, Zenith & many others. "New MTS" stereo add-on: mute & volume. Ideal for 400 and 450 owners! 1 (800) 826-7623, Amex, Visa, M/C accepted. **B & B INC.**, 4030 Beau-D-Rue Drive, Eagan, MN 55122.

CLASSIFIED AD ORDER FORM

To run your own classified ad, put one word on each of the lines below and send this form along with your check to:

Electronics Now Classified Ads, 500-B Bi-County Boulevard, Farmingdale, NY 11735

PLEASE INDICATE in which category of classified advertising you wish your ad to appear. For special headings, there is a surcharge of **$25.00.**

( ) Plans/Kits ( ) Business Opportunities ( ) For Sale
( ) Education/Instruction ( ) Wanted ( ) Satellite Television
( ) ____________________

Special Category: $25.00

PLEASE PRINT EACH WORD SEPARATELY, IN BLOCK LETTERS.
(No refunds or credits for typesetting errors can be made unless you clearly print or type your copy.) Rates indicated are for standard style classified ads only. See below for additional charges for special ads. **Minimum: 15 words.**

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15 ($46.50)
16 ($49.60)	17 ($52.70)	18 ($55.80)	19 ($58.90)	20 ($62.00)
21 ($65.10)	22 ($68.20)	23 ($71.30)	24 ($74.40)	25 ($77.50)
26 ($80.60)	27 ($83.70)	28 ($86.80)	29 ($89.90)	30 ($93.00)
31 ($96.10)	32 ($99.20)	33 ($102.30)	34 ($105.40)	35 ($108.50)

We accept MasterCard and Visa for payment of orders. If you wish to use your credit card to pay for your ad fill in the following additional information (Sorry, no telephone orders can be accepted.):

Card Number ____________________ Expiration Date ____________

Please Print Name ____________________ / Signature ____________________

IF YOU USE A BOX NUMBER YOU MUST INCLUDE YOUR PERMANENT ADDRESS AND PHONE NUMBER FOR OUR FILES. ADS SUBMITTED WITHOUT THIS INFORMATION WILL NOT BE ACCEPTED.

CLASSIFIED COMMERCIAL RATE: (for firms or individuals offering commercial products or services) $3.10 per word prepaid (no charge for zip code)...**MINIMUM 15 WORDS.** 5% discount for same ad in 6 issues; 10% discount for same ad in 12 issues within one year; if prepaid. **NON-COMMERCIAL RATE:** (for individuals who want to buy or sell a personal item) $2.50 per word, prepaid....no minimum. **ONLY FIRST WORD AND NAME** set in bold caps at no extra charge. Additional bold face (not available as all caps) **55¢ per word additional.** Entire ad in boldface, $3.70 per word. **TINT SCREEN BEHIND ENTIRE AD: $3.85 per word. TINT SCREEN BEHIND ENTIRE AD PLUS ALL BOLD FACE AD:** $4.50 per word. **EXPANDED TYPE AD: $4.70 per word prepaid.** Entire ad in boldface, $5.60 per word. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD:** $5.90 per word. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD PLUS ALL BOLD FACE AD:** $6.80 per word. **DISPLAY ADS:** 1" × 2¼"—$410.00; 2" × 2¼"—$820.00; 3" × 2¼"—$1230.00. **General Information:** Frequency rates and prepayment discounts are available. **ALL COPY SUBJECT TO PUBLISHERS APPROVAL. ADVERTISEMENTS USING P.O. BOX ADDRESS WILL NOT BE ACCEPTED UNTIL ADVERTISER SUPPLIES PUBLISHER WITH PERMANENT ADDRESS AND PHONE NUMBER.** Copy to be in our hands on the 5th of the third month preceding the date of the issue. (i.e., Aug. issue copy must be received by May 5th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding working day. Send for the classified brochure. Circle Number 49 on the Free Information Card.

TUBES, new, up to 90% off, SASE, **KIRBY,** 298 West Carmel Drive, Carmel, IN 46032.

T.V. notch filters, phone recording equipment, brochure $1.00. **MICRO THinc.** Box 63/6025, Margate, FL 33063. (305) 752-9202.

SPEAKER repair. All makes — models. Stereo & professional. Kits available. Refoaming $18.00 **ATLANTA AUDIO LABS,** 1 (800) 568-6971.

ENGINEERING software and hardware, PC/MSDOS. Circuit design and drawing, PCB layout, FFT analysis, mathematics, circuit analysis, etc. Data acquisition, generation, I/O PCB's, etc. Call or write for free catalog. (614) 491-0832, **BSOFT SOFTWARE, INC.**, 444 Colton Rd., Columbus, OH 43207.

CABLE TV Equipment. Most type available. Special: Oak M35B $39.95. No catalog. COD orders only. **1 (800) 822-9955.**

★★★★PRESENTING★★★★
CABLE TV DESCRAMBLERS
★★★★★ STARRING ★★★★★
JERROLD, HAMLIN, OAK
AND OTHER FAMOUS MANUFACTURERS
- FINEST WARRANTY PROGRAM AVAILABLE
- LOWEST RETAIL / WHOLESALE PRICES IN U.S.
- ORDERS SHIPPED FROM STOCK WITHIN 24 HRS
- ALL MAJOR CREDIT CARDS ACCEPTED

FOR ALL INFORMATION
1-800-345-8927

PACIFIC CABLE CO., INC.
7325½ Reseda Blvd., Dept. 2118
Reseda, CA 91335

80C52-Basic microcontroller board. Basic interpreter, 32K RAM, 16K Eprom, Eprom programmer, RS232, expansion connector. Bare board with manual, schematics $22.95. 80C52-Basic microprocessor chip $25.95. Assembled and tested $124.95. **PROLOGIC DESIGNS,** PO Box 19026, Baltimore, MD 21204.

JERROLD, Tocom and Zenith "test" chips. Fully activates unit. $50.00. Cable descramblers from $40.00. Orders 1 (800) 452-7090. Information (310) 867-0081.

TOCOM-Jerrold Impulse-Scientific Atlanta Converters, two year warranties, also **test modules** for your converters. Contact **NATIONAL CABLE,** (219) 935-4128 full details.

Dish System

LIFETIME WARRANTY

Quality Microwave TV Antennas

WIRELESS CABLE - IFTS - MMDS - Amateur TV
Ultra High Gain 50db(+) • Tuneable 1.9 to 2.7 Ghz.
- 55-Channel Dish System $199.95
- 36-Channel Dish System $149.95
- 20-Channel Dish System $124.95
- Optional Commercial Grid Antenna (not shown) Add $50.00
- Yagi Antennas, Components, Custom Tuning Available
- Call or write (SASE) for "FREE" Catalog

PHILLIPS-TECH ELECTRONICS
P.O. Box 8533 • Scottsdale, AZ 85252
(602) 947-7700 ($3.00 Credit all phone orders)
MasterCard • Visa • American Express • COD's • Quantity Pricing

PROTECT yourself and equipment from electrical shocks. Complete unit $98.95. **SAFETY-UNLIMITED,** 1743 Baldwin Road, Yorktown, NY 10598. S/H $5.00.

SCIENTIFIC Atlanta 8500 series as low as $129.00, Starcom 6 as low as $149.00. All makes in stock. **S.A.C.** 1 (800) 622-3799.

CB RADIO OWNERS!

We specialize in a wide variety of technical information, parts and services for CB radios. 10-Meter and FM conversion kits, repair books, plans, high-performance accessories. Thousands of satisfied customers since 1976! Catalog $2.

CBC INTERNATIONAL
P.O. BOX 31500RE, PHOENIX, AZ 85046

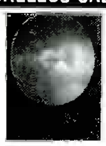
TEST-Aids for testing units in full servive mode. Starcom VII, $40.00; Starcom VI, $30.00; Starcom DPBB, $50.00; Pioneer, $75.00; Tocom VIP 5503/5507, $25.00; S.A. call; Zenith, $25.00; **N.E. ENGINEERING,** (617) 770-3830.

CABLE test chips S-A 8550, S-A 8500 — 310, 311, 320, 321 (specify) — $33.95. S-A 8580/338 — $69.95. Tocom 5503/07 VIP — $33.95. Starcom 6 — $33.95. Starcom 7 — $49.95. **TELECODE,** PO Box 6426-RE, Yuma, AZ 85366-6426.

OSCILLOSCOPE 50 MHz, Hewlett-Packard, solid state calibrated, manual $290.00. **1 (800) 835-8335 X-159.**

SECRET cable descramblers! Build your own descrambler for **less** than $12.00 in seven **easy** steps. Complete instructions $10.00. Radio Shack parts list and **free** descrambling methods that cost nothing to try included. **HARRYWHITE,** PO Box 1790D, Baytown, TX 77520.

WIRELESS CABLE RECEIVERS 1.9 TO 2.7 GHz



30 CH PARABOLIC DISH SYSTEM	$173.90
30 CH ROD ANTENNA SYSTEM	$193.90
30 CH CRYSTAL CONTROLLED SYSTEM	$294.95

SUN MICROWAVE INT'L. INC. P.O. BOX #34522 PHOENIX, AZ. 85067 (602) 230-1245 QUANTITY DISCOUNTS

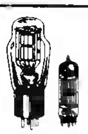
SEND $1.00 FOR CATALOG ON THESE AND OTHER FINE VIDEO PRODUCTS

VISA/MC/AMEX ORDERS ONLY 1-800-484-4190 CODE 9793

CABLE converters, retail at wholesale prices. Overstock reduction sale. Example RTC-56 $79.00 ea. Starcom 6 as low as $149.00. All makes available. **MT. HOOD ELECTRONICS** (206) 260-0107.

PREVENT descrambler damage. Don't bite the bullet! Snooper stopper data blocker $29.95. **VIDEO CONNECTIONS,** 1 (800) 933-3038.

STARCOM 6, Tocom, Oak, Pioneer, Scientific Atlanta, Zenith, as low as $39.00. **KABLE KONNECTION** (702) 433-6959.



RECEIVING TUBES
OVER 3000 TYPES IN STOCK!
Also hard-to-find transformers, capacitors and parts for tube equipment.
Send $2.00 for our 32 page catalog.
ANTIQUE ELECTRONIC SUPPLY
6221 S. Maple Ave.•Tempe, AZ 85283•602-820-5411

CABLE TV, Zenith, Jerrold, Oak, Scientific Atlanta, Hamlin, Tocom, wholesale to all. **ULTIMATE CABLE PRODUCTS,** (702) 646-6952.

PCB: Printed circuit board art work made to your specifications plotted on transparency. Multi layer and surface component capable. Circuit board production available, free estimate send schematic to **NEGRON ENGINEERING,** 159 Garfield Place, Brooklyn, NY 11215. Fax (718) 768-4028.

CABLE TV descramblers! Absolutely the lowest prices! All major brands. Nobody beats our prices! **CABLE PRICE CLUB,** 1 (800) 377-9742.

NO 800# — no catalog — no bull! Just the best prices on Zenith and SA descramblers. Also available — turn-on kits, call (305) 425-4378.

PRINTED circuit boards. Plated, etched and machined to your design. Small runs OK. Call or write: **SHORE PRINTED CIRCUITS,** 36 Fairview Avenue, Little Silver, NJ 07739. (908) 747-6300, 1 (800) 752-1574, Fax (908) 747-6301.

POWER inverter 100% portable 115V AC 12V DC 100W from built in rechargable battery 13 lbs $185.00 plus $10.00 S/H. Circuit and brochure only $10.00 (Refundable when ordering inverter). **PROGRESS TECH,** 13222 Carolyn St., Cerritos, CA 90701.

PC boards: Professional quality, 30 day guarantee, beat all prices. **A & D,** PO Box 311, Auburn, MI 48611. (517) 662-6633.

PLATED thru hole printed circuits. $25.00 minimum. Fast turnaround. For more information call **AP CIRCUITS,** (403) 250-3406 or BBS (403) 291-9342 (8,n,1).

FREE CATALOG

FAMOUS "FIRESTIK" BRAND CB ANTENNAS AND ACCESSORIES. QUALITY PRODUCTS FOR THE SERIOUS CB'er. SINCE 1962
FIRESTIK ANTENNA COMPANY
2614 EAST ADAMS
PHOENIX, ARIZONA 85034

TUBES: "oldest," "latest." Parts and schematics. SASE for lists. **STEINMETZ,** 7519 Maplewood Ave., R.E., Hammond, IN 46324.

RESTRICTED technical information: Electronic surveillance, schematics, locksmithing, covert sciences, hacking, etc. **Huge selection. Free brochures. MENTOR-Z,** Drawer 1549, Asbury Park, NJ 07712.

PLANS AND KITS

FASCINATING electronic devices! Dazers! Lasers! Transmitters! Detectors! Free energy! Tesla! Kits/assembled! Catalog $4.00 (refundable). **QUANTUM RESEARCH,** 17919-77 Ave., Edmonton, AB. T5T 2S1.

HOBBY/broadcasting/HAM/CB/surveillance transmitters, amplifiers, cable TV, science, bugs, other great projects! Catalog $1.00. **PANAXIS,** Box 130-F9, Paradise, CA 95967.

REMOTE CONTROL KEYCHAIN

Complete w/mini-transmitter and +5 vdc RF receiver
Fully assembled including plans to build your own auto alarm
$24.95 Check, Visa or M/C Add $3 shipping
5 @ $19.95, 10 @ $14.95
Visitect Inc. Box 14156, Fremont, Ca. 94539
(510) 651-1425 Fax (510) 651-8454

DESCRAMBLER kits. Complete cable kit $44.95. Complete satellite kit $49.95. Add $5.00 shipping. Free brochure. No New York sales. **SUMMIT RE,** Box 489, Bronx, NY 10465.

VIDEOCIPHER II/satellite/scanner/cable/amateur/cellular/repair manuals, modification books, software. Catalog — $3.00. **TELECODE,** PO Box 6426-RE, Yuma, AZ 85366-6426.

KENWOOD & ICOM service bulletins. 175+ pages covering all models. $39.95. Catalog — $3.00. CODs (602) 782-2316 / FAX (602) 343-2141. **TELECODE,** Box 6426-RE, Yuma, AZ 85366-6426.

FREE! Fabulous catalog of sensational kits. **LNS TECHNOLOGIES,** 20993 Foothill Blvd., Suite 307R, Hayward, CA 94541-1511.

SURVEILLANCE, counter-surveillance, security devices. Room and phone monitors, bug detectors, alarms, stunguns, etc. Send $3.00 for catalog. **HOME VU MERCHANDISE,** Box 38371, Detroit, MI 48238.

ROBOTICS, Build-it-Yourself! Hobby, personal, & service robot types — designs, parts and plans. Catalog $1.00, directory $10.00. **IPC,** Suite 251RE, 1019-A Old Monrovia Rd., Huntsville, AL 35806.

REMOVE LEAD VOCALS
From Records & CD's
513-444-2276

Build this kit which removes lead vocals from standard stereo records, CD's, tapes or FM broadcasts. Sing along with the background music. Use with any home component stereo. Additional kit adds reverb to your voice, then mixes it with music. **Pre-assembled** boards also available. Call or write for **free info. Weeder Technologies,** 14773 Lindsey Rd., Mt. Orab, Ohio 45154.

SURVEILLANCE transmitter kits tune from 65 to 305 MHz. Mains powered duplex, telephone, room, combination telephone/room. Catalog with **Popular Communications, Popular Electronics and Radio-Electronics** book reviews of **"Electronic Eavesdropping Equipment Design,"** $2.00. **SHEFFIELD ELECTRONICS,** PO Box 377785-C, Chicago, IL 60637-7785.

CELLULAR hackers bible. Theory — hacks — modifications — $53.95. **TELECODE,** PO Box 6426-RE, Yuma, AZ 85366-6426.

SATELLITE TV

FREE catalog — Lowest prices worldwide. **SKYVISION,** 1012 Frontier, Fergus Falls, MN 56537. 1 (800) 334-6455. See full page ad the Shopper section.

SATELLITE TV — Do it yourself — major brands discounted, we'll beat everyone's price. Call **LARRY** (609) 596-0656.

CABLE TV DESCRAMBLER LIQUIDATION!
FREE CATALOG!
Hamlin Combos $44, Oak M35B $60 (min. 5), etc.
WEST COAST ELECTRONICS
For Information: 818-709-1758
Catalogs & Orders: 800-628-9656

BUSINESS OPPORTUNITIES

YOUR own radio station! Licensed/unlicensed AM, FM, TV, cable. Information $1.00. **BROADCASTING,** Box 130-F9, Paradise, CA 95967.

LET the government finance your small business. Grants/loans to $500,000. Free recorded message: **(707) 449-8600.** (KS1).

MAKE $75,000.00 to $250,000.00 yearly or more fixing IBM color monitors. No investment, start doing it from your home (a telephone required). Information, USA, Canada $2.00 cash for brochure, other countries $10.00 US funds. **RANDALL DISPLAY,** Box 2168-R, Van Nuys, CA 91404 USA. FAX (818) 990-7803.

CONTINGENCY patent licensing. No fees anytime. Three decades experience: law, technology, negotiations. **PROPAT INTERNATIONAL CORPORATION,** 441 Summer Street, Stamford, CT 06901. (203) 325-3344.

BEST BY MAIL

Rates: Write National, Box 5, Sarasota, FL 34230

OF INTEREST TO ALL

RETIRE EARLY 1-900-776-3348 CODE AB 5180 Mention Code ($6.95).

BURGLAR ALARMS! WHOLESALE. Send $5.00 For Amazing Catalogue. Global Security, 672 Oldmill Road, Suite 320, DPT(A), Millersville, MD 21108.

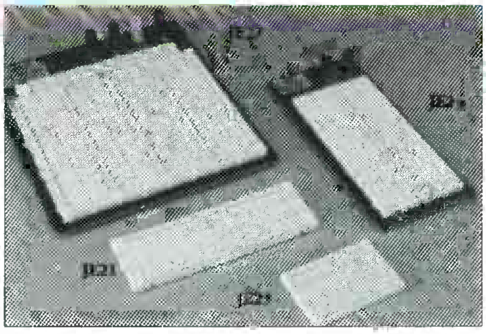
BOOKS · CATALOGS · MAGAZINES

UNLIMITED 2nd CREDIT FILE! VISA
CALL: 614-239-8284, Ext. 1
WRITE: 4th LIMITED • BOX 32431-RE • COL., OH 43232
ADC
VETERANS—SELF-EMPLOYED
WELCOME
"FAST CASH GUARANTEED"
VISA

A Monumental Selection

Test/Measurement and Prototype Equipment

Jameco Solderless Breadboards



Jameco's long-lasting breadboards feature screen-printed color coordinates and are suitable for many kinds of prototyping and circuit design. Larger models feature a heavy-duty aluminum backing with voltage and grounding posts.

Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price
JE21	3.25 x 2.125	400	0	$4.95
JE23	6.50 x 2.125	830	0	6.95
JE24	6.50 x 3.125	1,360	2	12.95
JE25	6.500 x 4.25	1,660	3	$17.95
JE26	6.875 x 5.75	2,390	4	24.95
JE27	7.250 x 7.50	3,220	4	32.95

GoldStar 20MHz Dual Trace Oscilloscope

The perfect unit for today's testing and measurement needs! Features include a 6" CRT display, and bandwidth from DC to 20 MHz. The GoldStar oscilloscope comes with two 40MHz probes, two fuses, power cord, operation manual, schematics and block and wiring diagram. It's lightweight and portable with a two-year warranty.

GS7020..........$399.95

Additional GoldStar Oscilloscopes

GS904RD 40Mhz 2 channel oscilloscope.......$799.95

GS8100 100Mhz 3 channel oscilloscope 1349.95

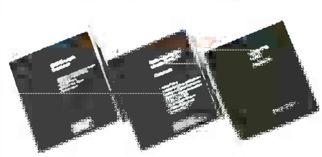
Call for additional Goldstar test equipment

JAMECO®
ELECTRONIC COMPONENTS
COMPUTER PRODUCTS

24 Hour Toll-Free Order Hotline
1•800•831•4242

Please refer to Mail Key 002 when ordering

National and Intel Databooks



400026 National General Purpose Linear Devices Databook ...$19.95

400039 National Logic Databook 19.95

400015 National Data Acquisition Linear Devices Databook 11.95

400104 National Special Purpose Linear Devices Databook 11.95

400044 National LS/S/TTL Databook 14.95

230843 Intel Memory Databook 24.95

270645 Intel Embedded Controller Processors Databook 24.95

Additional databooks available!

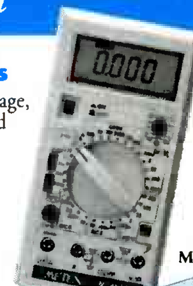
Metex Digital Multimeters

- Handheld, high accuracy • Measures AC/DC voltage, AC/DC current, resistance, diodes, continuity, and transistor current gain (except M3900)
- Manual ranging w/overload protection
- Comes with probes, batteries, case and manual

M3650 & M4650 only:

- Also measures frequency and capacitance

M3800	3.5 Digit Multimeter	$39.95
M3610	3.5 Digit Multimeter	$59.95
M3900	3.5 Digit Multimeter with tach/dwell	$59.95
M3650	3.5 Digit Multimeter w/frequency & capacitance	$74.95
M4650	4.5 Digit w/frequency & capacitance & data hold switch	$99.95



M4650

24 Hour Toll-Free Order Hotline!
1•800•831•4242

Jameco IC Test Clip Series

- Test Clips are designed for temporary connections to DIP components
- Heavy-duty spring loaded hinge provides positive contact

Part No.	Description	Price
JTC16	16-pin (for 8, 14 & 16-pin ICs)	$5.95
JTC20	20-pin (for 18 & 20-pin ICs)	6.95
JTC24	24-pin	7.95
JTC28	28-pin	8.95
JTC40	40-pin	11.95

EPROMs - for your programming needs

Part No.	Price	Part No.	Price	Part No.	Price
TMS2516	$4.25	2764A-25	$3.49	27C256-12	$6.49
TMS2564	5.95	27C64-15	3.95	27C256-15	5.95
TMS2716	5.95	27C64-25	3.49	27C256-20	5.49
1702A	3.95	27C64-45	2.95	27C256-25	4.95
2708	4.95	27128OTP	2.49	27512OTP	4.95
2716	3.95	27128-20	7.95	27512-20	6.75
2716-1	4.25	27128-25	7.75	27512-25	5.95
27C16	4.25	27128A-15	4.95	27C512-12	7.49
2732	4.95	27128A-20	4.75	27C512-15	6.95
2732A-20	4.49	27128A-25	3.75	27C512-20	6.49
2732A-25	3.49	27C128-15	5.75	27C512-25	5.95
2732A-45	2.95	27C128-25	7.95	27C010-15	9.95
27C32	4.95	27256OTP	4.19	27C020-15	17.95
2764-20	3.95	27256-15	5.49	27C020-20	15.95
2764-25	3.75	27256-20	5.29	68766-35	4.95
2764A-20	3.75	27256-25	4.89		

A.R.T. EPROM Programmer

- Programs all current EPROMs in the 2716 to 27512 range plus the X2864 EEPROM
- RS232 port • Software included

EPP..................................$199.95

UVP EPROM Eraser

- Erases all EPROM's • Erases 1 chip in 15 minutes and 8 chips in 21 min
- UV intensity: 6800 UW/CM2

DE4.......................................$89.95

• Partial Listing • Over 4000 Electronic and Computer Components in Stock! • Call for quantity discounts.

CIRCLE 114 ON FREE INFORMATION CARD

at Competitive Prices

Computer Upgrade Products and Electronic Components

Upgrade your existing computer system! Jameco will help you upgrade easily and economically.

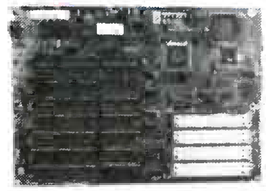
101-Key Enhanced Keyboard

This keyboard features 12 function keys, separate cursor and numeric keys.

- IBM PC/XT/AT and compatible computers
- Automatically switches between XT or AT
- LED Indicators for Num, Caps, and Scroll lock keys.

K101..**$49.95**

Jameco 80386SX Motherboard



- 16MHz processing speed
- Baby motherboard (8.5"x13")
- Zero or one wait state operation
- Supports up to 16MB of RAM
- Intel 80387SX/compatible math coprocessor socket
- AMI BIOS
- Six 16-bit and two 8-bit expansion bus slots
- One-year warranty

JE3616SN..................................**$249.95**

Toshiba 1.44MB 3.5" Internal Floppy Disk Drive

- IBM PC/XT/AT and compatibles
- Compatible with DOS versions 3.3 or higher
- Includes all necessary installation hardware
- 1.44MB formatted high density mode
- 720KB formatted low density mode
- Size: 1"H x 4"W x 5.9"D (actual drive size)
- One-year manufacturer's warranty

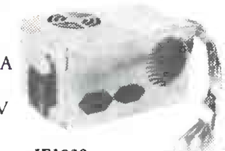
356KU...**$99.95**

Many more upgrade products available!

Jameco IBM Compatible Power Supplies

JE1030:
- Output: +5V @ 15A, -5V @ 0.5A, +12V @ 5.5A, -12V @ 0.5A
- 150 watts output power
- Switchable between 110/220V
- Built-in fan
- Size: 9.5"L x 5.5"W x 4.625"H
- One-year warranty
- CSA approved

JE1036:
- Output: +5V @ 20A, -5V @ 0.5A, +12V @ 8A, -12V @0.5A
- 200 watts output power
- Switchable between 110/220V
- Built-in fan
- Size: 6.5"L x 5.88"W x 6"H
- One-year warranty
- CSA approved



JE1030

Additional power supplies available!

JE1030 150 watt PC/XT power supply.........................**$69.95**
JE1036 200 watt AT power supply...............................**$89.95**

Integrated Circuits*

Part No.	1-9
74LS00	$.25
74LS02	.25
74LS04	.25
74LS08	.29
74LS14	.39
74LS30	.25
74LS32	.25
74LS74	.29
74LS76	.49
74LS86	.25
74LS112	.25
74LS123	.39
74LS138	.39
74LS175	.35
74LS193	.59
74LS244	.69
74LS245	.69
74LS373	.69
74LS374	.69

Linear ICs*

Part No.	1-9
TL082CP	$.59
LM317T	.59
LM324N	.35
LM336Z	1.09
LM339N	.45
NE555V	.29
LM556N	.49
LM723CN	.49
LM741CN	.29
LM1458N	.39
LM1488N	.45
LM1489N	.45
ULN2003A	.69
LM3914N	2.49
NE5532	1.19
7805T	.45
7812T	.45

* *Call for a complete listing of ICs*

Memory

Part No.	Function		Price
41256-120	256K DIP	120ns	$1.69
41256-150	256K DIP	150ns	1.59
511000P-80	1MB DIP	80ns	5.99
511000P-10	1MB DIP	100ns	5.49
41256A9B-80	256K SIMM	80ns	16.95
421000A9A-80	1MB SIPP	80ns	54.95
421000A9B-60	1MB SIMM	60ns	64.95
421000A9B-70	1MB SIMM	70ns	59.95
421000A9B-80	1MB SIMM	80ns	54.95

Miscellaneous Components*

Potentiometers

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

43PXX	3/4 watt,15 turn	$.99
63PXX	1/2 watt, 1 turn	.89

Transistors And Diodes

Part No.	Price	Part No.	Price
PN2222	$.12	1N751	$.15
PN2907	.12	C106B1	.65
1N4004	.10	2N4401	.15
2N2222A	.25	1N4148	.07
1N4735	.25	2N3055	.69
2N3904	.12	1N270	.25

Switches

JMT123	SPDT, on-on (toggle)	$1.15
206-8	SPST, 16-pin (DIP)	1.09
MPC121	SPDT, on-off-on (toggle)	1.19
MS102	SPST, momentary (push-button)	.39

**Additional components available*

Connectors

Part No.	Description	Price
DB25P	Male, 25-pin	$.65
DB25S	Female, 25-pin	.75
DB25H	Hood	.39
DB25MH	Metal Hood	1.35

LEDs

XC209R	T1, (Red)	$.14
XC556G	T1 3/4, (Green)	.16
XC556R	T1 3/4, (Red)	.12
XC556Y	T1 3/4, (Yellow)	.16

IC Sockets

Low Profile Part No.	Price	Wire Wrap(Gold) Level #2 Part No.	Price
8LP	$.10	8WW	$.54
14LP	.11	14WW	.79
16LP	.12	16WW	.89
24LP	.19	24WW	1.39
28LP	.22	28WW	1.69
40LP	.28	40WW	1.89

Call or write for your
FREE Summer Catalog:
1•800•637•8471

Mention Mail Key 002

24-Hour Toll-Free Order Hotline:
1•800•831•4242

JAMECO®
ELECTRONIC COMPONENTS
COMPUTER PRODUCTS
1355 Shoreway Road
Belmont, CA 94002

$30.00 Minimum Order
FAX: 1•800•237•6948 (Domestic)
FAX: 415•592•2503 (International)
Jameco ServiceLine™:
1•800•831•8020 (Computer Repair)
Technical Support: 1•800•831•0084
BBS Support: 415•637•9025

For International Sales, Customer Service, Credit Department and all other inquiries: Call 415•592•8097 between 7AM-5PM P.S.T.

CA Residents please add applicable sales tax.

Shipping, handling and insurance are additional.

Terms: Prices subject to change without notice. Items subject to availability and prior sale. Complete list of terms/warranties is available upon request.

CIRCLE 114 ON FREE INFORMATION CARD

EASY work! Excellent pay! Assemble products at home. Call toll free **1 (800) 467-5566** Ext. 5192.

HOME assembly work available! Guaranteed easy money! Free details! **HOMEWORK-R**, Box 520, Danville, NH 03819.

MONEYMAKERS! Easy! One man CRT rebuilding machinery. $6,900.00 rebuilt. $15,900.00 new. **CRT**, 1909 Louise, Crystalake, IL 60014. (815) 477-8655. FAX (815) 477-7013.

EDUCATION & INSTRUCTION

F.C.C. Commercial General Radiotelephone license. Electronics home study. Fast, inexpensive! "Free" details. **COMMAND**, D-176, Box 2824, San Francisco, CA 94126.

ELECTRONIC engineering. 8 volumes complete. $109.95. No prior knowledge required. Free brochure. **BANNER TECHNICAL BOOKS**, 1203 Grant Avenue, Rockford, IL 61103.

BIOMEDICAL newsletter explains ultrasound, cardiac computers, lasers, etc. Four postpaid issues $20.00. **PNP**, Box 70, Brooklyn, NY 11204. (718) 837-9349 ext. 33.

ANTIQUE RADIO CLASSIFIED

Free Sample!

Antique Radio's Largest Circulation Monthly. Articles, Ads & Classifieds.

6-Month Trial: $15. 1-Yr: $27 ($40-1st Class).
A.R.C., P.O. Box 802-L9, Carlisle, MA 01741

WANTED

INVENTIONS/ new products/ideas wanted: call **TLCI** for free information/inventors newsletter. 1 (800) 468-7200 24 hours/day - USA/Canada.

INVENTORS: We submit ideas to industry. Find out what we can do for you. **1 (800) 288-IDEA.**

CABLE TV DESCRAMBLERS

BEST BUYS BEST SERVICE

BULLET PROOF TV TESTED
WANT TO BUY:
TOCOM, SA 8590,DPV7212
Must be reasonable price.

***FREE* Catalog** Dealers Wanted

Multi-Vision (402)331-3228 **800-835-2330**
Electronics™ 2730 SO.123rd Ct.#126 Omaha, NE 68144

INVENTORS

INVENTORS! Can you patent and profit from your idea? Call **AMERICAN INVENTORS CORP.** for free information. Serving inventors since 1975. 1 (800) 338-5656.

SINGERS! REMOVE VOCALS!
Unlimited Backgrounds™
From Standard Records & CD's with the Thompson Vocal Eliminator™ Call for Free Catalog & Demo Record.
Phone: (404)482-4189 Ext 72
Singer's Supply, Dept RL-1
7987 Hightower Trail
Lithonia, GA 30058
24 Hour Demo/Info Request Line (404)482-2485 Ext 72
Singer's Supply - We Have Anything & Everything For Singers

BUY BONDS

FREE CATALOG!
1-800-648-7938
JERROLD HAMLIN OAK ETC
CABLE TV DESCRAMBLERS

- *Special Dealer Prices!*
- *Compare our Low Retail Prices!*
- *Guaranteed Prices & Warranties!*
- *Orders Shipped Immediately!*

REPUBLIC CABLE PRODUCTS, INC.
VISA 4080 Paradise Rd. #15, Dept RE992
Las Vegas, NV 89109
For all other information (702) 362-9026

CABLE TV DESCRAMBLERS
★CONVERTERS★
and ACCESSORIES.

SAVE MONEY. DON'T RENT!

PANASONIC, JERROLD, OAK, PIONEER, SCIENTIFIC ATLANTA
AND MORE. LOWEST PRICES. FREE CATALOG.
CABLE READY COMPANY (800) 234-1006

PAY TV AND SATELLITE DESCRAMBLING
ALL NEW 1992 EDITION ALL NEW

1992 Edition updates latest Circuits, Turn-ons, Bypasses, Bullets, Bags, Blackciphers, VCII Plus and B-Mac Fixes. Only $15.95. VCII Wizzard Hacker's Bible includes Plus. Tells All. $15.95. Pay TV and Satellite Descrambling Vol. 1 (Basics), 1989, 1991 Editions are all different. $14.95 each. MDS Handbook $9.95. Satellite Systems under $600. $12.95 (52). Any 3/$29.95 or 5/$49.95. Scrambling News Monthly will keep you up to date on Plus breaks. $24.95/yr. special. Everything we have including video, $10.95. New Catalog $1.

Scrambling News, 1552 Hertel Ave., Buffalo, NY, 14216. Voice/Fax (716) 874-2088
COD'S ARE OK. ADD $6

ELECTECH
CABLE T.V. DESCRAMBLERS
• All quality brand names •
• All fully guaranteed • All the time •
Knowledgeable Sales Service Department
FOR FREE CATALOG 800-253-0099

MC / COD / VISA
NO FLORIDA SALES

CABLE TV DESCRAMBLERS

WORLDWIDE CABLE

- BASE BAND
- TOCOM
- SCIENTIFIC ATLANTA
- JERROLD
- PIONEER
- ZENITH
- OAK
- HAMLIN

1 800-772-3233
1291 A POWERLINE ROAD, SUITE 109
POMPANO BEACH, FL 33069

Courteous Service • Discount Prices • Fast Shipping

ALL ELECTRONICS CORP.
Mail Order Electronic Parts And Supplies
P.O. Box 567 • Van Nuys, CA 91408

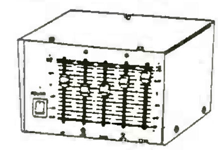
Car Lighter Coil Cord

Automotive cigar lighter plug with replaceable 5 amp fuse. Quality, retractable coil cord extends to approximately 6 feet. Terminates with a 5 pin DIN plug which can be cut-off. Ideal for battery charger or running 12 Volt devices from a car battery.
CAT# CLP-18
10 for $12.50 **$1.50 each**

VERY SPECIAL DEAL - 17 VDC 210 MA WALL TRANSFORMERS

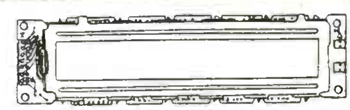
New 17 Vdc, 210 ma wall transformers. 6 ft. cord. Unusual co-axial device on end of cord can be cut off and used for another application. Large quantity available.
CAT# DCTX-1721
100 for $1.25 each
1000 for $1.00 each **$1.50 each**

Monoral Graphic Equalizer



Five band monoral graphic equalizer. Allows use of one source for background music and music-on-hold. Allows you to equalize and adjust the volume of one without changing the other. Useful in any application where equalization of a monoral source is desirable. RCA jack inputs and outputs. Removable metal control cover to prevent tampering. 6.75" X 5.75" X 3.125" h.
CAT# EQ-1 **$15.00 each**

LCD DISPLAY 40 Character X 2 Line



Optrex # DMC40218 or Hitachi # LM018L Built-in controller and drivers. 4 or 8 bit operation. 5 Vdc power. Display size: 6.05" X 0.7" Module size: 7.12" X 1.34". Character size: (5 X 7 dots) 3.2mm X 4.85 mm. Data sheets and instructions available.
CAT# LCD-3 **$15.00 each**

INVERTER

ERG, Inc.,"Smart Force"™ # LPS15-1-3. Input: 15-25 Vdc Output: 80-100 Vac@ 400 Hz. 4.1 ma. Designed to power electroluminescent lamps and glow-strips. Can be used in any application where low current, high frequency AC is desired. 1.25" X 0.85" X 0.95". CAT# INV-3
10 for $20.00 **$2.50 each**

TOLL FREE ORDER LINES
1-800-826-5432
CHARGE ORDERS to Visa, MasterCard or Discover

TERMS: Minimum order $10.00. Shipping and handling for the 48 continental U.S.A. $3.50 per order. All others including AK, HI, PR or Canada must pay full shipping. All orders delivered in CALIFORNIA must include state sales tax (7.25%, 7.5%, 7.75%, 8.25% 8.5%). Quantities Limited. NO C.O.D. Prices subject to change w/out notice.

Call or Write For Our FREE 64 Page Catalog
(Outside The U.S.A. Send $2.00 Postage)
ALL ELECTRONICS CORP.
P.O. Box 567 • Van Nuys, CA • 91408

CIRCLE 107 ON FREE INFORMATION CARD

HARDWARE HACKER

continued from page 93

Whole Earth Review. There are bunches of independent and non-profit inventor's organizations out there. One I can heartily recommend is Ed Zimmer's *Inventor-Entrepreneur Network*. For other regional sources, check out the *Encyclopedia of Associations* that you will probably find at your local library.

No, I just do not know of anyone anywhere who is dumb enough to buy raw, unproven, or undeveloped ideas. But I do know of several someones who sometimes might be interested in looking at tightly targeted products *if those products are now in their pre-production prototype stage and currently under active end-user beta testing*.

For instance, Mark Gottleib of *Design Tech International* is looking for innovative approaches to low-end consumer electronics, especially for those items that can be blister packed and need no consumer smarts to use.

Dennis Carper of *Redmond Cable* is seeking tested and proven interconnect and adaptor products that clearly solve obvious and well-defined problems.

John Simonton of *PAIA* (and a frequent author in **Electronics Now**) sometimes seeks out items with kit possibilities, especially if they are related to MIDI or electronic music.

And Steve Ciarcia of his *Micro Mint* is occasionally interested in any embedded processor applications—if they are unique.

Besides my own PSRT RoundTable on *GEnie*, you might also want to check out their HOSB, short for *Home Office and Small Business*. I've also formed my loosely knit *Synergetics Consultants Network* that centers on our voice helpline. Give me a call if you need more information.

New tech lit

From *Texas Instruments*, seven pounds of revised linear data books. Volume I is on op-amps; volume II is on A/D, DSP, and video; and volume III is on voltage regulators and really oddball stuff.

A pair of very readable new books: *The Triumphs and Trials of an Organ Builder*, by Jerome Markowitz, CEO of *Allen Organ*, and published by the *Vox Humania Press*. Among the other things, it reveals how trivially easy it is to have any technically solid and perfectly valid patent busted in court. Just because some epsilon minus does not happen to like you.

Plus *Accidental Empires* by the pseudonym *Robert X. Cringley*, newly published by *Addison Wesley*. Subtitled *How the boys of Silicon Valley make all their millions, battle foreign competition, and still can't get a date*. This book has a double handful of very funny one-liners in it. But otherwise it reads like something that Cringley would write.

I've found *very* few trade journals devoted to electronic servicing. One useful new one, though, is *MSM, the Magazine of Service Management*. The magazine puts a big emphasis on computer service and identification of sources for printer and disk-drive replacement parts and assemblies.

A great collection of navigation books, GPS (global positioning satellites) and otherwise, is offered by the *Navtech Information Service*. And a new *Spread Spectrum Scene* labor-of-love newsletter has recently started publication.

Two firms apparently still offer top octave generators and other classic electronic organ chips. The first is *Fistell Microelectronics* and the other is *Keyboard Systems*. The latter also builds workaround replacement modules for chips that are truly unavailable.

Turning to some of my own products, yet another obvious and major product selling resource is my recently improved *Incredible Secret Money Machine II*. The autographed copies are available per my nearby *Synergetics* ad.

As usual, I have gathered many of the resources mentioned together into the *Names & Numbers* or the *Product Marketing Resources* sidebars. Be sure to check those out *before* you use our no-charge tech helpline or call for a free hacker secrets brochure. **R-E**

ATV DOWNCONVERTER

continued from page 84

provided for you to make your own board, and the parts-placement diagram is shown in Fig. 4.

First install resistors R1–R13, and R15–R17. Next, install all capacitors except the chip capacitors and C10. Install mixer M1, and then wind and install coils L1, L2, L3, L5, L6, L7, L8.

Coils L1, L2, and L3 are three turns each of 20 AWG tinned wire wound around a No. 8 screw as a form (see Fig. 5) and then stretched to a length of 0.3 inch with the turn spacing evenly maintained. All three of those coils must be tapped as shown in Fig. 5. The lead from J1 (which can be coaxial 50-ohm line) has its center conductor soldered to L1 at ¾ turn from the grounded end. Resistor R5 is soldered 1½ turns from the end of L2 that connects to R6, C7, and C8. Coil L3 is tapped at 1 turn from the grounded end.

Coils L6 and L7 are 8 turns each of 22 AWG enamelled wire wound on a No. 8 screw. The screw is removed after winding the coil. Coil L8 is 9½ turns of 22 AWG enamelled wire, wound the same way as L6 and L7. However, after winding, the No. 8 screw is removed and a ferrite tuning slug is screwed into the winding as shown in Fig. 5. RF choke L5 is installed as if were a resistor.

Install Q2, Q3, D1, D2, and D3. Now install the chip capacitors. Chip capacitors require special installation procedures—and they all mount on the solder side of the PC board. Figure 6 shows where all of the chip capacitors, C10 (which we'll get to in a moment), and Q1 are mounted on the solder side of the board. As for the chip capacitors, first tin the area on the PC board where a chip is to be installed. Then hold the chip in place with the tip of a small screwdriver or tweezers and tack solder one side. After it's tacked in place, fully solder both sides of the chip.

Now install Q1, whose long lead is the drain. Make sure you use a grounded iron and work in a static-free area. Treat Q1 as you would a delicate CMOS IC. The tuning potentiometer (R14) can be mounted in different positions for added flexibility; it can be mounted off the board for remote tuning purposes.

Make sure all holes marked "G" in Fig. 4 have jumper wires passed through them and soldered on both sides of the PC board as shown in Fig. 7. Also, both sides of the board must be grounded together with copper foil tape, also as shown in Fig. 7. Once the tape is in place, solder both sides.

Next make capacitor C10. Take a small square of G-10, 0.062 material (the same as the PC board material) and trim it to a 3/16-inch square. Install it on the solder side of the board as shown in Fig. 8. Connect coaxial 50-ohm cables to J1 and J2, and DC power leads to D3 and ground. Set trimmer capacitors C1, C5, and C6 to about 20% of maximum, and set C9 to about 80% of maximum. If you use R14, it can be set halfway. If R14 is not used, R10 should be temporarily connected to a supply of about +8 volts. Figure 9 shows the author's prototype.

Tune up

Tuning consists of peaking the tuned circuits for best reception. Using a frequency counter connected across R12, adjust C9 for a nominal frequency of 370 to 375 MHz. If installed, R14 should vary that by about ±15 MHz. If R14 is not installed, 0 to +12 volts applied to R10 should do the same. The oscillator might stop if less than 2 volts is applied to R10—which is acceptable as long as you can obtain a frequency range of 30 MHz.

Connect the converter to a TV set tuned to channel 3 and to an external antenna for ATV reception. Find a signal and peak L1, L2, and L3 for the best picture. You can also use an RF signal generator tuned to 435 MHz if no on-the-air signal is available. As a last resort, you can also peak L1, L2, and L3 on noise.

It is also possible to experimentally peak the converter on UHF channels 14, 15, or 16 if no other signals are available. Set C9 for a L.O. frequency of around 410 to 420 MHz. Note: This is only to see if everything works if there's no other way to obtain an ATV signal and you have no access to a signal generator. You will later have to repeak the converter to 420 to 450 MHz.

If a sweep generator is available, simply peak the converter for a response as shown in Fig. 10. By trimming C10 (use a file on the edge of it) you can also experiment with the coupling and resultant bandpass shape. You can also do this with a calibrated RF signal generator and a receiver and/or RF voltmeter, but this will take more time.

The converter should be mounted in a weatherproof metal box, if outdoor use is intended. A metal box reduces stray signal pickup, and also protects the converter from damage.

If you will be remote-tuning the converter (as was shown in Fig. 3), the converter should be mounted right at the antenna or very close to it. That permits a short cable from J1 to the antenna, reducing signal losses. The converter can then be mounted as far as 300 feet from the TV monitor. **R-E**

DRAWING BOARD

continued from page 96

case, you should trim the level because the circuits we'll be building expect a 1-volt signal.

The only other thing to notice here—there just isn't much to the circuit at all—is that the video signal being fed to the base of the transistor is related to both positive voltage and ground through R1 and R2. The circuit is going to run on a regulated 5-volt supply; it must be steady because the level of the supply voltage is going to have an effect on the level of the video. Wire up the circuit shown in Fig. 4 and get the video source in place. When we get together next time we'll start designing some kind of circuit to screw up the signal. **R-E**

ADVERTISING INDEX

Electronics Now does not assume any responsibility for errors that may appear in the index below.

ADVERTISING SALES OFFICE

Gernsback Publications, Inc.
500-B Bi-County Blvd.
Farmingdale, NY 11735
1-(516) 293-3000
President: **Larry Steckler**

For Advertising ONLY
516-293-3000
Fax 1-516-293-3115

Larry Steckler
publisher
Christina Estrada
assistant to the President
Arline Fishman
advertising director
Denise Mullen
advertising assistant
Kelly McQuade
credit manager

Subscriber Customer Service
1-800-288-0652
Order Entry for New Subscribers
1-800-999-7139
7:00 AM - 6:00 PM M-F MST

ADVERTISING SALES OFFICES
EAST/SOUTHEAST
Stanley Levitan, Eastern Advertising Sales Manager
Electronics Now
1 Overlook Ave.
Great Neck, NY 11021
1-516-487-9357, 1-516-293-3000
Fax 1-516-487-8402

MIDWEST/Texas/Arkansas/Okla.
Ralph Bergen, Midwest Advertising Sales Manager
Electronics Now
One Northfield Plaza, Suite 300
Northfield, IL 60093-1214
1-708-446-1444
Fax 1-708-559-0562

PACIFIC COAST/Mountain States
Marvin Green, Pacific Advertising Sales Manager
Electronics Now
5430 Van Nuys Blvd. Suite 316
Van Nuys, CA 91401
1-818-986-2001
Fax 1-818-986-2009

EN Shopper
Joe Shere, National Representative
P.O. Box 169
Idyllwild, CA 92549
1-714-659-9743
Fax 1-714-659-2469

NO PROBLEMO

You want a bargraph & a full range counter – Optoelectronics can deliver!

$199.

Don't Wait, This Offer Can't Last!
No discounts, No trade-ins.

Now for a limited time only, $160. off the list price. for our Full Range Model 2810 with bargraph – plus:

- Full range -10Hz to 3GHz.
- LCD display (daylight visibility).
- True state-of-the-art technology with the high speed ASIC.
- NiCads & Charger included.
- Ultra-high sensitivity.
- 4 fast gate times.
- Extruded metal case.
- Compatible with MFJ207.

Suggested options

TA100S:
Telescoping Whip Antenna..................$ 12.

CC30
Vinyl Carry Case................................$ 15.

BL28:
EL Backlight for use in roomlight and low light...$ 45.

TCXO 30:
Precision ±0.2ppm 20 to 40°C temp. compensated time base ....$100.

Made in the USA

Universal Handi-Counter™ Model 3000, $375. and Bench Model 8030, $579. Both offer frequency, period, ratio and time interval.

OPTOELECTRONICS

Call for free catalog - Factory Direct Order Line:

1-800-327-5912

FL (305)771-2050 • FAX (305)771-2052

5821 NE 14th Ave. • Ft. Lauderdale, FL 33334
5% Ship/Handling (Max. $10) U.S. & Canada.
15% outside continental U.S.A.
Visa and Master Card accepted.

CIRCLE 184 ON FREE INFORMATION CARD

Within budget. Without compromise.

Get more of what you want in a 6½ digit DMM for just $995.

The HP 34401A gives you more performance than any other DMM for the price. More resolution. Better accuracy. The highest reading speed. Fastest throughput. And widest AC bandwidth..

It has more standard features. Like HP-IB, RS-232 and built-in SCPI commands for more system flexibility. Plus ten extended functions including continuity, diode test, limit test, reading hold, dB and null to give you greater flexibility on the bench.

What more could you want? The HP 34401A also comes with a 3-year warranty, standard.

☎ **For more information, or same-day shipment from HP DIRECT, call 1-800-452-4844****. Ask for **Ext. TB26.** And we'll send you a data sheet.

HP 34401A Digital Multimeter	
DC Accuracy (1 year)	0.0035%
AC Accuracy (1 year)	0.06%
Maximum input	1000 Vdc
Reading speed	1000/sec
Resolution	100 nV, 10 nA, 100 μΩ

* U.S. list price
** In Canada call 1-800-387-3867, Dept. 434

There is a better way.

HEWLETT PACKARD

CIRCLE 178 ON FREE INFORMATION CARD