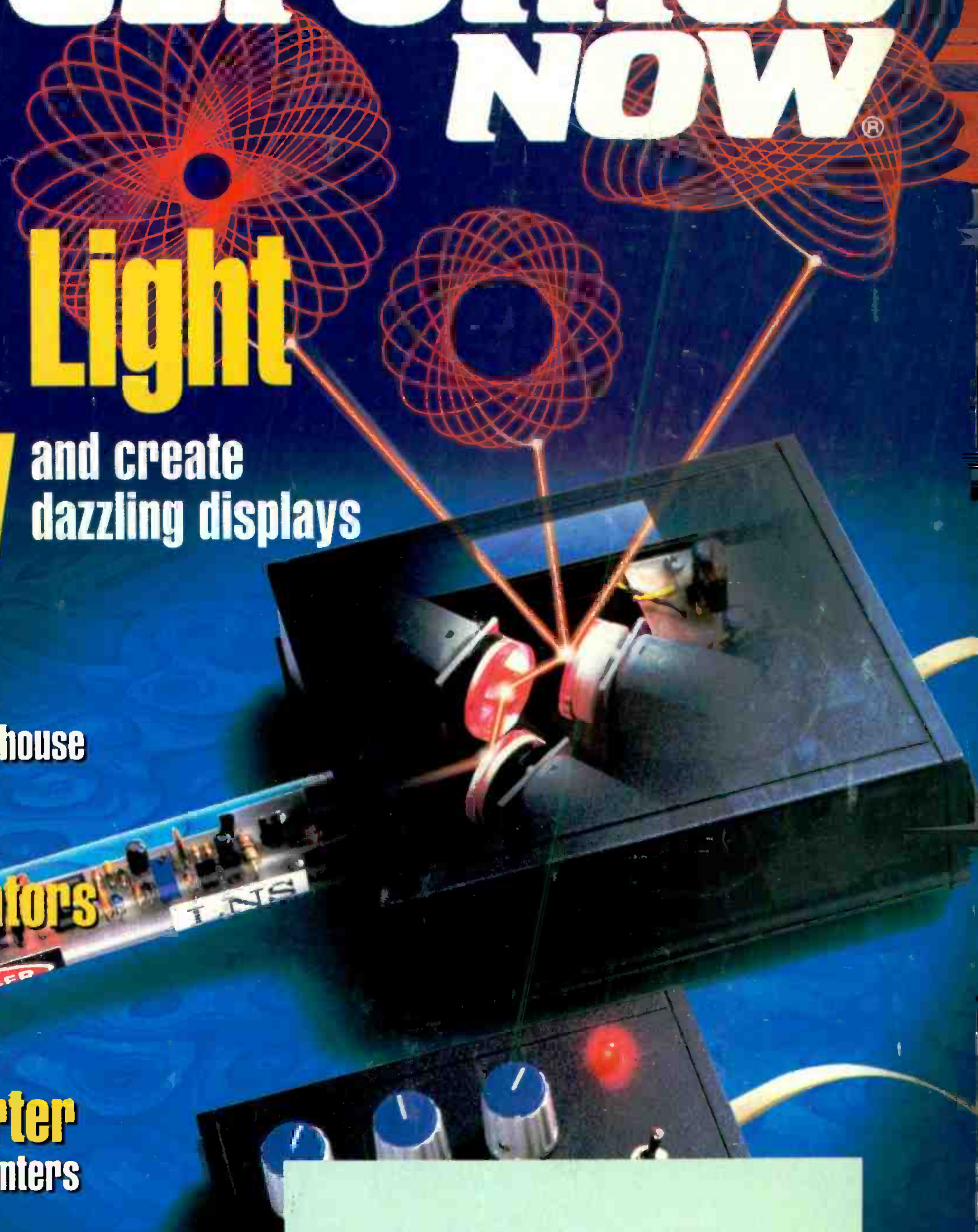
MAKE CUSTOM PANEL-METER FACES WITH YOUR PC

April 1995

Electronics NOW

Combined with Radio-Electronics®



Build This Laser Light Show
and create dazzling displays

Put that Phone On Hold
from anywhere in the house

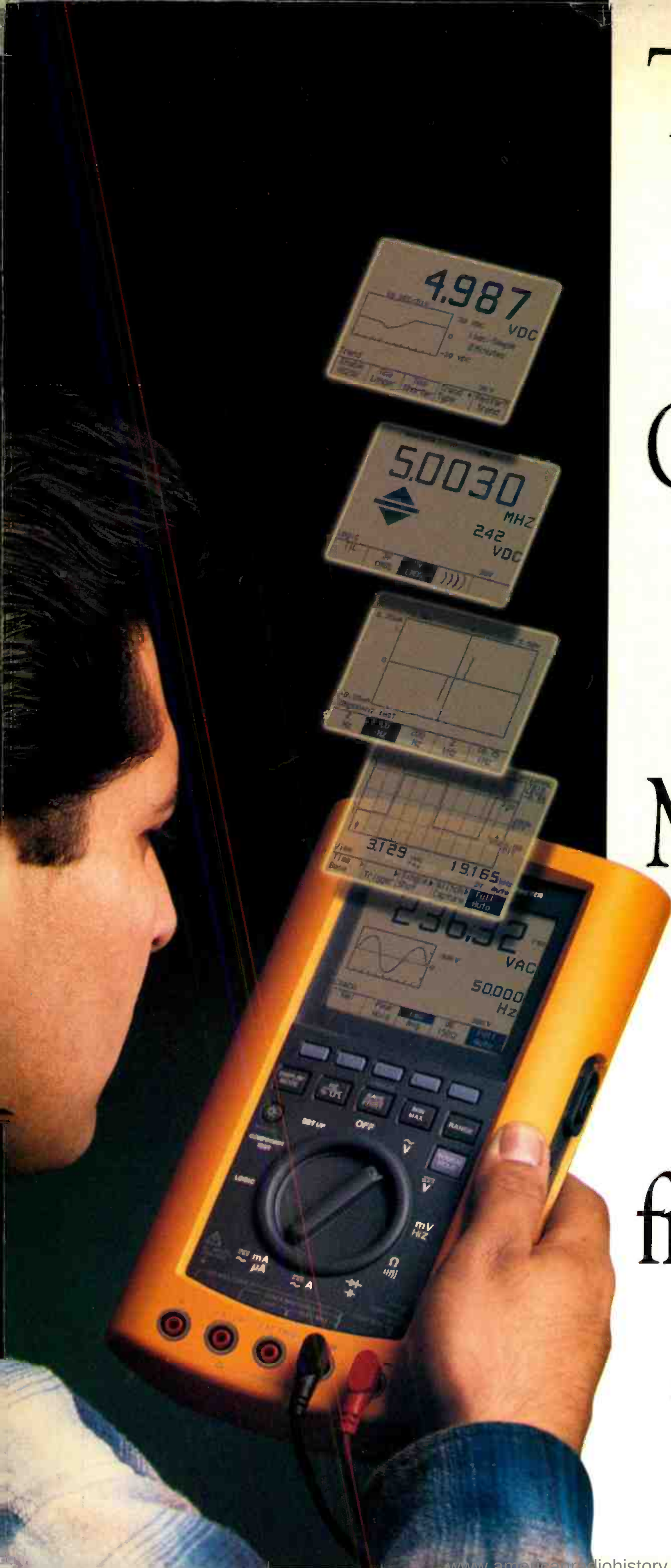
How to work with Off-Line Regulators
in your next project

Low-power Voltage Converter
circuits for experimenters

Build a Telephone Meter
and keep intelligent track of your phone costs

$3.50 U.S.
$3.95 CAN.

A GERNSBACK PUBLICATION



The new

Introducing a whole new category of handheld instruments: the new 860 Series Graphical™ MultiMeters (GMM) from Fluke. GMM™ test tools pair the world's most advanced multimeter capabilities with graphical display power. You choose *what* information you want to see, and *how* you want to see it. All by turning the simple, multimeter-style rotary knob and pressing the Display Mode button. It'll feel so familiar, yet what you'll *see* is brand new.

Turn the knob to the function you want, press Display Mode to select waveform display, and you'll see noise, waveform distortion, and intermittent failures – or capture glitches – *automatically.*

Graphical™

Use In-Circuit Component Test to look at component signatures in-circuit, without risking damage to sensitive components. Or let the GMM test tool monitor a test set up, plotting meter readings for up to 30 hours with the TrendGraph™ Display Mode.

With the 860 Series, you'll be using the most accurate handheld meter ever made – 0.025% basic dc accuracy and a 32,000-count (more than 4-2/3 digit) display. All functions offer true IEC 1010-1 Class III 1000V protection. Plus the most comprehensive set of multimeter functions (including capacitance and dB) in a handheld meter. The Dual Display (primary and secondary numeric readings) along with the Analog NeedleGraph™ display, lets you see frequency, pulse width, or duty cycle.

MultiMeters

And you don't have to buy special test leads; one simple set of meter leads supports every function of the fully integrated 860 Series.

GMM test tools start at $795. For a graphic demonstration, see your local FLUKE distributor or call **1-800-59-FLUKE** for direct connection to a distributor near you. For immediate fax-back of 860 Series literature, call **1-800-86-FLUKE.**

from Fluke.

Serious Tools for Serious Work.

FLUKE®

CIRCLE 121 ON FREE INFORMATION CARD

TECHNOLOGY UPDATE

New microprocessor puts the brain of a $50,000 car under your hood...

Breakthrough remote control lets you start your car, turn on its headlights, sound a panic alarm and unlock the doors and trunk...from up to 400 feet away.

by Charles Anton

How many times have you had to bundle up and brave freezing weather to start your car? Or sit in a sticky car and touch a blistering-hot steering wheel to get your car started? What else can you do besides shiver while a defroster blows cold air in your face or roast in the scorching heat of your car?

A better way. The new AutoCommand keychain transmitter gives you the power to start your car from the comfort of your home or office. Simply press a button to start warming up or cooling off your car from up to 400 feet away. You can turn on the heater, air conditioner or defroster without leaving your seat.

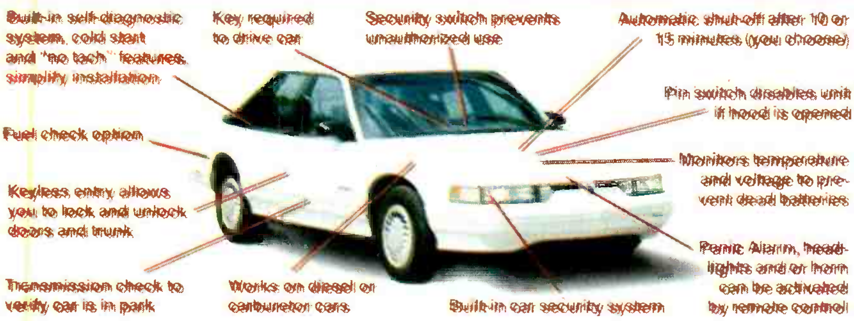
The powerful microprocessor brain learns your car's starting pattern. It adjusts the starting routine based on the outside temperature, battery voltage and the amount of time since your car was last run to guarantee starting every time.

> **Why AutoCommand is better...**
>
> **Range.** *Most remotes only work up to 100 feet away. AutoCommand gives you a range of up to 400 feet.*
>
> **Self-diagnostics.** *The unique feedback lights on AutoCommand confirm proper wire connections during and after installation, just like a car's on-board computer.*
>
> **Total security and convenience.** *AutoCommand gives your car the capability of remote car starting, keyless entry, panic alarm and car security. It also has built-in low temperature and low battery voltage start options.*

Give your car a brain. AutoCommand gives your car the same features as luxury cars, and even some they don't have, by adding this microprocessor brain. In addition to remote car starting, your car will have features such as keyless entry and built-in car security.

You can call for help or scare someone away with the panic alarm; locate your car with CarFinder; and have your car automatically turn on its headlights when it gets dark or turn them off 20 seconds after leaving your car. You can even leave your car running with the doors locked and no key in the ignition. If you forget your car is running, it will automatically shut off after 10 or 15 minutes, you choose.

AUTOCOMMAND FEATURES



Intelligent benefits. With AutoCommand, your car can't be driven until a key is put into the ignition. The AutoCommand immediately cuts off the engine if your vehicle's hood is raised, brake pedal is pressed or the vehicle is shifted out of gear without the key in the ignition, preventing theft or tampering.

AutoCommand also monitors your car while you are away. The built-in Vacation Option will automatically start and run your car for 10 minutes every four to six hours when the temperature drops below zero. On hot summer days, AutoCommand will also start your car when the interior reaches 140 degrees. If your battery drops below 11 volts, AutoCommand will start your car to recharge it.

> **UPGRADE OPTIONS.**
>
> You can replace your existing garage door remote control with the Garage Door Remote Control replacement system. This system can be added to any garage door that has an existing electrical garage lift unit. It will share the same transmitter as the AutoCommand, eliminating extra keychain remotes! You can also add the Shock Sensor option to the built-in car security system. It detects any impact on your car, giving you added protection.
>
> 
>
> The keychain transmitter works with all the available features.

Try it risk-free. At Comtrad, we back all our products with a risk-free home trial. Try AutoCommand in your car and if you're not completely satisfied with its value and performance, return it within 90 days for a full refund, "No Questions Asked." AutoCommand is also backed by a two-year manufacturer's limited warranty. Most orders are processed within 72 hours and shipped UPS.

Exclusive $50 installation discount

AutoCommand comes with an installation video and has patented self-diagnostic feedback lights which confirm wire connections step-by-step during installation. But for those who prefer to have AutoCommand professionally installed, we offer a $50 installation discount. Use the money for professional installation, or install it yourself and keep the money. Either way, AutoCommand makes it easy and affordable to add luxury car features to your automobile.

AutoCommand®	~~$349~~	$14 S&H
with installation discount	$299	$14 S&H
AutoCommand Upgrade Features		
Garage Door Opener	$79	$8 S&H
add Shock Sensor to alarm	$49	$4 S&H

Please mention promotional code **691-ET-1109.**

For fastest service call toll-free 24 hours a day

800-992-2966

To order by mail, send check or money order for the total amount including S&H (VA residents add 4.5% sales tax.) Or charge it to your credit card, enclosing your account number and expiration date.

COMTRAD INDUSTRIES
2820 Waterford Lake Drive, Suite 106
Midlothian, Virginia 23113

Vol. 66 No.

CONTENTS

APRIL 1995

ON THE COVER

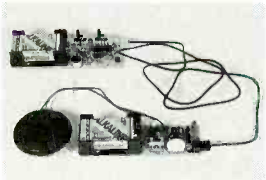
TECHNOLOGY

ELECTRONICS NOW, (ISSN 1067-9294) April 1995. 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. Canada Post IPM Agreement No. 334103, authorized at Mississauga, 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 $3.50. © 1995 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.

BUILD THIS

DEPARTMENTS



AND MORE

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
Evelyn Rose, editorial assistant

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

PRODUCTION DEPARTMENT
Ruby M. Yee, production director
Karen S. Brown
advertising production
Kathryn R. Campbell
production assistant

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 Chris Gould
Cover design by David Loewy

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

Advertising Sales Offices listed on page 94.
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

WHAT'S NEWS

A review of the latest happenings in electronics.

Blue-LED fabrication

Researchers at Boston University's College of Engineering and the Center for Photonics Research have developed a new method for making a gallium-nitride light-emitting diode (LED) that emits light in the ultravioltet-blue spectrum. The blue LED—the first of its kind made in the United States—is critical in the development of the much-awaited blue semiconductor laser and is expected to have a major impact on U.S. competitiveness in the technological marketplace.

Industry analysts predict that blue LEDs will constitute 20% of a $2 billion LED display market by the turn of the century. Low-cost UV-blue lasers will be significant components in the combined color copier, printer, and fax market, which is expected to grow to $8 billion by 2003. The largest market segment expected to benefit from this technology breakthrough is optical storage, which is expected to reach $30 billion by 2003.

According to Dr. Donald Fraser, director of the Center for Photonics Research, "The blue/ultraviolet semiconducting laser, when available, will revolutionize the way the world does its copying, printing, and storing of data, and create enormous markets for those companies with the technology," adding, "The Photonics Center will work with industrial partners to assure that our country retains this advantage."

Professor Theodore Moustakas and his research team first produced a long-life, room-temperature blue LED in April 1994, using a method distinctly different from that introduced the same month by Japanese researchers from Nichia Chemical Industries Ltd. The Boston University method involves the reaction of gallium with atomic nitrogen and leads to uniform deposition over large water areas. Because the LED devices do not require any post-growth treatment for their operation, some of the problems associated with the metallorganic chemical-vapor deposition (CVD) method used in Japan are avoided.

RESEARCHERS AT BOSTON UNIVERSITY have developed a new method to make a gallium nitride blue/ultraviolet LED that is expected to speed the development of a blue semiconductor laser.

For more than two decades, scientists have been trying to develop semiconducting materials that produce true bright blue light efficiently. Red, yellow, and green LEDs were developed in the 1960s and became commercially available in the 1980s. The third primary color, blue, however, has eluded semiconductor researchers.

One of the most promising potential applications for the blue laser is in low-cost optical storage. It would allow a four to ten times increase in storage density over current CD-ROM systems. Blue LEDs will be used most dramatically in bright, full-color displays, such as those intended for sports stadiums. Other potential applications include their use in diagnostic and therapeutic medical equipment, true-color printing, underwater communication, and satellite to satellite communication. The same materials are also suited for electronic and electromechanical applications such as high-temperature, microwave, and spacecraft electronics.

Moustakas, a professor of electrical, computer, and systems engineering and a professor of physics, said, "Making the blue LED from gallium nitride is the first step in getting to the [low-cost, durable blue] laser."

NAB vs. satellite radio

The National Association of Broadcasters (NAB) submitted a point-by-point response to a document filed with the FCC by a proponent of satellite radio. The NAB says that the document, filed by CD Radio, Inc., erroneously downplays the competitive effects of satellite radio on local radio service nationwide.

"Any loss in national advertising revenues... will have a significant impact on overall (radio) station profits and the station's ability to serve local needs," the NAB report—titled "The Truth About Satellite Radio," said. In particular, it pointed out that "any diversion of audience by satellite services will reduce the revenues local advertisers will pay local stations."

The NAB reminded the FCC of a 1992 Price Waterhouse study, which revealed that three out of five U.S. radio stations lost money. Between 1987 and 1993, radio revenue growth has not kept pace with inflation. Small-market radio stations are particularly vulnerable to the impact of satellite radio, which "will provide virtually no opportunity for diversification of ownership and will have virtually no public interest or minority employment obligations," the NAB said in its critique.

Broadcasters also contend that there is little demand for new radio service, citing the FCC's own conclusion, just two years ago, that there were too many radio stations in the U.S. New FCC rules, adopted at the time, encouraged a market-driven consolidation.

The NAB believes that adding mobile satellite radio service to the mix would set up the nation's 11,000

Continued on page 92

VIDEO NEWS

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

DAVID LACHENBRUCH

• **Status of HDTV.** The "Grand Alliance" digital high-definition system has been delayed again. The companies charged with manufacturing a working prototype for testing failed to meet the January 31 deadline for delivery to the Advanced TV Test Center and announced a delay until March. There was some cynicism about the new March deadline, since the earlier deadline for delivery of the equipment was late in 1994. Assuming that the new deadline is met, testing could begin some time in April, but now there seems to be little chance that the timetable of a final recommendation to the FCC by early August will be met. The major equipment work remaining was completion of performance testing of the video encoder-decoder at Bell Telephone Laboratories. The remainder of the system has been assembled at David Sarnoff Research Center and waits final testing when the encoder-decoder arrives. According to a Grand Alliance spokesman: "The equipment is working, we have pictures, and we just need a little more time to finish our work."

• **"TV Information Center."** Some time within the next month or

THE AT&T TELEVISION INFORMATION CENTER, available in a set-top box or built-in to a Zenith TV (shown) allows an ordinary TV to be used as a telephone answering machine, for electronic banking, and to supply information services.

portfolio updates tailored to the individual user, will be added. A hand-held remote control is used to access the information, which is delivered over ordinary phone lines. The Information Center black box will sell for $329, according to AT&T, and a "basic group" of services will cost less than $10 a month. Zenith will manufacture TV sets and cable boxes with the Information Center built in.

so, you'll be able to go to your local electronics store or AT&T Telephone Store and buy a black box that will link your television set to your phone lines, according to AT&T. The "Television Information Center" is designed to connect to products that almost everyone owns to supply information services. AT&T says that it's not necessary to have a computer to be "on line," since the TV is a ubiquitous display device in the home and the telephone line can feed it. Initially the Information Center will provide telephone answering and electronic banking and bill-paying with on-screen displays. Custom services, such as sports scores and stock-

Zenith, which is partnered with AT&T in developing home hardware for the system, says that the system "advances our strategy to position the television as the primary source for interactive services." However, just in case someone wants to use a computer instead of a TV set, AT&T will also offer a PC interface. And for someone who wants the system but doesn't want to tie up either the TV or the computer (or the phone line), AT&T will offer a telephone with two lines and a built-in screen for $199. The basic Information System has a built-in, 2400-baud modem and more than a megabyte of DRAM and flash memory.

• **Satellite Success.** The consumer-electronics success story of 1994 unquestionably was the Digital

RCA'S DSS SATELLITE SYSTEM was 1994's surprise consumer-electronics hit, quickly surpassing all projected sales figures.

Satellite System, or DSS, the high-powered satellite home-delivery system that is supplying TV programming to well over a half million homes in the United States that are equipped with 18-inch satellite dishes. Thomson Consumer Electronics announced that it had shipped 593,098 RCA-brand DSS receiving systems to dealers between last June's launch and the end of 1994, and that it has started a $40-million expansion of its Juarez, Mexico plant to handle the demand. Two versions of the system are available—priced at $699 and $899—with installation available for $200 or on a do-it-yourself basis.

Ironically, the very success of DSS will end RCA's exclusivity prematurely. Under the terms of Thomson's pact with its partners Hughes Electronics and U.S. Satellite Broadcasting, Thomson has the exclusive right to make and sell receivers for 18 months or until the first million systems are sold. Now the goal of selling one million units might be reached in May, since

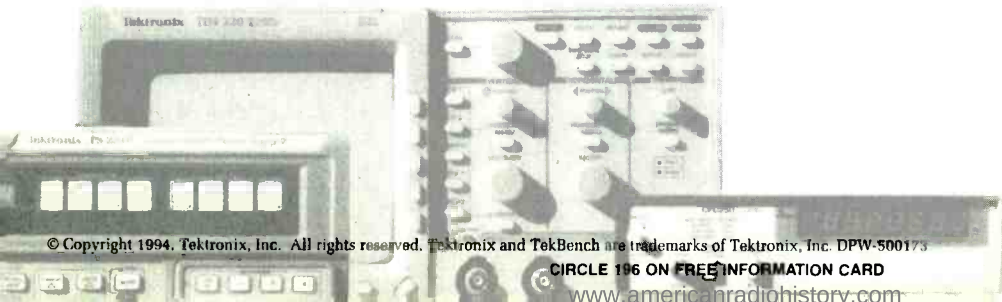
Continued on page 89

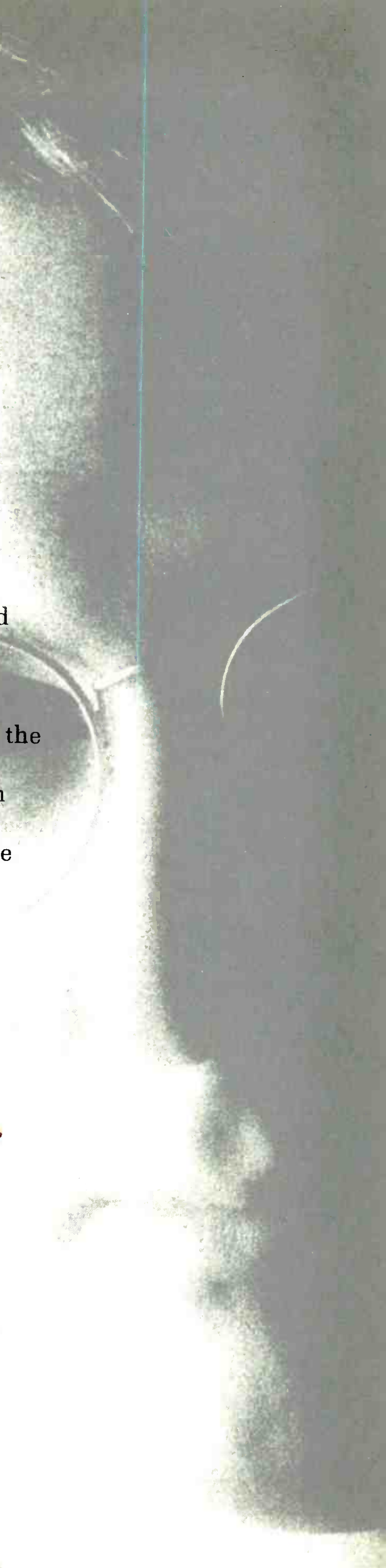
Look beyond our scope.

Tektronix gives you an entire bench of affordable test instruments.

You know us for our oscilloscopes. (Considering we are the widely accepted market leader, it's not surprising.) ■ Now we've expanded our vision. And it's grown to include function generators, counters, timers, multimeters, power supplies, and accessories. All built with the same devotion to accuracy and reliability that you've experienced in our scopes. It's all compatible, fully integrated and best of all, simple to use. ■ And all made available to you in a comprehensive, affordable portfolio we call TekBench™. ■ Come, try one out when you next need something for your bench. We believe we'll be well within your scope. For more information or the name of the Authorized TekBench™ Distributor nearest you, call 1-800-426-2200. (When prompted, press 3 and request ext. 335.)

TEKBENCH™
from Tektronix





Tektronix

Q & A

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

NEGATIVE REGULATOR

Could you please explain what a constant negative voltage regulator is and could you also draw a schematic of one?—Justin Williams

A constant negative voltage regulator is inserted into the negative supply instead of the positive supply line. Figure 1 shows the basic difference between how a 7905 negative 5-volt regulator and a 7805 positive 5-volt regulator are used in a circuit. Figure 2 shows how the two regulators can be used in a bipolar power supply (one with positive and negative outputs).

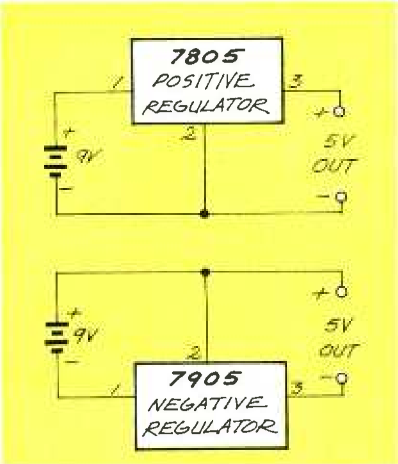


FIG. 1—HERE'S THE BASIC difference between how a 7905 negative 5-volt regulator and a 7805 positive 5-volt regulator are used in a circuit.

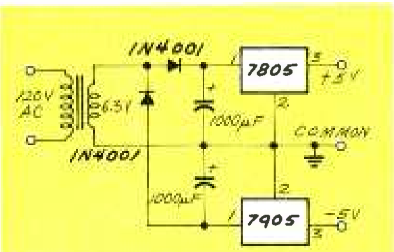


FIG. 2—TWO REGULATORS can be used to make a bipolar power supply.

MINI RADIO STATION

We are a small community within an American city. We would like to build a small AM or FM broadcasting station to cover a 10- to 20-mile radius. The language used will not be purely English. Can you comment about the legality of such a project? Is any kind of permit required, and from whom?—Bandar Al-Mashary

A low-power license-free transmitter can cover at most only a couple of miles. Your station will have to be licensed by the Federal Communications Commission (Washington, DC 20554). The best way to proceed is to find someone who is already operating a similar station, and get guidance from them.

Another option is to transmit your programs on a subcarrier of an existing FM station, like a third stereo channel. Members of your community would then use special receivers to pick up the broadcasts. Ethnic communities in a number of cities are already doing this. The station engineer of any major FM station can tell you what's being done in your area. In fact, if your community is large enough, someone who is already in the broadcasting business may be interested in setting up a commercial radio station to serve it.

MONITOR SWITCHER

I have two 386DX computers that I am using as file servers. The two computers sit next to each other and their monitors are almost always turned off. Can I use a switch box to connect one monitor to both computers?—Brian D. Allison

In principle, yes. In practice, the high frequency of VGA analog video signals makes ordinary switches unsuitable. Frequency response has to be flat from DC to over 30 MHz, and you have to switch five signals at once without introducing crosstalk between them.

As you noted in your letter, commercial VGA switch boxes do exist, but they are expensive. I have had some success switching VGA signals with reed relays; that's the direction to go in if you want to build your own. Alternatively, here's a "no parts" solution: just plug the monitor into whichever computer needs it at the time. You can unplug a monitor from a running computer and plug it back in without harm, as long as you take care to touch the case of the computer first in order to discharge static electricity.

NO HOT BOOT

I have a 486 DX2 computer that boots up fine from a cold start, but if I attempt to reset it, it refuses to recognize the hard drives. I have had several professional computer technicians look at it and they are stumped. Do you have any ideas?—R. Notarfranco

One of two things might be wrong. If there's a temperature-dependent loose connection, the computer will start when cold but not when warmed up. To track it down, substitute parts one by one, starting with the disk controller.

It's also possible that something is happening at boot-up that interferes with access to the boot ROM when you reset the computer. In that case, turning the computer off—even for a moment—will reset it correctly even if the reset button doesn't. To solve the problem, simplify your configuration as much as possible until you find out which device driver or other piece of software is responsible. Also, check your CMOS configuration settings and tell it not to copy the ROM BIOS into RAM.

READY-TO-USE TRANSMITTER

I lack the tools and expertise to build the "FM Stereo Broadcaster" (*Radio-Electronics*, July 1992). Can you recommend a company that can provide an assembled and tested unit?—Brian D. Murphy

How about an easy-to-assemble

Continued on page 18

LETTERS

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

CABLE COMPLAINTS

Regarding your article and interviews on the subject of signal theft, I think you missed the boat on some points. The vast majority of customers who "steal signals" are people who would not otherwise pay for the service. To say that cable, pay television, and subscription services "lose" billions of dollars is an unfair characterization. The fact is that a certain number of people will pay regardless of the cost of the service, some will pay unless they feel the service is cost prohibitive, and some will *never* pay—regardless of the cost.

If you count lost revenue against the number of people you believe are "stealing" your service, and then add the number of people who you failed to properly disconnect upon termination of their service, and then add the number of people who illegally reconnect their own service upon termination, then, yes, it's a big number of dollars. If you take reality into account and count lost revenues against the number of people who would actually pay you for the service, then the number is much smaller.

There will always be a certain element of loss in any business, and subscription television is no exception. The trick is weighing the costs of making the system so secure that it is virtually impregnable versus providing a quality product.

If you spend a lot of money providing a good quality product that you can deliver at a reasonable cost, then no one will even bother trying to "steal" your signal. If you spend a lot of money "protecting" a product of lower quality, then the consumers will feel little remorse about stealing your signal. Likewise, the money spent protecting your product will be passed on to consumers, resulting in a system that is so incredibly cost-prohibitive that the government might even have to step in to protect people from those tariffs. Does that sound more like reality?

People who distribute videotapes, laserdiscs, and other electronic software rarely incorporate any form of copy protection into their products. Those products are readily available to anyone, and some people take advantage and illegally copy videotapes. Many are prosecuted and a lot are in jail where they belong.

Cable television, on the other hand, is a subscription product that the company can deny you if you do not comply with their standards and practices. They can simply remove the product from any household and make it extraordinarily difficult, if not impossible, for the subscriber to reconnect the service on his own. The industry does not need any protection. Cable companies are more than capable of protecting themselves. All they really need are substantial and effective standards and practices. The industry is too young to have developed all of these yet, but once they are in place and accepted, there won't be any surprises. Consumers will know what to expect of the product and of the industry as a whole. They won't be upset about changes from one tier of service to another because, while all of the service providers will have their subtle differences in the level of service and the manner in which it is delivered, the fundamental components of that service will meet a basic standard.

To all you service providers: Get off your duffs and stop blaming the customers for all of your problems. Most consumers are honest and only want a respectable level of service for their money. If you can't do that, technology will obviate the need for your service altogether. Big communications companies will not buy you out; you will just die a long and painful death as customers and profits migrate to these newer, better technologies and their delivery systems.

Have you seen DSS? It offers more service options than any cable company in existence. While the service may now be expensive, costs will come down. You have to compete in this market—and you desperately need competition. Up until now you have been unable or unwilling to provide a level of service that would eliminate the need for such competition. The market is ripe, and you have grown old and fat. You must compete or die.

PATRICK LEARY
Sherman Oaks, CA

THE DIALOG CONTINUES

I'm writing to respond to Donald G. Chessier's letter in the November 1994 issue of *Electronics Now*, in which he commented on my letter (August 1994) concerning D.A. Butch's "Telephone Ring Amplifier" letter (February 1994).

Contrary to Mr. Chessier's theories, there are no errors in the design I described.

I considered Mr. Butch's design, and my modification, to be a good way to build a simple and practical device that shouldn't cost anything if made from readily available junkbox components. For commercial production of telephone ringers, there are several specialty ICs available, but they often carry fairly high single-unit prices.

My suggested changes to the Butch design were based on a circuit that I came up with about 11 years ago. Since then, I've built more than two dozen units for myself and friends, and only one has failed (due to a breakdown in capacitor C4).

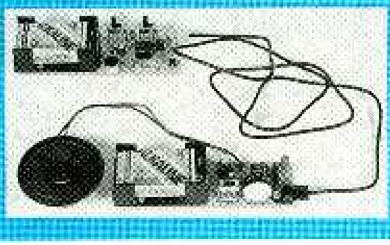
The design recognized that the capacitor would only supply usable power for a limited number of rings each time (about eight or nine in the case of a 4700-µF capacitor). But that, I decided, was enough to get anyone's attention and represented

Continued on page 17

EQUIPMENT REPORTS

Elenco Electronics FO-30 Fiber Optics Kit.

Learn the principles of data communications over fiber-optic cable with this inexpensive and easy-to-build kit.



The transmission of light waves over fiber-optic cables has become a practical alternative to the transmission of electrical signals over copper wires. The increasing availability and falling costs of conversion electronics have accelerated its acceptance. Fiber-optic communication offers many advantages over wire communication including broader bandwidth, reduced cable size and weight, signal security, and safety.

The waves of the future

In addition to transmitting far more information than comparably sized wire and cable (thus replacing big bundles of wire), fiber-optic cable saves weight and space in underground and building ducts. Optical-fiber cables are difficult (if not impossible) to tap, so they offer higher data and message security than wire and cable-based systems.

Signals transmitted over fiber-optic cable are immune to interference from nearby electrical wires or other electromagnetic interference sources. Also, because the fiber-optic cables carry no electricity, shock hazards are eliminated, and there is no danger of electrical arcing. Thus fiber-optic cables can be passed safely through places where there are explosion or fire hazards. It can also be placed under water without the corrosion problems of copper wire and cable.

The nation's telephone operating companies are replacing large bundles of conventional cables with thin fiber-optic cables. The cables are also serving in computer local area networks (LANs) and in industrial process control systems. Reports of new applications for fiber-optic technology appear regularly in newspapers and magazines.

The FO-30 Fiber Optics kit

The *FO-30* Fiber Optics Kit from Elenco Electronics (150 W. Carpenter Ave., Wheeling, IL 60090, 708-541-3800) offers an excellent opportunity for anyone who wants to learn more about the fascinating subject of fiber optics while, at the same time, gaining hands-on experience. With this $19.95 kit, one can build a working system in a single evening and then have the necessary hardware to perform many different interesting and educational experiments.

Fiber-optic fundamentals

Glass or plastic optical fibers function like wires, but they are actually waveguides for the transmission of light rather than electricity. Light passes easily through the core, but it is reflected back from the cladding because of its different optical properties, thus confining the light to the core as it travels.

Thus lightwaves reflect back and forth off the cladding as they propagate down the fiber, much as radio frequency waves bounce off the ionospheric layers as they are transmitted around the world. However, lightwaves, like radio waves, are attenuated as they travel, so they lose strength in transmission. Thus amplifying relays are required for long-distance links.

All signals to be transmitted over a fiber-optic cables must first be converted into a light signal (photons). Those photons must then be converted back into electrical signals by the receiver.

Transmitter and receiver

The Elenco Electronics Fiber Optics Kit consists of a transmitter and receiver board that must both be built from scratch. Each circuit board contains only a few components, so the whole project can be built in less than two hours. For those not in a hurry to complete the project, the work can be spread out over a couple of evenings by building only one board each night.

The transmitter board contains a microphone, an amplifier IC, an infrared-emitting diode (LED), and a collection of other simple components. In one position a slide switch applies the signal from the microphone to the amplifier, and in its second position the amplifier IC is converted into an oscillator.

The signal from the amplifier IC (either the amplified microphone signal or the oscillator tone) is converted to a light signal by the LED. A second switch turns power on and off, and a LED lamp lights to indicate that power is turned on.

The receiver board contains a fiber-optic phototransistor, an amplifier IC, a speaker, and a few other components. A switch here also turns power on and off, and a potentiometer permits the speaker volume to be adjusted. Another LED lamp indicates when power is on. The signal received at the phototransistor is amplified and can be heard from the speaker. Two 9-volt batteries are required to power the system, one for each board.

The kit includes a 3-foot length of fiber-optic cable. After preparing the cable ends, this cable makes the connection between the transmitter and receiver board. The ends of the optical fiber must be cut off at 90° with respect to the fiber axis with a sharp razor blade. It can then be polished with a wet square of fine-grit sandpaper that is included with the kit.

Then a short length the black plastic cable jacket is removed from each end with an 18-gauge wire stripper. The prepared ends of the cable are inserted into the openings in the LED emitter and phototransistor on the transmitter and receiver boards. The cable ends are clamped with a threaded collar that tightens on each end.

When the two boards are completed and connected by the fiber-optic cable, the system is ready to use. When both sides are powered, either the microphone input or the oscillator tone is heard from the speaker, depending on the setting of the function switch.

The manual included with the kit clearly explains how the circuitry works, how to build the kit, and how to use it. The principles of light communication and fiber optics are explained. The manual contains schematic and parts placement diagrams and soldering tips, and troubleshooting hints are provided.

Many interesting and educational experiments can be performed with the completed data communications system. For example, if the fiber-optic cable is disconnected from the transmitter (while leaving it attached to the receiver), and the open end of the cable is pointed at a bright light source, a hum will be heard from the speaker; the brighter the light, the louder the hum.

If a television/stereo infrared remote control is pointed at the open end of the fiber-optic cable, and a button on the remote is pressed, the sound of a pulsed tone will be heard. Different tones can be heard if different buttons are pressed.

The lightwave transmission system built from Elenco's Fiber Optics Kit is an economical and effective demonstrator of fiber-optic communications. The builder will gain practical hands-on experience in building a working system as well as some mastery of the theory behind fiber optics. The resulting circuitry will be suitable for personal experiments and as useful addition to any inventory of classroom science equipment. Ω

TECHNOLOGY UPDATE

How to get surround sound without buying the theater...

Chase Technologies brings you an amazing new patent pending surround sound decoder that turns your stereo into a five-channel home theater.

By Charles Anton

As much as I love renting videos, it's just not the same as seeing a movie in a theater. I remember the first time I saw *Jurassic Park*—I nearly jumped out of my seat when the dinosaurs roared. One of the reasons movies seem so real is because surround sound makes it seem like you're actually there when events are happening. Now there's an incredible new device that lets you use a stereo receiver to get that same surround sound in your home.

It takes more than five speakers to get surround sound; there needs to be a way of separating the signals. The new Chase Technologies HTS-1 decoder does just that, and in a revolutionary way that rivals the best Dolby Pro-Logic and THX systems.

Wins over critics. In the September '94 issue of "High Performance Review," noted audio critic Daniel Kumin said "the HTS-1 can do quite a job of recreating a 3D theatrical experience...surround effects emanated with satisfying fullness... sound was clean at any level...with quite involving and natural sound ambience." Plus, John Sunier, the leading authority on surround sound and producer of *Audiophile Audition*, a nationally syndicated radio program for audio enthusiasts, says, "...the new Chase HTS-1, when used to decode the hidden ambience in all musical recordings, definitely outperforms all the Dolby and THX processors (which could cost you up to $3,000)...I am impressed!"

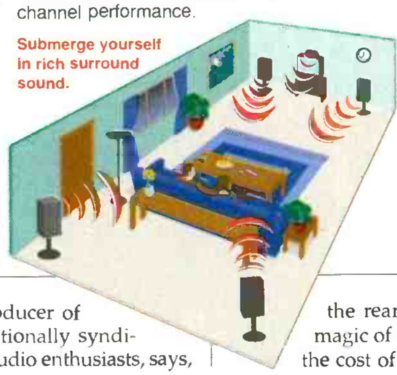
The secret of surround sound

Surround sound has become the rage of the 90's because it adds depth and realism to stereo sound, giving you the home theater experience. It makes you feel like you're actually at a concert or theater. To "fill a room" with surround sound, you need more than two channels. The HTS-1 provides five channels of sound from any two-channel stereo source.

Free center channel. By connecting your VCR or laserdisc player to your TV, you get sound from your TV speaker; this acts as the fifth or "center channel."

Upgradeable. The new HTS-1 gives you the ability to upgrade by adding the "Dialog" powered center channel speaker (instead of using your TV speaker.) The decoder can also feed an extra amp for the rear speakers if you want the ultimate in discreet five channel performance.

Submerge yourself in rich surround sound.



Passive circuit. Last year, audio industry veteran and Chase president Bob Rapoport invented a new five-channel "passive" circuit for decoding every surround sound encoded movie available. This new decoder can be used with two, three, four, or five channels of amplification, making it the most cost effective method for upgrading an existing stereo system to full home theater performance on the market today.

Breakthrough. The HTS-1 is able to decode the *Dolby Surround™* signals in a stereo, videotape or laserdisc because the spatial and depth cues have been matrixed into the "out-of-phase" L minus R portion of the program. By decoding passively, the HTS-1 avoids costly and noisy signal processing. Plus you don't need any extra amps! Just connect the HTS-1 to your existing stereo, add two speakers for the rear, and you'll experience the magic of home theater at a fraction of the cost of all other systems.

Easy installation. Hooking up the HTS-1 is easy—just connect the speaker outputs of your receiver or amp to the HTS-1, then connect speaker wire to the front and rear speakers. The rear channel speakers don't have to be big. We suggest the Chase ELF-1 in either black or white finish to match your decor.

Center Channel. The "Dialog" powered center channel speaker is the perfect add-on for home theater. It keeps voices and sound effects centered on screen for stunning localization and clarity.

The ELF-1 rear channel speakers integrate perfectly with the HTS-1.

Risk-free home trial. The best way to evaluate surround sound is in your home, not in a showroom. That's why we're offering this risk-free home trial. We're so sure that you'll be delighted with the quality of these products and the surround sound experience that we are giving you 30 days to try them for yourself. If they're not everything we say, return them for a complete "No Questions Asked" refund.

The Dialog powered center channel speaker is video shielded.

HTS-1 Home Theater Decoder..........**$99** $10 S&H

Speakers designed by Chase for the HTS-1:

ELF-1 Rear Channel Speakers (pr)......**$99** $10 S&H
DIALOG Center Channel Speaker........**$75** $8 S&H

Please mention promotional code 117-ET1108.

For fastest service call toll-free 24 hours a day

800-992-2966

To order by mail, send check or money order for the total amount including S&H (VA residents add 4.5% sales tax.) Or charge it to your credit card, enclosing your account number and expiration date.

COMTRAD INDUSTRIES
2820 Waterford Lake Drive Suite 106
Midlothian, Virginia 23113

AWARD-WINNING DESIGN

At the 1994 Summer Consumer Electronics show in Chicago, the HTS-1 won the Design and Engineering Award for being one of the best and most innovative new products of 1994. This award-winning design from Chase Technologies is a breakthrough for it's ease of use, affordability and outstanding performance.

The new award-winning HTS-1 Decoder.

LETTERS

continued from page 12

a good capacitor recharge time compromise.

Mr. Chessier's claim that the 4148 diode's ratings aren't sufficient is in error! First of all, the old Bell ring voltage specifications allow a Central Office level between 85 and 100 volts AC RMS (and that voltage can drop to as low as 55 volts AC at the end of a long loop). Even at maximum voltage levels, the worst that can happen is that the diodes break down and Zener at a safe level determined by the two 33 kilohm resistors. No harm is done to either the diodes or the other circuit components. If you want to use 1N4004 diodes, by all means do so, but it isn't necessary. Mr. Chessier's claim that doing so would impart some protection against electrical storm transients is a bit much. If you want that kind of protection, it won't come about from just changing some of the components (a chain is no stronger than its weakest link). Instead, that would best be done by putting a 250–300 volt MOV (metal oxide varistor) across the phone line where it enters the building.

As for Mr. Chessier's second point (also wrong), the base current trough Q1 is design limited to about 30 µA, so the transistor never fully switches on, giving a collector current that is well within specified limits. Transistor Q2, although fully switched on during part of a ring, is also current-limited through the internal resistance of the buzzer.

Point three: I've done a lot of playing around with various piezo buzzers and one thing I've found common to all those I've tested is that they can all handle a 50-volt supply in intermittent service (such as with a phone ringer), regardless of their rated voltage. Some were bought at Radio Shack, some as surplus, and others came out of discarded greeting cards (where they played a tune) and broken "Hong Kong" telephones.

Although no polarity was shown for the buzzer in the original figure, anyone who knows which end of a soldering iron to grab should have no problems figuring that one out. As for the voltage rating of transistors Q1 and Q2, the 2N3904s, at 60 volts, are quite adequate.

If the unit has rung itself out (nine rings or so), the C4 capacitor will not go below the off-hook voltage of about 6 volts and would still be able to signal another incoming call (although at low volume) immediately after hanging up. Even when newly installed, with zero charge on C4, it will ring several times after only four or five minutes (not the 15 minutes claimed in Mr. Chessier's letter).

RUNE H.J. SODERMAN
Jandrain, Belgium

A READER'S SUGGESTIONS

Your fine January 1995 issue prompted me to comment on two articles that appeared there. The first is the article by Doyle Whisenant: "Build an Isolation Transformer." The information is fine, but the project might be improved by keeping the filament windings and connecting them, with suitable switching, to provide adjustable output voltage. Besides compensating for incorrect line voltage, this allows the equipment under test to be run above or below normal voltage to help uncover latent faults.

The second comment is directed to Tom Heald and his very helpful article, "Phantom of the Ether." It's possible that he's looking for an electronic solution to a problem that is essentially optical. Fluorescent tubes contain argon gas (or perhaps xenon or krypton), which has strong spectral lines in the 1000-nanometer region. If those lines could be suppressed by changing the composition of the glass in the tube or by some overcoating that would absorb in this region but be transparent to visible light, the problem would go away.

Keep up the good work. I've been a regular reader of *Electronics Now* and its predecessors for at least 50 years and have found it to be at least as helpful as a number of "professional" journals that I use regularly.

E. FRED CLOSE
Apache Junction, AZ Ω

Q & A

continued from page 8

kit? Try the FM-10 from Ramsey Electronics (793 Canning Pkwy., Victor, NY 14564), featured in the February, 1995, issue of our sister magazine, *Popular Electronics*. Alternatively, maybe you can use one of the low-priced FM transmitters designed to transmit a CD player's output to a car radio.

BATTERY ISOLATOR

Do you have plans for the circuitry used in automotive dual-battery isolators? Do the batteries have to have similar or identical output-current ratings? If they're not isolated, will one battery just drain the other?—Randal Christman

You could probably connect two batteries in parallel without harm if they are both in good condition and are matched for voltage (not necessarily matched for capacity). If one battery developed a shorted cell, it would discharge the other battery; otherwise, they'd be OK.

The purpose of a battery isolator is to let you use one battery without discharging the other one. The main battery can remain available for

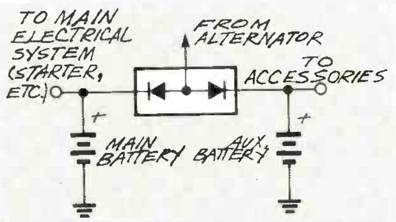


FIG. 3—BATTERY ISOLATOR CIRCUIT. The diodes ensure that current can flow into both batteries from the alternator, but the main battery can't feed the accessory system, nor vice versa.

starting power even if you run the other battery down operating camp lights or other accessories.

Figure 3 shows the circuitry inside an isolator. The diodes act as one-way valves so that current can flow into both batteries from the alternator, but the main battery can't feed the accessory electrical system, nor vice versa. The batteries need not have the same capacity as long as they have the same voltage.

The diodes must be able to handle heavy current (80 amps or more) with as little forward voltage drop as possible. Suitable diodes, such as the NTE 6075 or ECG 6075, cost over $13 each. You'll probably do just as well buying a complete isolator from an auto parts store. One source for the NTE 6075 is Tandy National Parts (800-322-3690).

CONCRETE DRAIN

Please! Educate me, or help me put a myth to rest. All my life I've been told that lead-acid batteries will lose their charge if they're stored resting directly on concrete. I can see no logical reason for this to happen.—Larry Ball

We've heard the same thing and it doesn't make sense to us either. We know of no way that a concrete floor can discharge a battery. But if the battery cracks open, the acid will certainly damage the concrete.

VCR MODIFICATION

I want to use a VCR to record programs while on the road in my RV. I haven't been able to locate any 12-volt DC units (all I've found are video player-only units). Since all solid-state electronics operate on DC, why can't I modify a conventional AC-powered VCR?—William Rauch

Mainly because some of the voltages in a VCR are higher than 12 volts. To obtain them, you'd have to use a DC-to-DC converter, which is essentially an inverter followed by a rectifier. If you're going to do that, you might as well feed the VCR with 120 volts AC from a regular inverter, rather than building one. Ω

NEW PRODUCTS

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

CIRCLE 20 ON FREE INFORMATION CARD

PCMCIA MODEMS. Motorola's Transmission Products Division has introduced two series of credit-card-sized modems called *Lifestyle* and *Power*. The 14.4 PCMCIA modems conform to the standards of the Portable Computer Memory Card International Association (PCMCIA).

The Lifestyle data and fax modems are intended for laptop, notebook and palmtop personal computers with PCMCIA slots. The modems permit the sending and receiving of faxes and files over standard phone lines. They also permit connection for on-line services such as banking and shopping. The Lifestyle modems can be upgraded for use with cellular telephones.

By contrast, the Power data and fax modems for laptop, notebook and palmtop personal computers with PCMCIA slots are intended for use with cellular or traditional phones. The series permits the sending and receiving of faxes, E-mail, and the downloading of files anytime, anywhere in the world.

A Motorola MC^2 flip cellular telephone is required for compatible cellular connectivity. The Power modems supports Motorola's proprietary EC2 (Enhanced Cellular Control) technology for improved cellular phone operation.

Both series of modems can be inserted in computers with PCMCIA Release 2.0 and higher, Type II slots. They are fully compatible with the installed base of CCITT Group III and EIA Class I modems. When used with Class 1 software, the modems can send and receive a document at 14,400, 12,000, 9600, 7200, 4800, or 2400 bits per second, assuring compatibility with most fax machines and modems.

The modems automatically adjust speed as needed. Both series of modems perform T.30 error correction for increased data reliability and fax cost reduction. Power reduction of 25 to 90% in standby modes over competitive modems is claimed.

The Lifestyle modem (pictured) is priced at $279.00, and the Power modem is priced at $390.00. The price for both modems includes Delrina WinFax/WinCom software, and one month of free service on America OnLine, CompuServe, Prodigy, and the Reuters Money Network.

Motorola Transmission Products Divsion
5000 Bradford Drive
Huntsville, AL 35805-1993
Phone: 800-365-6465
Fax: 508-261-1058

16-CHANNEL LOGIC ANALYZER. Hewlett-Packard's HP 54620 16-channel logic analyzer can be coupled to an oscilloscope to permit quicker and easier troubleshooting of complex digital circuits. Priced in the same range as a 100-MHz delayed-sweep oscilloscope, it permits timing analysis across all of its 16 channels.

The logic analyzer was designed for those who routinely use an oscilloscope instead of a logic analyzer for testing and debugging. It features a simplified control panel and easier setup procedures to encourage its use. The HP 54620 has a 500-millisecond sampling speed and 20-screens/second display update rate. An auto-scale feature lets users display active channels with the push of a button. All functions are accessible through multilayer menus.

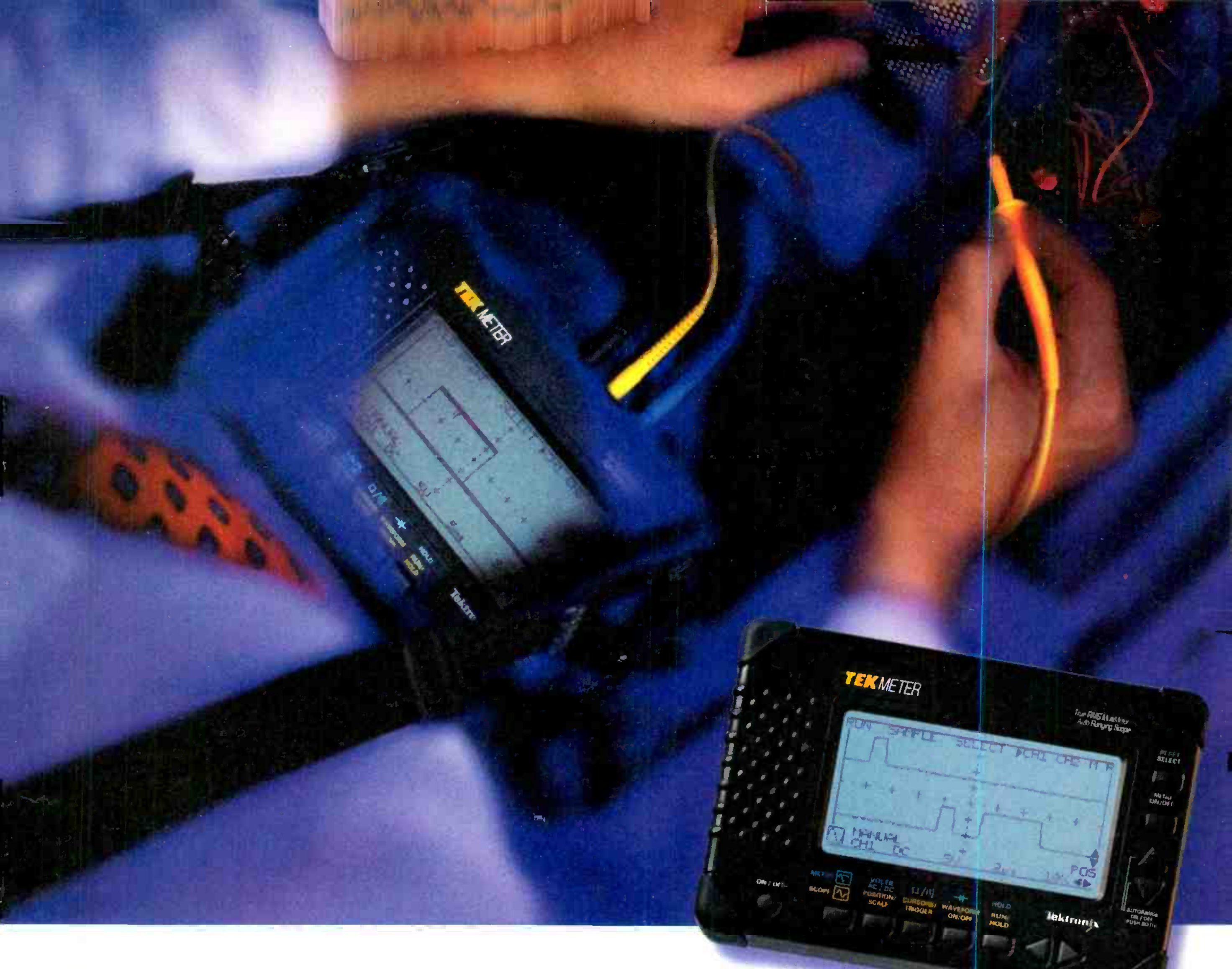
The HP 54620A provides a front-panel trigger output to link the logic analyzer to an oscilloscope. This gives users a complete picture of circuit operation, with the logic analyzer providing signal relationship information while the oscilloscope displays the related parametric waveform information.

With the HP 54620A linked to an oscilloscope, the triggering capability of the logic analyzer can capture elusive glitches so that the signal can be examined in detail. It offers simple edge triggering, pattern triggering qualified with an edge, or advanced triggering sequences for applications where simpler triggering methods won't isolate the event of interest.

CIRCLE 21 ON FREE INFORMATION CARD

The new logic analyzer is compatible with the HP 54600-series add-on modules for computer I/O, data storage and test automation. HP 34810A BenchLink/Scope (version 1.2) software allows users to import logic-analyzer data into their own Windows applications.

The HP 54620A 16-channel logic analyzer is priced at $2995.00



TekMeter™ can show you the answer before you even know the question.

TekMeter™ is the new handheld instrument from Tektronix that combines the functions of a DMM and an oscilloscope. It's practically "auto everything." Which in the service business means you'll get the answers you need faster than ever before.

It's easy. Just connect the probes. TekMeter finds the signal then makes the correct scope or DMM settings to display voltage, current or waveforms in the most meaningful way. What's more, your hands

CHECK OUT THE ENTIRE TEKTOOLS™ LINE FOR ALL YOUR MEASUREMENT NEEDS.

remain free to probe more accurately and safely. Especially in small places.

Weighing barely 2 pounds, TekMeter includes a host of features like cursors and spike detect that improve your ability to maintain and troubleshoot a wide range of equipment. TekMeter can even capture incoming line voltage spikes and sags, measure voltage and current simultaneously, compute true power, and more. All automatically. For as little as $875.*

TEKTOOLS

TekMeter is the answer you've been looking for. Contact your local authorized Tektronix distributor today, or call **800-426-2200, ext 299.**

Tektronix

CIRCLE 92 ON FREE INFORMATION CARD

Hewlett-Packard Company
Direct Marketing Organization, P.O. Box 58059
MS51L-SJ
Santa Clara, CA 95051-8059
Phone: 800-452-4844

SPECTRUM ANALYZER. The SA2600 spectrum analyzer from DKD Instruments can convert a personal computer into a spectrum analyzer/receiver. It covers the 100-kHz to 2.4-GHz frequency range and draws less than 12 watts at 12 volts. The SA2600 offers fully synthesized tuning with a crystal reference. Less than 2-Hz frequency resolution is provided by its direct digital synthesizer. Video and resolution bandwidth are programmable from 300 kHz to 500 Hz for making precise measurements.

CIRCLE 22 ON FREE INFORMATION CARD

With a spurious free dynamic range of 80 dB and the optional internal, programmable, 60-dB step attenuator, signals from −130 dBm to +20 dBm can be accurately measured. Internal gain compensation and power calibration give power accuracy to ±1.4 dB. In addition, wide and narrow FM demodulators provide audio for directed search and surveillance.

The software supports features such as overlays, trace math, marker functions, and autologging and hard copy to a printer. The instrument's features include signal track, peak search, and delta marker. Maximum hold and spectrum averaging allow special measurements to be made.

The SA2600 spectrum analyzer has a base price of $4995.00.

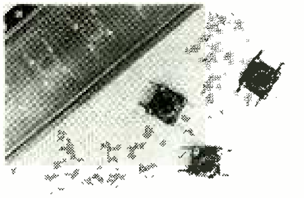
DKD Instruments
1406 Parkhurst
Sun Valley, CA 93065
Phone: 805-581-5771
Fax: 805-583-8270

SURFACE-MOUNT TOROIDS. The KM Series of toroidal inductors from Associated Components Technology is intended for surface-mounting on circuit boards. They are suitable for use in miniature high-frequency switching power supplies where energy storage and filter inductance are critical and noise-filtering ability is a desirable feature.

The toroids' molypermalloy powder cores makes them suitable as noise filters in situations where the inductors must withstand AC voltages as high as 100 to 220 volts without core saturation. The cores have a flat frequency response between DC and 1 MHz. Intended for unidirectional drive applications, the inductors can be placed in a circuit in either direction without concern about damaging them.

When used to store energy within the circuit, the toroids offer high capacity in a small volume. A 2-ampere toroid can store 8 microJoules, and a 0.25-ampere unit can handle up to 20 microJoules. The toroids occupy 0.40 by 0.38 inches of board space.

The inductance values of the toroids range from 10 to 250 microhenries (μH), and DC resistance is between 0.04 and 0.7 ohms. The safe operating temperature range for the toroids is from −55°C to +125°C.



CIRCLE 23 ON FREE INFORMATION CARD

The toroids are sold on tape reels in lots of 1000 on 13-inch diameter, 25-mm wide reels.

KM Series surface-mount toroids are priced at $1.60 each in quantities of 1000.

Associated Components Technology
11576 Trask Avenue
Garden Grove, CA 92643
Phone: 800-234-2645 and (714-636-2645 CA)
Fax 714-636-8276

AMATEUR RADIO LINEAR MOSFET AMPLIFIER. The ALS600 amateur radio linear amplifier from Ameritron requires no tuning or warmup, so it is works as soon as it is turned on. It includes four Motorola TMOS radio-frequency power MOSFETs. A separate AC power supply (ALS-600PS) with cord can be plugged into the amplifier and the 120-volt AC outlet.

CIRCLE 24 ON FREE INFORMATION CARD

Rated for 600 watts PEP and 500 watts CW, the amplifier covers the 1.5- to 22-MHz band continuously. It includes a cooling fan and an illuminated cross-needle standing-wave ratio (SWR)/wattmeter. To safeguard the amplifier, both SWR and over-power protection are included to prevent damage to the amplifier if the wrong band is switched, the wrong antenna is connected, or the SWR on the transmission line is high. The amplifier is packaged in a case measuring 6 × 9½ × 12 inches and it weighs 12.5 pounds.

The ALS-600 amplifier with the ALS600PS power supply is priced at $1,299.00

Ameritron
P.O.Box 494
Mississippi State, MS
Phone: 601-323-8211
Fax: 601-323-65551

INSULATED TOOL KIT. Jenson Tools has introduced a set of electrically insulated tools to protect users when working on live power circuits. Made in Germany, each tool has been individually test to withstand 10,000 volts and is certaified to protect the user at either 1000 volts AC or 1500 volts DC.

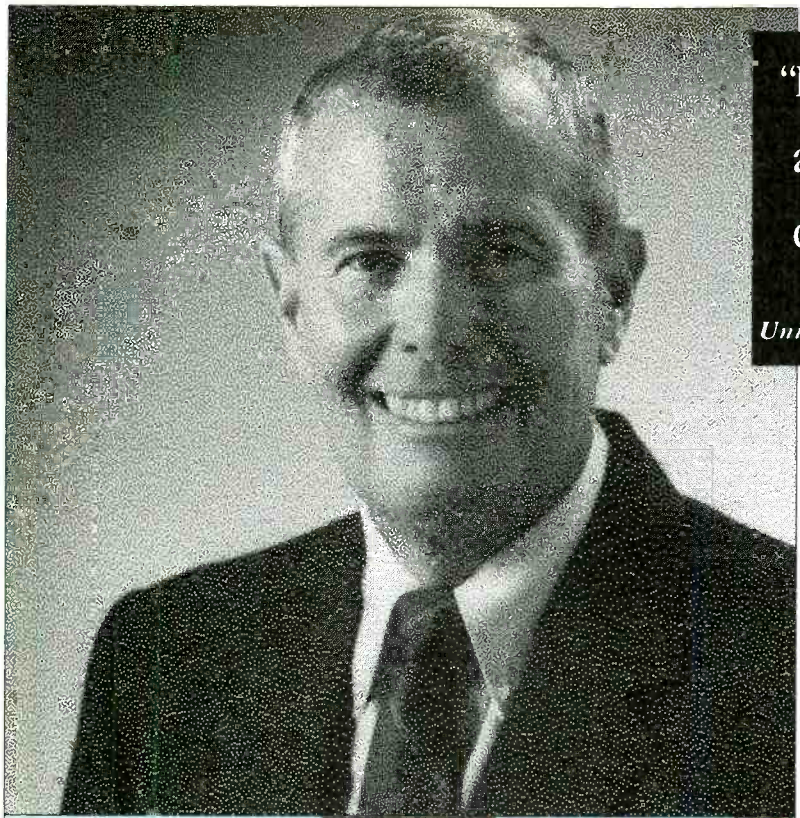
CIRCLE 25 ON FREE INFORMATION CARD

The tool set contains 11 vanadium steel tools: 7-inch side cutters; 8-inch long nose pliers; 6½-inch-long nose pliers; 8-inch lineman's pliers; and seven assorted screwdrivers. Each tool has a permanently attached insulated sheath. All the tools are packaged in a handy zippered case.

The insulated tool kit (Jensen Part No. 194B675) is priced at $225.00.

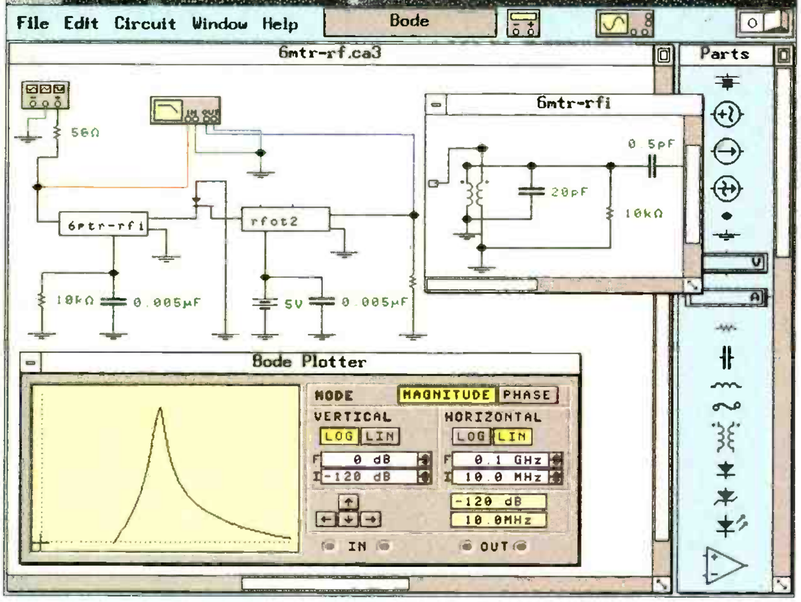
Jensen Tools Inc.
7815 South 46th Street
Phoenix AZ 85044
Phone 800-426-1194

Continued on page 28

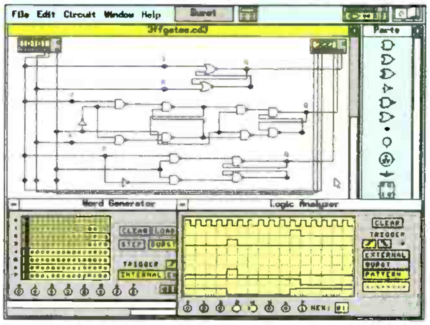


> "Electronics Workbench – As an affordable tool for performing design trade-offs, you can't beat it."
>
> *PROF. M.A. Chapman (retired)*
> *University of California San Diego Physics Dept.*

Electronics Workbench gives you the freedom to quickly translate your design concepts and specs into a workable circuit. Fine tune effortlessly. Play 'what if' scenarios. And monitor the circuit response. The simulated components and test instruments work just like the real thing.



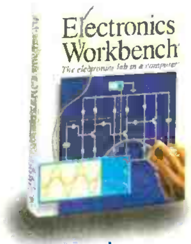
Analog Module: Tuning an RF front end.



Digital Module: Analyzing a logic circuit.

With a full complement of professional test instruments and an unlimited supply of components, it's the ideal proving ground for your design concepts. Electronics Workbench puts you in control. Guaranteed!*

The standard for simplicity and power for over six years, Electronics Workbench is the most popular tool of its kind. It has gained worldwide acclaim as the ideal complement to any test bench. **Fact: Over 90% of our customers recommend it to their friends and colleagues.**



Just $299**

For DOS, Windows or Mac Version.

VISA MasterCard

Electronics Workbench®

The electronics lab in a computer™

Call: 800 263-5552

INTERACTIVE IMAGE TECHNOLOGIES LTD.
908 Niagara Falls Blvd. #068, North Tonawanda, NY 14120-2060
Telephone: (416) 977-5550 FAX: (416) 977-1818

*30-day money-back guarantee.

Prices in U.S. dollars, shipping $15. Offer valid in U.S. and Canada only.
All trademarks are the property of their respective owners.

MICROSOFT WINDOWS COMPATIBLE

INTERACTIVE

CIRCLE 126 ON FREE INFORMATION CARD

NEW LITERATURE

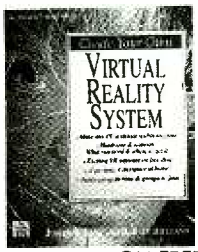
Use The Free Information Card for fast response.

Create Your Own Virtual Reality System; by Joseph R. Levy and Harley Bjelland. Windcrest /McGraw-Hill, Blue Ridge Summit, PA 17294-0850; Phone: 800-233-1128; Fax 717-794-2103; Paper $32.95, Hard $44.95; 320 pages, 62 illustrations; includes disk.

Virtual reality (VR), now a common high-tech "buzz" word, refers to the combined computer and video technologies that place the observer in computer-generated situations for obtaining new and exciting visual experiences vicariously, training in the operation of moving vehicles, gaining insights into architectural structures, and yes, even—playing games.

This book by Levy and Bjelland provides an excellent introduction to the concepts of VR, yet it does not require that the reader have training and experience in the technologies discussed. Experiments in VR are now taking place in some of the most advanced research laboratories in the world. An accompanying disk will help the reader to grasp the fundamentals.

Included in the book are descriptions of consumer-grade VR hardware and software products now on the market. It gives prices along with the addresses, telephone and fax numbers of the suppliers. Chapters in the book explain how to build and install head-mounted displays, "data gloves," stereoscopic glasses, audio speakers, and other VR components.



CIRCLE 337 ON FREE INFORMATION CARD

The authors also explain how to play interactive VR games, generate real-time VR images, and carry out many different interesting VR experiments.

The book discusses the limitations and advantages of desktop VR systems. It also includes information on how to obtain free or low-cost VR demonstration disks and how to contact VR-related organizations and publications. Finally, the book looks beyond the existing equipment and technology to explore the future of VR and its applications in science, medicine, commerce, entertainment, and other human activities.

The PC Toolbox; Dynamic Learning Systems, P.O. Box 805, Marlboro, MA 01752, Phone: 508-366-9487; Fax: 508-898-9995; Compuserve: 73652,3205; start-up newsletter; one-year subscription (six issues), $39.00; two year (12 issues), $69.00.

This newly announced newsletter is intended for personal computer users at all levels of experience, wherever they are. However, it is focused on the PC enthusiast who wants to optimize the operation of his PC and keep it functioning at top efficiency despite today's short life cycles of processors, software and peripherals.

The newsletter publisher expects both business and home PC users to benefit from the feature articles, regular columns, and practical tips for that can be applied immediately. He believes that the editorial coverage will help readers

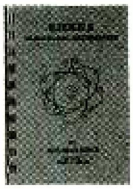
CIRCLE 338 ON FREE INFORMATION CARD

make more efficient use of their present hardware and software. Nevertheless, objective product reviews will offer the reader guidance in the purchase of replacement PCs, processors, circuit boards or software when updating is advisable.

The newsletter, supported by subscription only, will contain no advertisements. This will eliminate any possible conflict of interest. The introductory issue contains articles on optimizing conventional memory, installing CD-ROM drives, and mastering both DOS and Windows operating systems.

Kieke's Electronic References; by W.H. (Wes) Kieke. United Printing Arts, Inc., 3509 Oak Forest Drive, Houston, TX 77018; Phone: 713-688-6115; Fax: 713-956-6576; $9.00

This pocket-sized, plas-


CIRCLE 339 ON FREE INFORMATION CARD

tic-bound reference book is crammed with basic information on electronics. Whether an experienced professional engineer or technician, a student or a hobbyist, the reader will find this book handy in recalling those basic formulas and concepts that are fundamental to electronics. It will prove useful on the desk, workbench, or even in the tool kit.

In addition to its charts, formulas, and symbols, the little reference book reviews Ohm's law, impedance, resistance, inductance, and magnetism. Other topics covered are the fundamentals of diodes and transistors and the principles of phase, amplifiers, wavelength, biasing, testing, and repairing. Who can tell when one might need to recall a fact or formula to complete a task or solve a problem at the desk or in the field?

Answers are easier and faster to find in this little book than in most comprehensive electronic handbooks and texts.

48-volt DC Power Supplies for Telecommunications. James Electronics Inc., 4050 North Rockwell Street, Chicago, IL 60618; Phone 800-438-1400; Fax: 312-463-1504; four pages; free.

This catalog describes

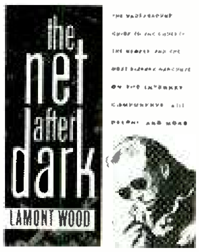
CIRCLE 340 ON FREE INFORMATION CARD

12 separate 48-volt power supplies with output power ratings from 10 to 480 watts. These products are packaged as modules, wall-outlet plug-in units, and in floor-mounted or rack-mounted cases. Many accept AC line power from 90 to 260 volts, 50 to 60 Hz.

The power supplies are intended for PBX consoles, data-interface systems, T-1 telephone and fiber-optic systems. Complete mechanical and electrical specifications and pricing is included. All models meet applicable UL, CSA, and European safety standards.

The Net After Dark; by Lamont Wood. John Wiley & Sons, Inc., Professional Reference and Trade Group, 605 third Avenue, New York, NY 10158-0012; Phone 1-800-CALL-WILEY; $16.95.

This book, subtitled "The Underground Guide to the Coolest, and the Newest, and the Most Bizarre Hangouts on the Internet, Compuserve, AOL, Delphi, and More," was written to introduce readers to the recreational aspects of computer networking. It offers tips and "secret handshakes" to the unusual services and exchanges available on the various personal computer networks.



CIRCLE 341 ON FREE INFORMATION CARD

This entertaining book includes the on-line addresses to hundreds of unusual and perhaps even bizarre exchanges, including many local cult or special interest bulletin board services.

Computers in Science & Art Catalog. Media Magic, P.O. Box 598-PR, Nicasio, CA 94946; Phone: 415-662-2426; 132 pages; free.

This mail-order catalog lists more than 1000 products that provide information on the leading-edge of art, science, and technology. It is a valuable resource for determining what material is available for classroom and self-education in those fields.

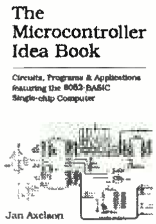
CIRCLE 342 ON FREE INFORMATION CARD

The catalog covers such varied topics as artificial life, astronomy, chaos theory, computer animation, computer networking, fractals, mathematics, medical imaging, multimedia, robotics, satellite imaging, three-dimensional art, scientific visualization, and the world of virtual reality (VR).

These subjects are presented in such diverse media as books, MAC and IBM-PC compatible (DOS) software, video tapes, and CD-ROMs.

The Microcontroller Idea Book; by Jan Axelson. Lakeview Research, 2209 Winnebago Street, Madison, WI 53704; Phone: 608-241-5824; $31.95 +$3.00 S&H; 277 pages.

This is a book of circuits and programs for applying the popular Intel 8052-BASIC microcontroller (MCU). The MCU, otherwise known as the single-chip computer, contains all the CPU functions of the microprocessor (MPU) as well as memory and I/O functions not found on the MPU chip. Although more limited in computational capability than the MPU, the MCU chip is ideal for repetetitive control and data logging.



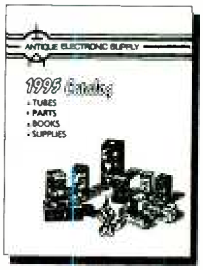
CIRCLE 343 ON FREE INFORMATION CARD

Axelson's book contains complete circuit diagrams, parts lists, design theory, and construction tips for working with the 8052-BASIC. Its on-chip BASIC-52 programming language simplifies the task of writing applications software. Special commands store programs in EPROM or other non-volatile memory.

In addition to its coverage of the basic circuits needed to complete any project, this book explains how to add keypads, switches, relays, displays, sensors, clock/calendars, motor controls, wireless links, and other input/output interfaces.

1995 Antique Supply Catalog. Antique Electronic Supply, 6221 South Maple Avenue, Tempe, AZ85283; Phone: 602-820-5411; Fax: 800-706-6789; $2.00

This is the 1995 edition of a catalog for antique radio and instrument collectors and the hobbyists and professionals who like to restore them—or perhaps even or build new ones from scratch. Newly expanded to 36 pages, the catalog lists more than 3000 different kinds of receiving, transmitting, audio, and industrial vacuum tubes.



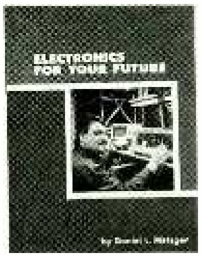
CIRCLE 344 ON FREE INFORMATION CARD

In addition, the catalog lists capacitors and other electronic components suitable for use with AC line- and battery-powered receivers and instruments of the vacuum-tube era. Included is a list of 75 books devoted to the collection and restoration of vacuum-tube circuits.

Electronics For Your Future; by Daniel L. Metzger. Technology Training, Inc., 6969 Streamview Drive, Lambertville, MI 48144; Phone/Fax 313-854-3605; 300 pages; $35.00.

This basic textbook on electronics emphasizes brevity and reader friendliness. Each page is divided into six panels—like a comic book—with colorful sketches, icons, and diagrams to illustrate the basic concepts behind electronics.

Metzger's book covers a wide range of subjects

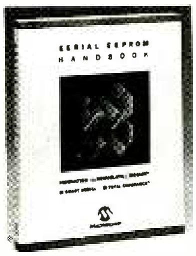


CIRCLE 345 ON FREE INFORMATION CARD

from diodes, transistors, power supplies and amplifiers to overviews of linear and digital integrated circuits. Each topic is covered on a single page or a pair of facing pages, and diagrams appear in the same panel that explains them. Each of the 24 chapters concludes with four pages of review and examples of circuits that have been analyzed. The book is suitable for self-study or as a text in formal training courses.

Serial EEPROM Handbook; Microchip Technology Inc., 3255 West Chandler Blvd., Chandler, AZ 85224-6199; Phone: 602-786-7200; Fax 602-899-9210; 480 pages; free from Microchip sales offices or distributors.

This handbook is the first reference published for enginners who use Microchip's serial EEPROMs. It



CIRCLE 346 ON FREE INFORMATION CARD

includes 25 product specifications sheets, more than 12 applications notes, and nine qualification reports on the company's EEPROMs development tools. Included are data on the 64-kilobit serial EEPROM and the Total Endurance Disk. Ω

NEW PRODUCTS

continued from page 24

MULTIFUNCTION GENERATOR. Compuvideo has introduced the Series 7000 multufunction video, sync, and test pattern generators that meet NTSC or PAL transmission standards. Outputs include the S-VHS, composite, and component.

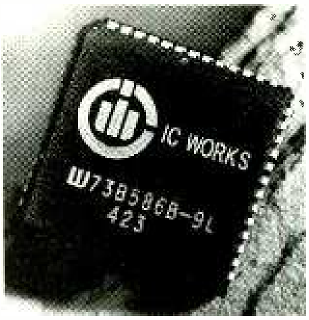
CIRCLE 26 ON FREE INFORMATION CARD

The six models in the series are intended for TV editing, production, post-production, and maintenance. The generators consist of four sections: 12 test patterns; six black-burst outputs; sync and sub-carrier outputs; and an audio generator.

The pricing for Series 7000 multifunction generators is from $299.00 to $1199.00, depending on unit configuration

Compuvideo, Inc.
3861 Oceanview Avenue
Brooklyn, NY 11224
Phone: 212-213-6818
Fax: 718-714-9873

CACHE DATA RAMS FOR PENTIUM, 486, AND POWERPC PROCESSORS. IC Works has introduced the W73B586B cache data RAM for Pentium and 486 microprocessors and the W73B601 cache data RAMs for PowerPC microprocessors. Both offer access times from 9 to 12 nanoseconds, and they support burst sequence addressing at 66 MHz with a two-bit wrap-around counter.



CIRCLE 27 ON FREE INFORMATION CARD

The RAMs have 32-kilobit by 18-bit organizations, and they can be interfaced directly with an external cache controller and the CPU. The cache data RAMs ease the installation of cache memory in systems with microprocessors by meeting the processors' requirements for setup and hold time at 66 MHz. They will also support zero-wait state memory access and burst sequence addressing.

The W73B586B and W73B601 cache data RAMs, packaged in 52-pin plastic leadless chip carrier (PLCC) packages, are priced from $30.00 to $35.00 (based on speed) in quantities of thousands.

IC Works, Inc.
3725 North First Street
San Jose, CA 95134-1700
Phone: 408-922-0202
Fax: 408-922-0833

100 -MHz, THREE-CHANNEL OSCILLOSCOPES. Leader Instruments has introduced two new analog oscilloscopes, the Models 8103 and 8104. Both of its new oscilloscopes have 100-MHz bandwidths, three channels, and the same basic operating characteristics.

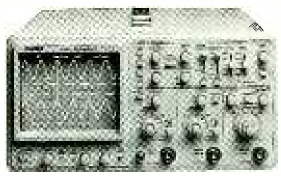
Both oscilloscopes offer calibrated sweep with alternate sweep so that the main and delayed traces can be viewed simultaneously.

Six traces are displayed in an alternate sweep mode when three channels are active. The sum (or difference with channel 2 inverted) of channel 1 and 2 can also be displayed together with channels 1 to 3. This makes it possible to view eight traces.

The main time base ranges from 50 nanoseconds per division to 0.5 seconds per division in 22 steps. The times 10 magnifier increases the fastest sweep speed to 5 nanoseconds per division. A single sweep mode captures one-time events.

Trigger capabilities include a time-saving automatic source selection coordinated with V-mode operation. Manual override allows the source to be selected from any of three channels and the power line.

The trigger modes include AUTO, NORMAL, and FIXED. Trigger coupling settings include dedicated horizontal and vertical TV sync separators for video observations.



CIRCLE 28 ON FREE INFORMATION CARD

The Model 8104 can make automatic cursor measurements of voltage, time, frequency, and phase, and it can display on-screen sensitivity, time-base, and delay-time setting messages.

The Model 8103 is priced at $1600.00 and the Model 8104 (pictured) is priced at $1900.00

Leader Instruments Corp.
380 Oser Avenue
Hauppauge, NY 11788
Phone: 800-646-5104
(516-321-6900 in NY) Ω

The Four-Year Electronics Degree Program That Really Hits Home!

Bring The Technology Home With A Bachelor Of Electronics Engineering Degree. No Hassles. No High Cost!

Now's the time to prepare for a profitable career.

We've lowered the cost of higher education.

It's true! You can earn a four-year Bachelor of Electronics Engineering Technology degree today ... and prepare yourself for a high-paying electronics career ... without quitting your job or ever leaving your home. Because World College, an affiliate of the Cleveland Institute of Electronics, offers you the total flexibility of independent study programs proven effective for people like you who truly want to succeed! World College independent study lessons help you build valuable skills step-by-step, and expert instructors are personally available to you with a toll-free call. What a way to earn an education!

Mail/Fax Today or Call 1-800-696-7532

A world of opportunity.

Where is your career headed? With a four-year bachelor's degree from World College, you call the shots, choosing from incredible, high-paying opportunities in electronics, telecommunications, computer, electrical power, and many other growing fields.

World College gives you the skills, the knowledge, the power to take advantage of your best opportunity in electronics. And you can do it all at your own pace!

Without leaving home.

World College continually works to provide its students with the most advanced education tools. From the latest equipment and reference books to breakthrough computer-simulated experiments, students are exposed to the latest technological advancements.

All the equipment, parts, and software you need are included in your affordable tuition, including more than 300 hands-on lab experiments you can complete in your home.

Choose your own pace.

Earn your bachelor's degree on your time — and at your pace — because you pay tuition to World College only as you complete the upper-level semesters close to graduation. The faster you make it through, the less you pay. So you have an incentive to make your future happen quickly — yet the freedom to choose your own pace!

Send today for your FREE course catalog — and give yourself that future you've always wanted — with an electronics degree education from World College.

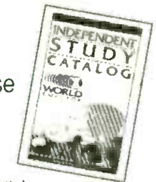
Take charge of your future in electronics.

Four Powerful Reasons To Connect With World College Today:

1. Earn your four-year degree!
2. Self-paced training!
3. Independent study in your home!
4. Expert instruction!

Give Me The Power!

Send me a FREE World College course catalog today!



(Please Print Neatly)

Name ______________________

Address ______________________

City ______________________

State, Zip ______________________

Phone ( ) ______________________

Age ______________________

For faster service, call 1-800-696-7532, or call 1-804-464-4600.

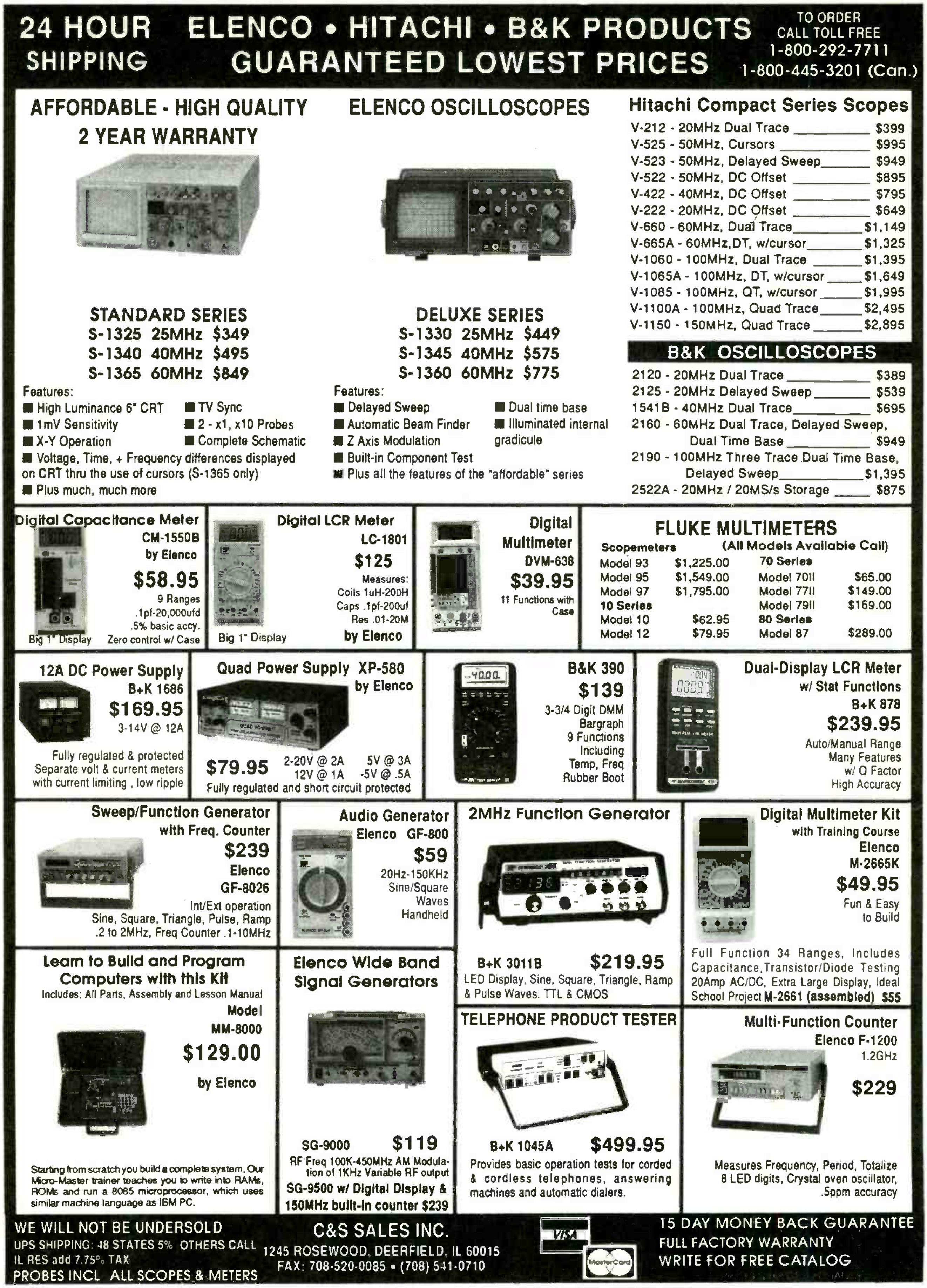
Or fax this coupon to 1-804-464-3687.

WORLD COLLEGE
Lake Shores Plaza
5193 Drive, Suite 113
Virginia Beach, VA 23455-2500

CIE

Affiliated with Cleveland Institute of Electronics

WAE20



CIRCLE 109 ON FREE INFORMATION CARD

LASER LIGHT SHOW

Amaze your friends and family with the dazzling displays you can create with your own laser light show.

DAVID WILLIAMS

HAVE YOU EVER BEEN IMPRESSED by a professional laser light show at a nightclub or a concert? Now you can impress all of you friends by creating your very own laser light show! This easy-to-build project works with any laser to create unlimited complex geometric patterns.

Safety Notice: The laser beam that is projected by this device is harmful if aimed directly into the human eye. **Never** look directly into the laser beam, nor aim the laser at anyone else. The unit should be used only by adults or with adult supervision. It is not a toy and must be used only in a safe and responsible manner.

When assembled, this laser product must conform to the safety regulations of the C.D.R.H. (Center for Devices and Radiological Health) of the Food and Drug Administration. The regulations classify lasers by power, mechanical requirements, and so on. (Detailed information on these requirements are available from the Center for Devices and Radiological Health, Office of Compliance, 2098 Gaither Road, Rockville, Maryland 20850.)

Mechanics and optics

The project consists of a base unit and a wire-linked remote control. The base unit houses the mirrors, motors, and motor-drive circuits, in addition to a solid-state laser assembly. The handheld remote unit contains an on/off switch and speed-control circuits.

The light show project creates fascinating patterns by reflecting a laser beam from three "wobbly" mirrors. Each mirror adds a unique spiral pattern to the beam, and the patterns combine to create complex geometric shapes. Each mirror is mounted slightly off-axis on a small DC motor, and each motor is driven by a separate speed-control circuit. As the speed of each motor is adjusted, the size and shape of the spiral laser pattern is altered.

The circuit

Refer to the schematic of the laser light show in Fig. 1. An

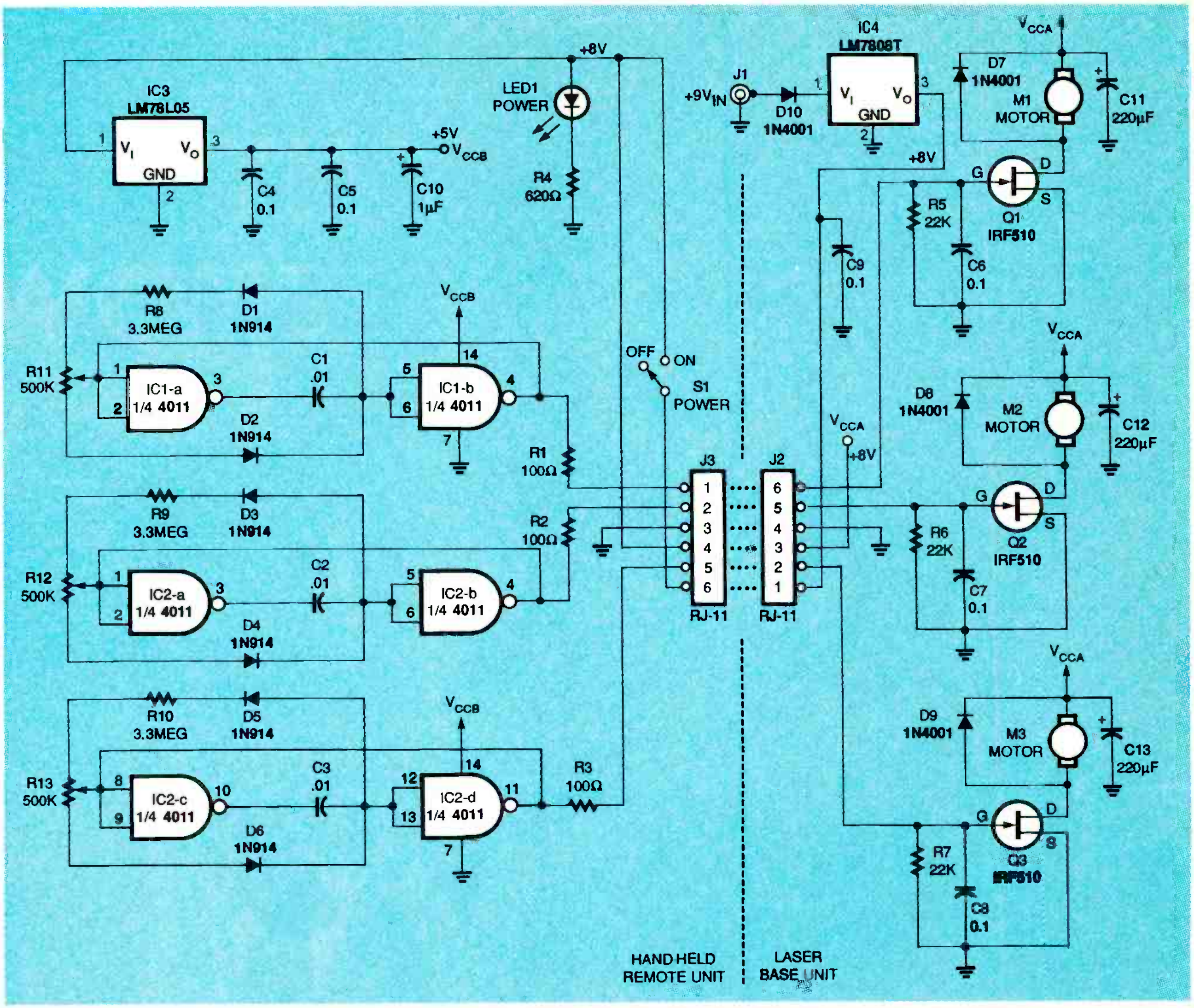


FIG. 1—SCHEMATIC OF THE LASER LIGHT SHOW. An external DC wall-outlet adapter powers the circuit at J1; the LM7808 voltage regulator produces a constant +8 volts to power the rest of the circuit.

external DC power adapter plugs into connector J1 to power the circuit. Diode D10 provides reverse-polarity protection for the voltage regulator, IC4. The LM7808 voltage regulator and capacitor C13 convert the transformer voltage to a constant regulated +8 volts to power the rest of the circuit. This main power is fed to the handheld remote through an RJ-11 modular cable and jacks J2 and J3 and is switched on and off by S1. Light-emitting diode LED1 indicates when power is on.

On the handheld remote side, the LM78L05 (IC3) regulates the 8-volts down to 5 volts to power the CD4011 quad NAND gate ICs. Although IC1 and IC2 would operate fine at 8-volts, powering them from the output of IC3 helps to isolate the oscillator circuits from the electrical noise produced by the DC motors. The remote section has three identical oscillator circuits that produce pulse-width modulated signals to control the speed of the DC motors in the base unit. Each oscillator consists of two NAND gates from a CD4011 (wired as inverters), and a 0.01-microfarad capacitor that determines the oscillation frequency.

Two signal diodes and a 500-kilohm potentiometer control the duty cycle, or on time of each pulse-width modulator. With the 3.3 megohm resistor in the circuit, the duty cycle can be varied from 0% to only about 20%. (Without the 3.3 megohm resistor, the potentiometer can vary this on time from 0% to 100%.) The 0% to 20% duty-cycle gives a good speed range with the motors used in the author's prototype unit. You might have to experiment with the values of R8, R9, and R10 depending on the motors that you choose.

The three motor-control signals pass through connector J3 and a six-conductor modular cable to J2 on the base unit. In the base unit, each pulse-width modulated signal controls the motor speed by switching an IRF510 N-channel MOSFET transistor. The 100-ohm resistor and the 0.1µF capacitor filter noise in the cable and the 22-kilohm resistor connected to the gate of each MOSFET keeps the transistors biased off if the remote is unplugged. Each DC motor has a 1N4001 diode wired across it to suppress reverse voltage spikes. The 220 μF capacitor supplies instantaneous current when the MOSFET turns on and also provides extra power filtering.

Construction

The easiest way to build the laser light show is to use PC boards. We've provided foil patterns for the two boards, but if you don't want to make your own boards, pre-etched and drilled boards can be purchased from the source given in the Parts List.

Start by assembling the handheld remote unit. Figure 2 is the parts-placement diagram for that board. Use two 14-pin DIP sockets for IC1 and IC2. Mount the LED to the PC board with a ¾-inch plastic spacer. This will allow the LED to protrude through a hole in the plastic cover.

To connect the three potentiometers, cut nine 4-inch pieces of stranded hookup wire and solder the wires from the PC board to the potentiometers, as shown. Do the same for switch S1. Last, install IC1 and IC2 in their sockets, observing the proper orientation of pin 1.

Drill a row of three holes in the top of the case for the three potentiometers. Mount the PC board in the bottom half of the case with any suitable hardware. Determine where the LED will protrude through the top of the case, and drill a 3⁄16-inch hole in that spot. Drill another 3⁄16-inch hole for S1 in any open location on the cover. Test fit the case's end panels, and cut an opening in one end to allow access to modular connector J3. Mount the three potentiometers and switch S1 on the case cover. Align the cover so that the LED fits through its hole, and secure the two halves of the enclosure together. Set the remote unit aside for now and begin assembling the base unit.

Refer to Fig. 3 for the parts-placement diagram of the base unit. When installing the electrolytic capacitors C11, C12, and C13, be sure to follow the proper polarity orientation. Jack J1 is a 2.1 millimeter power connector that attaches to the PC board and accepts power from a wall transformer. You can either install J1 or you can attach the wires from a DC-output wall-outlet adapter directly.

Install the three MOSFET transistors on the board. Be sure that the metal tabs are oriented as shown in Fig. 3 before soldering them in place. Note that MOSFET transistors are ESD-sensitive, so always take precautions to discharge static electricity from your body by touching grounded metal be-

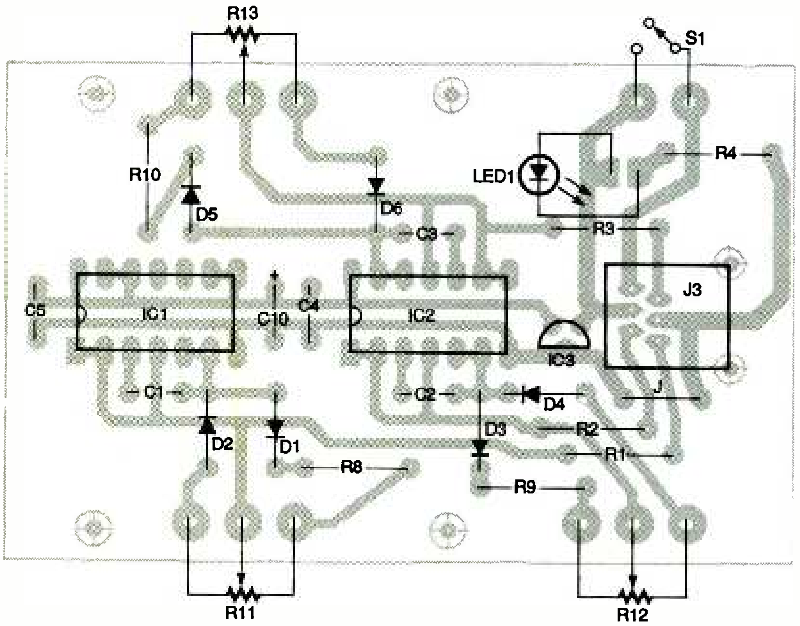


FIG. 2—HANDHELD REMOTE parts-placement diagram. Use 14-pin DIP sockets for IC1 and IC2.

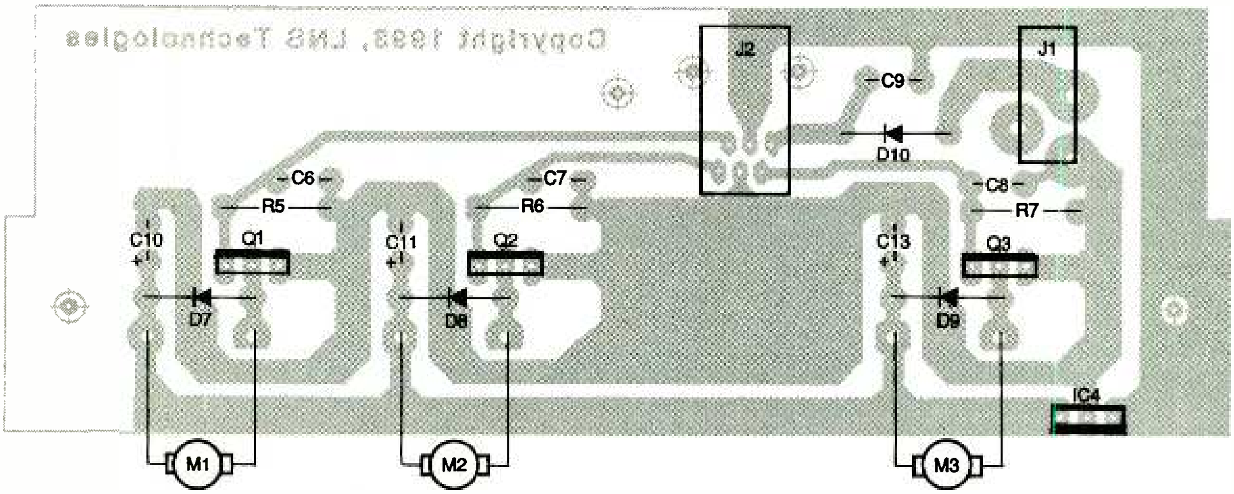


FIG. 3—BASE UNIT parts-placement diagram. You can install power jack J1 or attach the wires from a DC-output wall-outlet adapter directly.

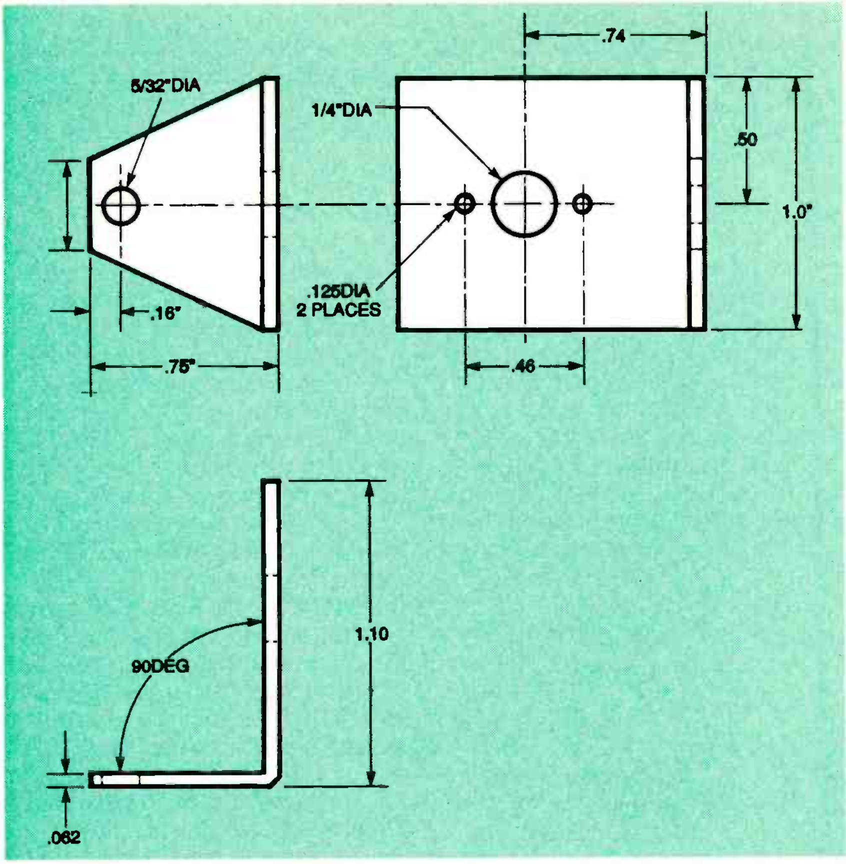


FIG. 4—RIGHT-ANGLE ALUMINUM brackets. These are attached to the motors and can pivot on the base for alignment adjustments.

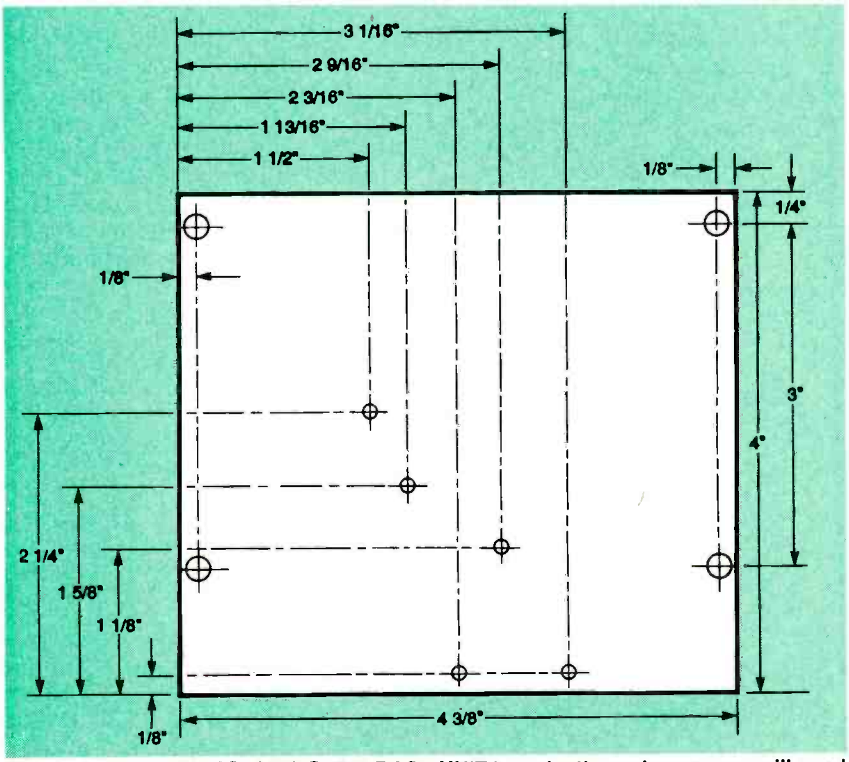


FIG. 5—IF YOU ARE MOUNTING THE BASE UNIT in a plastic enclosure, you will need an aluminum baseplate cut and drilled to these dimensions.

fore you handle them. Next install the voltage regulator IC4, observing the proper orientation of the metal tab. Solder six

PARTS LIST

All resistors are ⅛-watt, 5%.
R1–R3—100 ohms
R4—620 ohms
R5–R7—22,000 ohms
R8–R10—3.3 megohms
R11–R13—500,000 ohms, panel-mount potentiometer

Capacitors
C1–C3—0.01 µF, ceramic disk
C4–C9—0.1 µF, ceramic disk
C10—1 µF, 16 volts, tantalum electrolytic
C11–C13—220 µF, 16 volts, electrolytic

Semiconductors
IC1, IC2—CD4011 quad 2-input NAND gates
IC3—LM78L05, 5-volt regulator (TO-92 case), Motorola or equiv.
IC4—LM7808T, 8-volt regulator (TO-220 case), Motorola or equiv.
Q1–Q3—IRF510 N-channel MOSFET transistors, International Rectifier
D1–D6—1N914 diode
D7–D10—1N4001 rectifier diode
LED1—red light emitting diode, T-1-¾

Other components
J1—2.1 mm power jack
J2, J3—6-pin RJ-11 jacks
M1–M3—DC hobby motor
S1—SPST subminiature toggle switch, PC mount

Miscellaneous: 9-volt DC, 300 mA wall outlet adapter; plastic enclosures (remote, Serpac A-21; base unit, Serpac A-31); knobs for potentiometers; three aluminum motor brackets (see Fig. 4); three 1-inch diameter round plastic mirrors and three plastic mounting disks; two PC boards; two 14-pin IC sockets; 3-foot, 6-conductor modular cord; No. 24 gauge stranded wire; hardware; glue; solder.

Note: The following items are available from LNS Technologies, 20993 Foothill Blvd, Suite 307R, Hayward, CA 94541-1511, 1-800-886-7150:

• Complete kit of parts for the Laser Light Show (LSHOW-KIT) includes two PC boards, brackets, mirrors, enclosures, motors, and all components listed above (laser not included, see below)—$99.00

• Solid State Laser Kit (LASER-KIT)—$89.00

Add $5.00 S&H to all orders. California residents add local sales tax. MC/VISA orders accepted.

pieces of 6-inch long stranded hookup wire to the board as shown for connecting the three DC motors later on.

Final assembly

The three motors and their mirrors must be mounted securely and aligned accurately to properly deflect the laser beam. The right-angle aluminum brackets shown in Fig. 4 attach to the motors and can pivot on the base for alignment adjustments. If you don't purchase the kit for the laser show, you'll have to fabricate these brackets yourself. If you are mounting the base unit in a plastic enclosure like the author's prototype, you will also need the aluminum baseplate shown in Fig. 5. Otherwise, you can simply attach the three motor brackets to a wood base as long as you match the hole spacing to the base plate shown in Fig. 5.

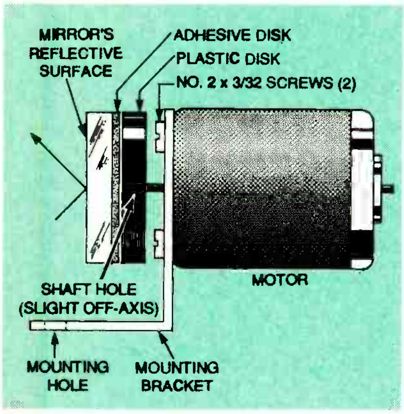


FIG. 6—AN ALUMINUM BRACKET is attached to each motor with two No. 2 × 3⁄32 self-tapping screws. The mirror-mounting disk should be pressed onto the motor shaft as far as possible without contacting the screws.

You need three 1-inch diameter mirrors for your light show. Do not use glass mirrors. They are too fragile and can break or shatter and cause injury. At most plastic supply houses or hobby shops, you can purchase mirrors made of plastic. Ask the clerk to cut the material into 1-inch circles or carefully cut your own. You also need three 1-inch round disks to attach the mirrors to the motors. Here you can use wood or plastic. Whatever material you choose for the mirror mounts should be approximately ⅛-inch thick.

Before mounting the plastic mirrors to the disks, you must drill a hole in the center of each disk. The hole should be a bit smaller than the diameter of the motor shaft to make for a snug fit and it should be drilled at a very slight angle. The angled axis will give the mirror a slight wobble as it spins. A small amount of wobble is necessary for proper operation, but an excessive amount will prevent proper alignment.

Put together the motorized mirror assemblies by attaching the mirrors to the mirror mounts. Use quick-set epoxy, cyanoacrylate adhesive (super glue), or double-sided foam tape and make sure the reflective side faces away from the motor. Repeat the procedure for all three mirrors and mounts, and wait at least an hour for any adhesive to set.

Next attach an aluminum bracket to each of the motors, as shown in Fig. 6, with two No. 2 × 3⁄32 self-tapping screws. Press a mirror onto each motor shaft. The mounting disc should be pressed onto the shaft as far as possible without hitting the motor screws. If the mirrors spin freely, remove them and then reinstall them using a few drops of adhesive to permanently bond them to the

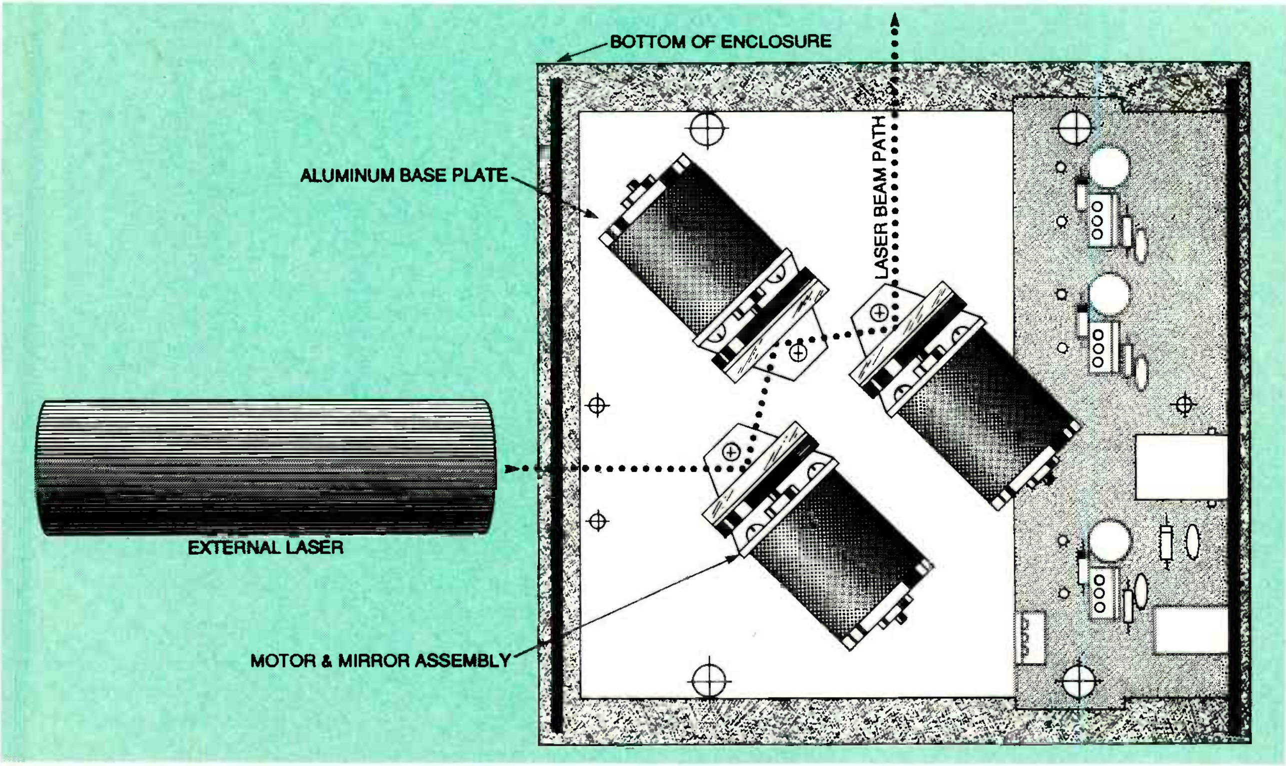


FIG. 7—THE MOTOR ASSEMBLIES can pivot on the baseplate to allow for alignment of the laser beam.

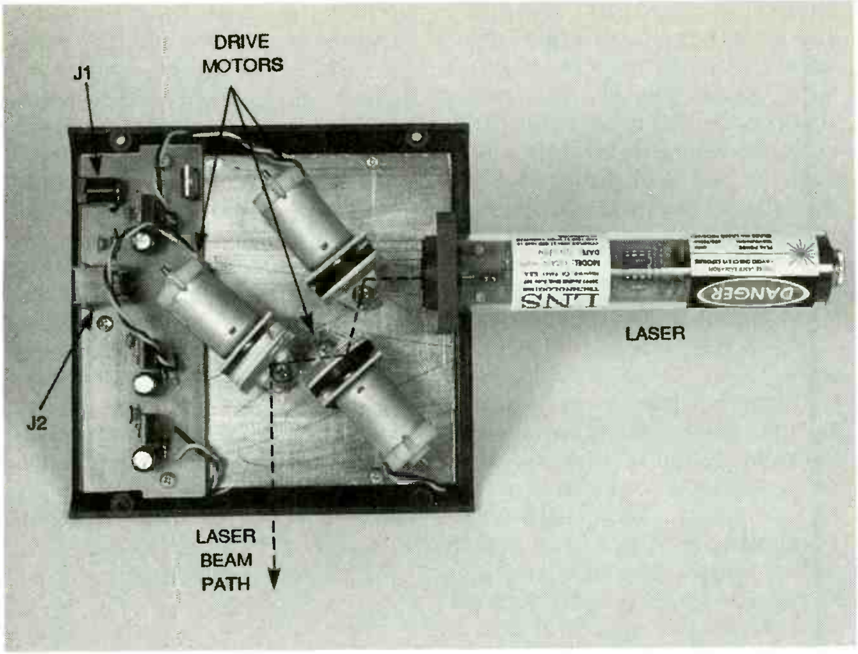
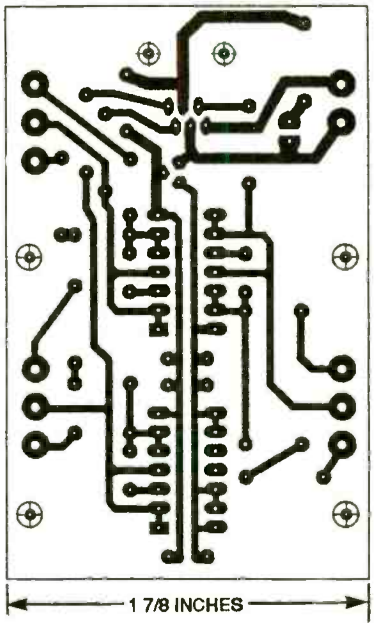


FIG. 8—LASER BASE UNIT. Any laser will work with the laser light show. The laser shown here is a solid-state unit from an available kit.



REMOTE CONTROL FOIL PATTERN.

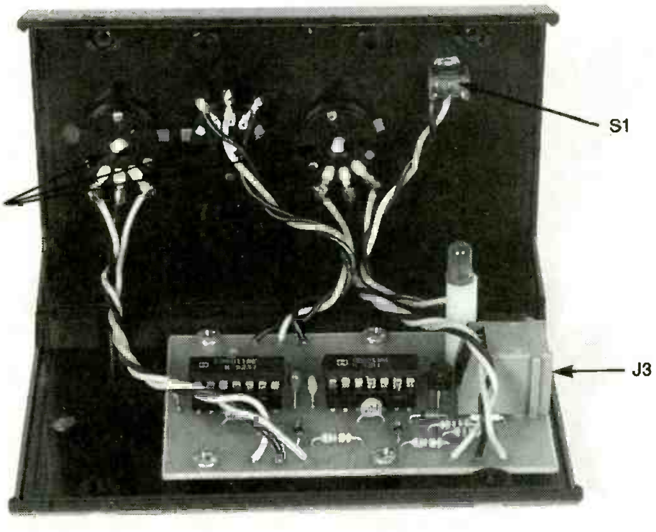
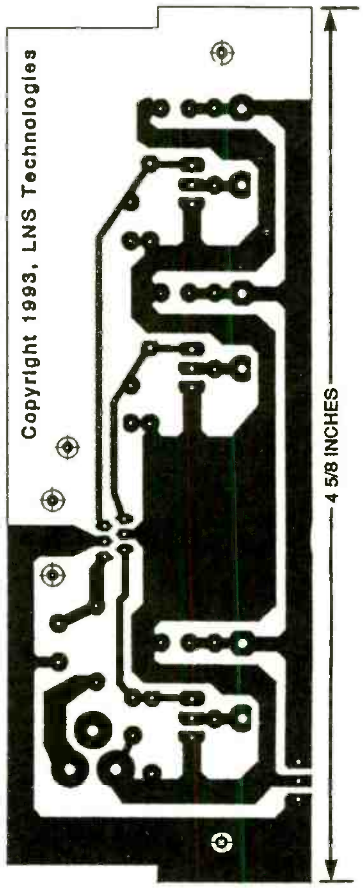


FIG. 9—THE REMOTE CONTROL UNIT lets you vary the speed of the three motors in the base unit individually.



LASER BASE FOIL PATTERN.

motor shafts.

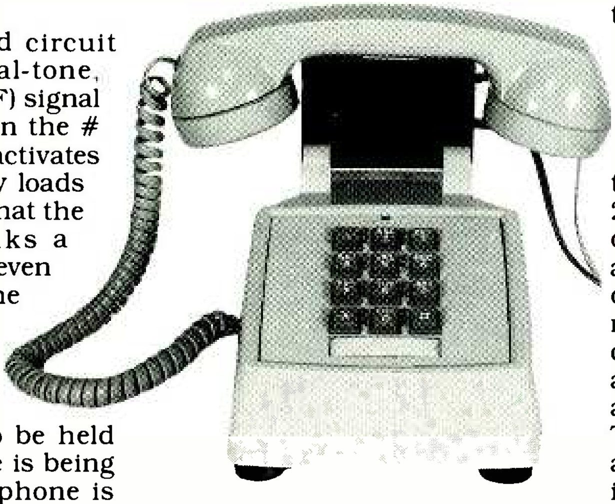
After everything has dried, carefully inspect each motor and mirror assembly. Make sure that the plastic mount, the mirror, and the motor are all firmly attached to each other. Any loose part could fly off and injure somebody. Make sure each mirror turns freely. Do not run the motors if anything is binding or rubbing. Correct any problems now.

Mount the motor assemblies on the baseplate as shown in Fig. 7 and partially tighten the mounting screws. A final alignment will be done later with the laser in place. Solder a pair of wires from the base-unit board to each motor (see Fig. 3). Before soldering, the leads can be trimmed in length to fit the case. It doesn't matter which wire goes to which terminal on each motor.

Any laser will work with the laser light show, as long as the device can be mounted so that the laser beam can be bounced off the mirrors as shown in Fig. 7. The author used a solid-state laser for which a kit is available (see the Parts List). That laser

Continued on page 54

PUT THAT PHONE ON HOLD!



Build a telephone hold circuit that works from any phone in your home—even cordless!

FRANK MONTEGARI

IF YOU HAVE TOUCH-TONE TELEphone service, you can now put a call on hold from any phone in your house by plugging this simple device into any telephone jack. The universal hold circuit works with any phone that has a keypad with a # key. To put a call on hold, press the # key and hang the phone up. A timer extends the #-key function while you hang up phones that have a keypad built into the handset.

The universal hold circuit first detects the dual-tone, multifrequency (DTMF) signal that is generated when the # key is pressed. It then activates a circuit that partially loads the telephone line so that the central office thinks a phone is still off-hook even after it is hung up. The hold circuit remains active for five seconds after the # key is released, so the key does not have to be held down while the phone is being hung up. When any phone is again picked up, the hold function is canceled.

How it works

Figure 1 shows the schematic diagram of the universal hold circuit. The telephone line is connected to the hold components through bridge rectifier BR1 so that the input is not polarity sensitive. The positive side of the line is always connected to Zener diode D2, and the negative side of the line is always connected to IC2. The telephone line also connects to tone-decoder IC4 through C4 and T1. Power is supplied to the circuit by a 12-volt DC power adapter and by IC5, a 78L05 5-volt regulator, and is filtered by C2 and C3.

Optoisolator IC1 contains a silicon-controlled rectifier (SCR) that latches on after it's turned on by current flowing through an optically coupled LED within the IC. The SCR continues to conduct even after the LED current is removed, providing that enough anode current is available to sustain it. When the SCR anode voltage is removed and conduction stops, it will not resume until the SCR is again triggered by the internal LED.

When all phones on the line are on-hook, the voltage across the telephone line is about 48 volts. When a phone is taken off-hook, it places a load on the line and a current of about 20 milliamps flows through the phone, which causes the line voltage to drop to about 3 to 8 volts, depending on the telephone. Current also flows through circuits at the central office, indicating that a phone has been picked up.

A call is put on hold when all phones are hung up and the SCR in IC1 is triggered on by circuits driving its LED. When the SCR conducts, current flows through BR1, D2, LED1, IC1, IC2 and back through BR1, placing a load on the line that keeps the central-office circuits active. A 15-volt drop across D2, a 2-volt drop across D1, a 1.5-volt drop across the LED in IC2, and about a 1.5-volt drop across the diodes in BR1 result in the normal 48-volt line voltage being clamped to about 20 volts. That allows line current to flow, but at a higher voltage than normal. The LED lights to indicate that a call is on hold. When a phone is picked up and the line voltage drops to 8 volts or less, there is no longer enough voltage to keep current flowing through D2, D1 IC1, IC2, and BR1, and the hold function is canceled.

The telephone line also connects through capacitor C4 and transformer T1 to capacitor C8, which couples the DTMF signal to the input of IC4, a Motorola MC145436 DTMF decoder used to detect the #-key tone. Zener diode D6 clamps IC4's input voltage to 9.1 volts to prevent damage from transients. The decoder has four outputs that produce a hexadecimal code corresponding to the tones it receives when a key is pressed (see Table 1). Notice that only when the # key is pressed will pins 13 and 14 both go high (logic "1"). That is convenient, as the circuit has to monitor only two outputs of IC4 to decode the # key.

Decoding the outputs of IC4 pins 13 and 14 is done by a logical AND circuit consisting of two diodes, D4 and D5, whose cathodes must both be high for their anodes to be pulled high by R5. That discharges C1 through R4 into the positive

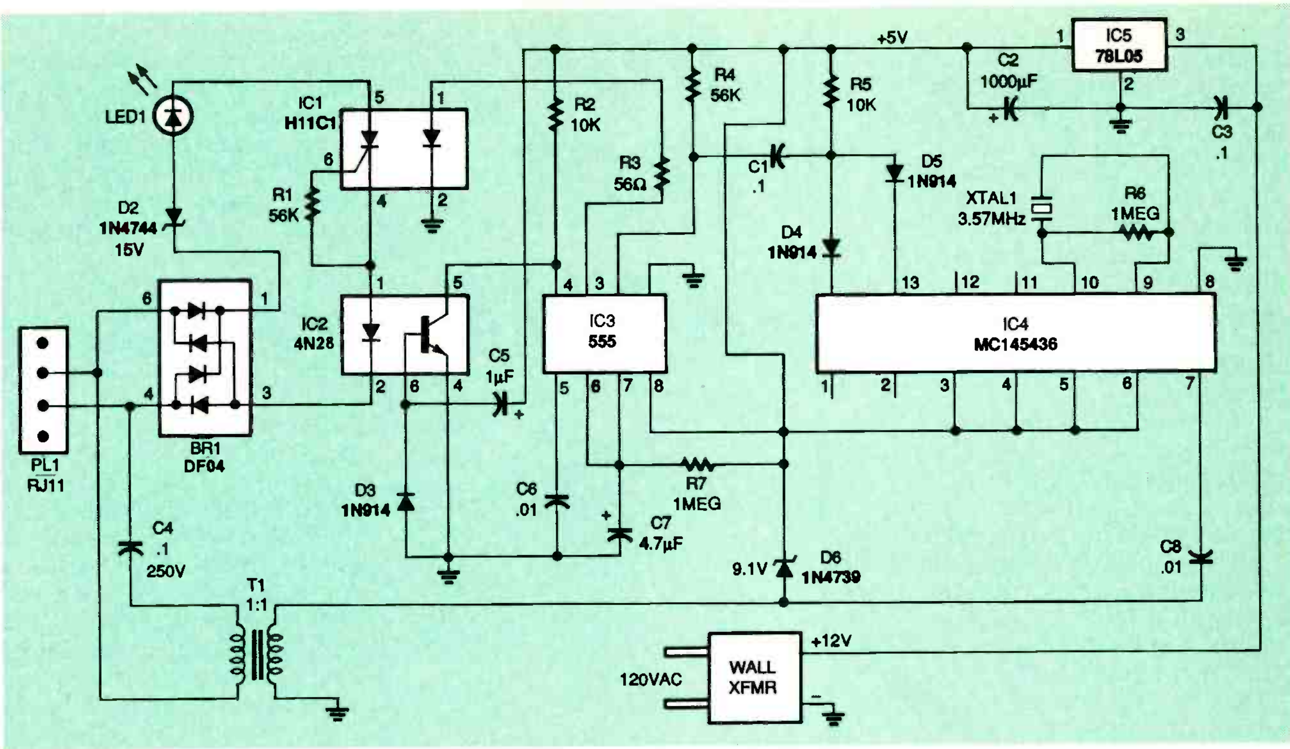


FIG. 1—SCHEMATIC DIAGRAM of the universal hold circuit. The telephone line is connected to the hold components through bridge rectifier BR1, so that the input is not polarity sensitive.

supply. When the # key is released, pins 13 and 14 go low again and a negative pulse is produced by C1 and R4 at the trigger input (pin 2) of 555 timer IC3. That starts IC3's timing cycle where pin 3 goes high for about five seconds. That drives current through R3 into the LED within IC1, latching the internal SCR. The five-second output from IC3 keeps current flowing long enough to hang up the phone. The 5-second duration is controlled by R7 and C7 and may be altered by changing the value of R7.

Optoisolator IC2 has a transistor output. After the # key is pressed and the phone is hung up, telephone line current flowing through the LED in IC2 turns its transistor on, which resets timer IC3.

The reset function removes current from the LED in IC1 and allows a hold to be canceled immediately after initiating it without having to wait for the five-second cycle to complete. The transistor within IC2 also performs a power-on reset by having its base coupled through C5 to the positive supply. When

TABLE 1—IC4 OUTPUTS

Key	IC pin 13	IC pin 14	IC pin 1	IC pin 2
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
0	1	0	1	0
*	1	0	1	1
#	1	1	0	0

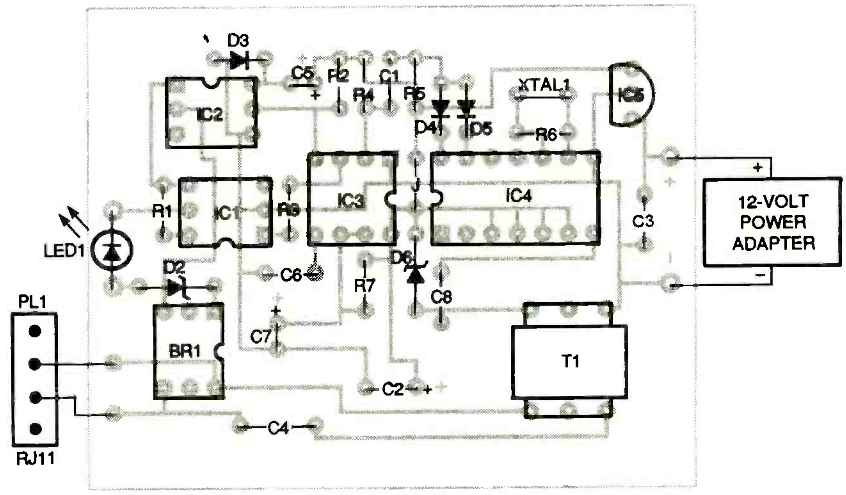


FIG. 2—PARTS-PLACEMENT DIAGRAM. Leave LED1's leads long and bend them in an "S" shape so its position can be adjusted later to fit through a hole in the top of the case.

PARTS LIST

All resistors are ⅛-watt, 5%, unless noted.
R1, R4—56,000 ohms
R2, R5—10,000 ohms
R3—56 ohms
R6, R7—1 megohm

Capacitors
C1, C3—0.1 µF, 50 volts, metal film
C2—1000 µF, 16 volts, electrolytic
C4—0.1 µF, 250 volts, polyester
C5—1 µF, 50 volts, electrolytic
C6, C8—0.01 µF, 50 volts, metal film
C7—4.7 µF, 35 volts, electrolytic

Semiconductors
IC1—H11C1 SCR optoisolator (Harris or equiv.)
IC2—4N28 transistor optoisolator (Harris or equiv.)
IC3—555 timer
IC4—MC145436 (Motorola or equiv.) or CD22204 (Harris or equiv.) DTMF decoder
IC5—78L05 voltage regulator
BR1—DF04 1-ampere, 400 volt, DIP bridge rectifier (Allied Electronics or equiv.)
D1—not used
D2—1N4744 Zener diode, 15-volts, 1 watt
D3–D5—1N914 silicon diode
D6—1N4739 Zener diode, 9.1 volts, 1 watt
LED1—light-emitting diode, any color, T1-¾

Other components
XTAL—3.579545 MHz crystal
T1—matching transformer, 600-ohm primary, 600-ohm secondary (Jameco P/N 105902)
PL1—RJ11 modular plug attached to telephone wire

Miscellaneous: three 6-pin IC sockets, one 8-pin IC socket, one 14-pin IC socket, 120-volt AC to 12-volt DC, 100 milliamp, power adapter, 2- × 3- × 1-inch plastic project box (Jameco P/N 18921), two cable ties, PC board, wire, solder

Note: The following items are available from American Electromechanical Inc., 134 Van Voorhis Terrace, Wappingers Falls, NY 12590:
- **Complete kit of parts including PC board and pre-drilled enclosure—$49.95**
- **Etched and drilled PC board only—$6.95**

Check or money order, only. Add $4.00 shipping and handling. NY State residents must add sales tax

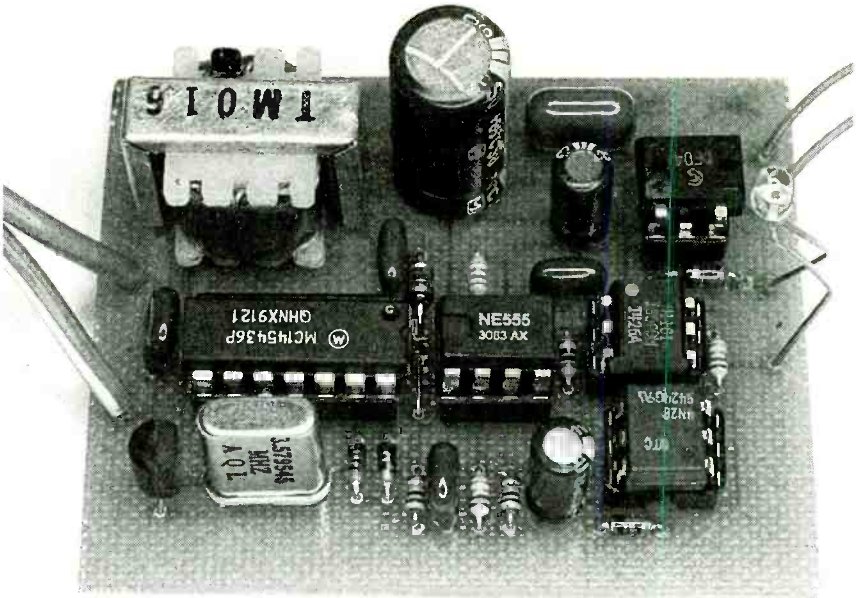


FIG. 3—THE COMPLETED PC BOARD. Point-to-point wiring will also work for this project.

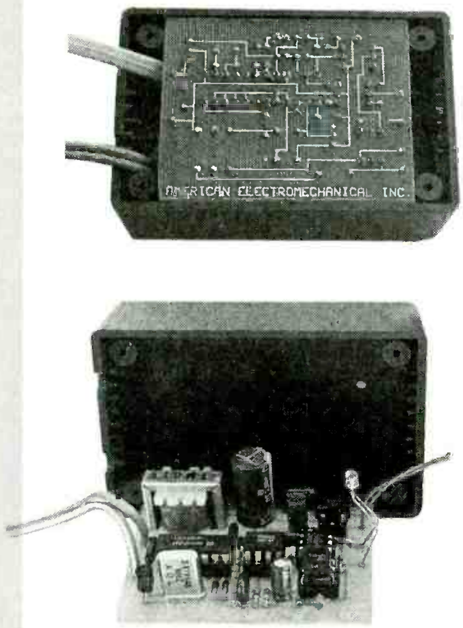


FIG. 4—THE BOARD FITS tightly in a 2- × 3- × 1-inch plastic case, and is held securely without any hardware.

power is turned off, C5 discharges through D3.

Construction

Since this is a low-frequency circuit, parts layout and wiring are not at all critical, parts tolerances are not critical, and equivalent types may be substituted.

The prototype was built on a small PC board for which we've provided a foil pattern. Point-to-point wiring will work just as well, however.

If the printed-circuit board is used, use Fig. 2 as a guide to install the parts. It's always best to use IC sockets for all ICs, although they aren't absolutely necessary.

When installing LED1, leave its leads long and bend them in an S shape so its position can be adjusted later on to fit through a hole in the top of the case. After all parts are installed, plug the ICs into their sockets. Keep in mind that IC4 is a CMOS device that is sensitive to ESD or electrostatic discharge. Figure 3 shows the completed PC board.

The author installed the board in a 2- × 3- × 1-inch plastic case (see Parts List), in which the board fits perfectly and is held securely without any hardware. You are free to use any case you like, but the installation details are up to you if you decide to go that route.

Place a nylon tie around the power leads and the telephone wire to act as strain reliefs, or tie knots in them to serve the same purpose. Cut and file slots in the edge of the case to pass the wires through and drill a hole in the top of the case directly above where the LED will be once the board is installed. Figure 4 shows how the board fits into

Continued on page 54

RAY MARSTON

VOLTAGE

Learn how to build a variety of voltage integrated circuits and put them

THIS ARTICLE EXPLAINS THE DEsign of a many different low-power electronic voltage converters. These circuits generate higher-value supply voltages from low-voltage DC sources and negative DC voltages from positive DC voltage sources. The circuits in this article include the popular 555 industry-standard timer IC and the Harris Semiconductor ICL7660 voltage converter IC, devices that simplify the design and construction of a variety of voltage converter circuits.

Low-voltage generation.

The easiest way to increase the voltage level of a DC source voltage or reverse its polarity is to apply that DC voltage to a free-running, squarewave generator whose output is fed to a multisection capacitor-diode voltage-multiplier network. Figure 1 shows block diagrams for positive and negative output voltage converters.

If a positive output voltage is desired, the multiplier must provide a noninverting response, as shown in Fig. 1-a. But if a negative output is required, the multiplier must function as an inverter, as shown in Fig.1-b.

Voltage converters are based on a variety of multivibrator circuits. These converters can include free-running, squarewave- generating multivibrators based on bipolar or field-effect (FET) transistors or CMOS or TTL integrated circuits. In general, the squarewave generators should oscillate at frequencies between 1 kHz and 10 kHz so that the multiplier section can operate efficiently. This frequency range permits the use of multiplying capacitors with low values.

An easy way to build a voltage converter is to design it around an industry-standard 555 timer IC. (This versatile device and many practical circuits that include it were discussed in the November and December issues of *Electronics Now*, starting on pages 61 and 62, respectively.) The 555 can source or sink up to 200 milliamperes when set up as a free-running squarewave generator.

Figures 2, 3, 4, and 5 are voltage-converter circuits based on the 555. The 555 is configured

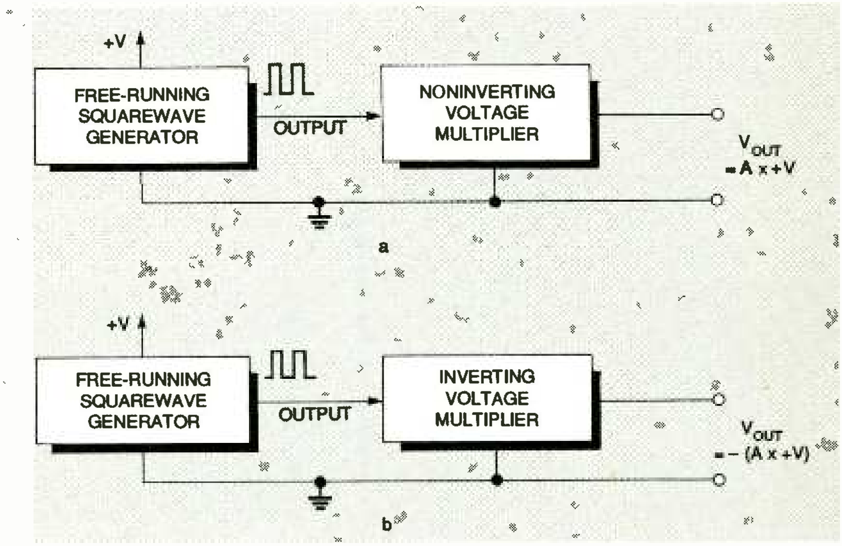


FIG. 1—VOLTAGE CONVERTER BLOCK DIAGRAMS: positive output (*a*) and negative output (*b*).

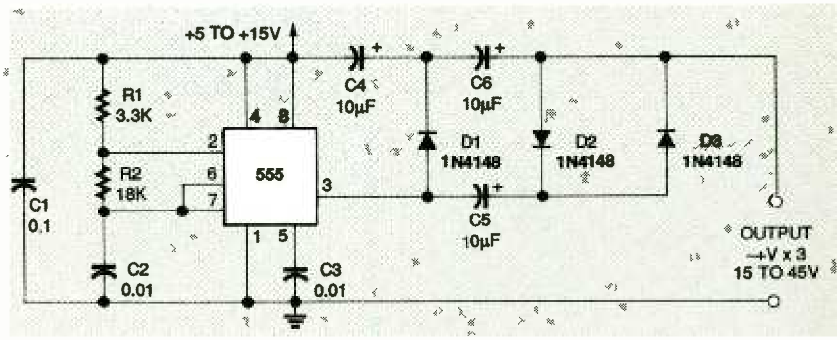


FIG. 2—DC VOLTAGE-DOUBLER circuit based on the 555 timer IC.

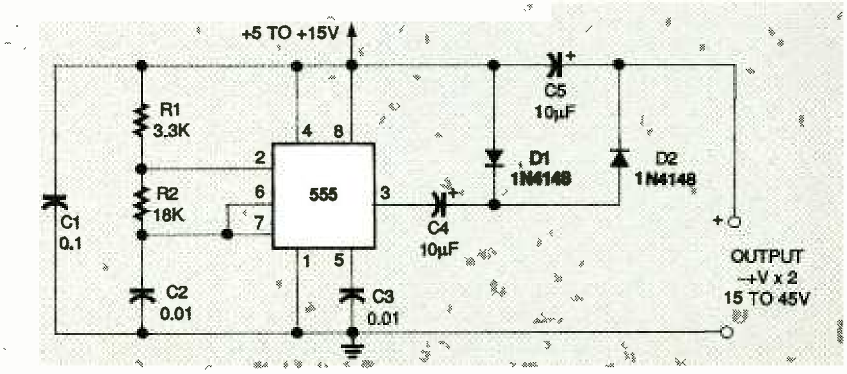


FIG. 3—DC VOLTAGE-TRIPLER circuit based on the 555 timer.

CONVERTERS

-conversion circuits from popular to work in your own circuit designs.

as a free-running astable multivibrator (squarewave generator) operating at about 3 kHz in all of these circuits. The 3-kHz frequency is determined by the values of resistors R1 and R2 in series with capacitor C2. Supply-line capacitor C1 prevents the 3-kHz output of the 555 from feeding back into the device, and capacitor C3 enhances circuit stability.

The circuit in Fig. 2 is a DC voltage-doubler that generates a DC output voltage with a value that is approximately twice that of the supply voltage. The 555's output is fed to a voltage-doubler network made up of capacitors C4 and C5 and diodes D1 and D2. The network produces the approximate *two times supply voltage output* when that output is unloaded.

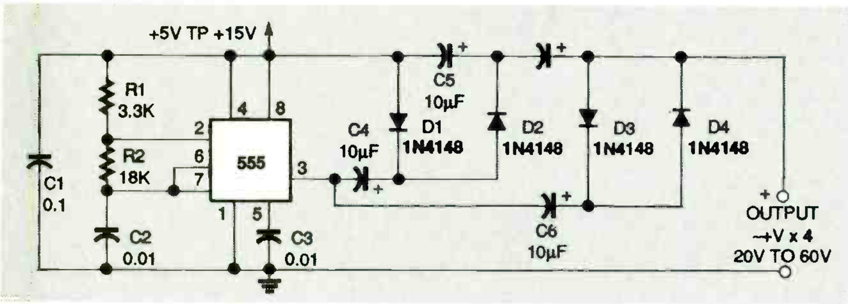


FIG. 4—DC VOLTAGE-QUADRUPLER circuit based on the 555 timer.

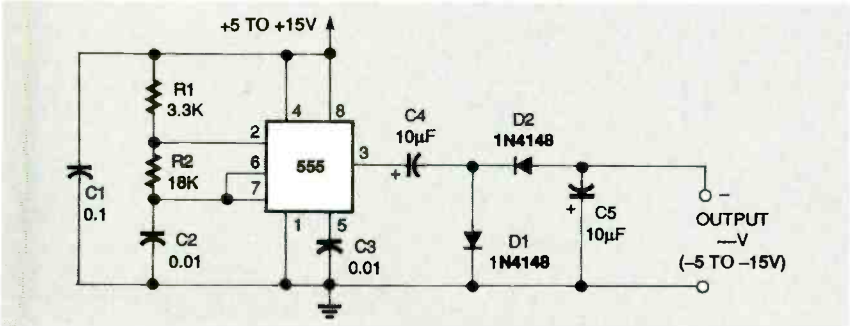


FIG. 5—DC NEGATIVE VOLTAGE generator based on the 555 timer.

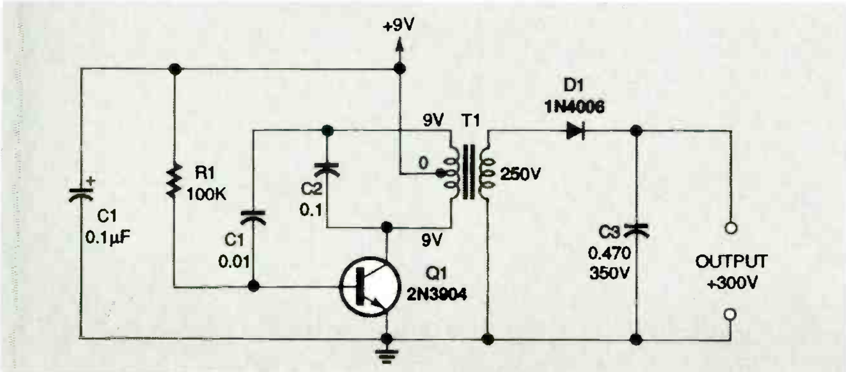


FIG. 6—NINE-VOLT-TO-300-VOLT DC-to-DC converter.

The precise output value is:

$$2 \times V_{peak} - (V_{fd1} + V_{fd2})$$

Where: V_{peak} is the peak output voltage of the squarewave generator V_{fd1} and V_{fd2} are the forward voltage drops (about 600 millivolts) of multiplier diodes D1 and D2.

The output voltage of the circuit decreases when the output is loaded.

The Fig. 2 *voltage doubler circuit* will work with any DC supply of 5 to 15 volts. Because of its voltage-doubling response, it can provide voltage outputs over a range of about 10 to 30 volts. Higher voltage can be obtained by adding more multiplier stages to the circuit.

The Fig. 3 *DC voltage tripler* circuit can provide output voltages from 15 to 45 volts. The Fig. 4 *DC voltage quadrupler* circuit can provide output voltages from 20 to 60 volts.

Figure 5 is the schematic for a *DC negative-voltage generator*, capable of producing an output voltage that is approximately equal in amplitude but opposite in polarity to that of the power supply. It also operates at 3 Hz, and it drives an output stage consisting of capacitors C4 and C5 and diodes D1 and D2. This circuit's *split-supply* output is useful for powering ICs that require both positive and negative power from a single-ended source.

High-voltage generation. The generation of higher output voltages with voltage multipliers is usually cost-effective only when the values of the required voltages are less than six times the supply voltage. Where very large step-up ratios are required (e.g., hundreds of volts generated from a 12-volt supply), other circuit designs are recommended.

It is usually cost-effective to apply the output of the low-voltage oscillator or squarewave generator as the input to a suitable step-up voltage transformer. The required high AC output voltages appear across the transformer's secondary winding.

This AC voltage can easily be converted back to DC with a

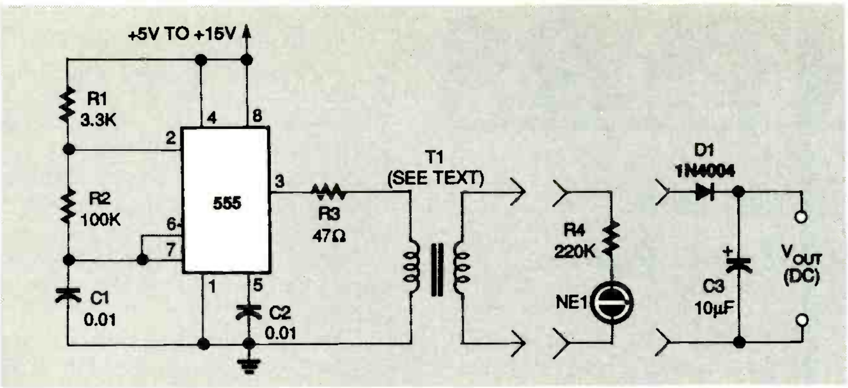


FIG. 7—HIGH-VOLTAGE GENERATOR that can also be a neon lamp driver.

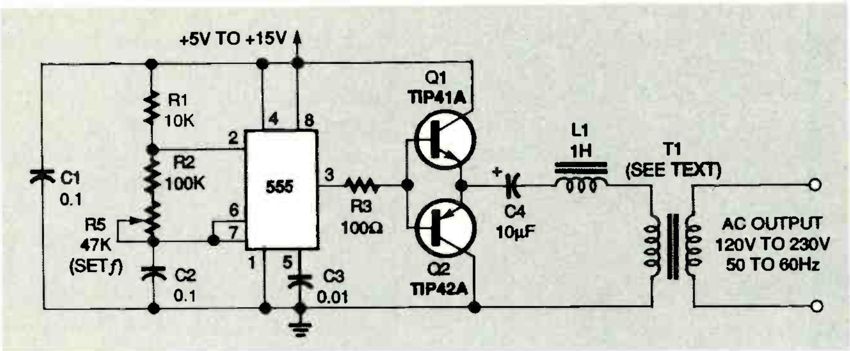


FIG. 8—DC-TO-AC INVERTER based on the 555 IC.

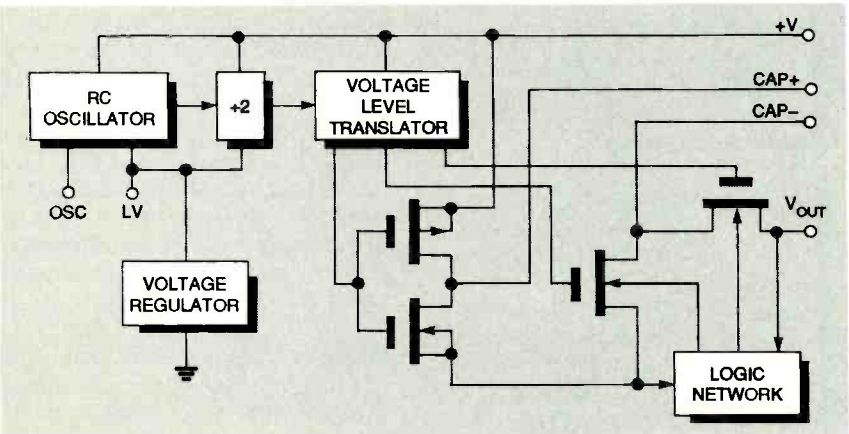


FIG. 9—FUNCTIONAL DIAGRAM for the ICL7660 CMOS voltage converter.

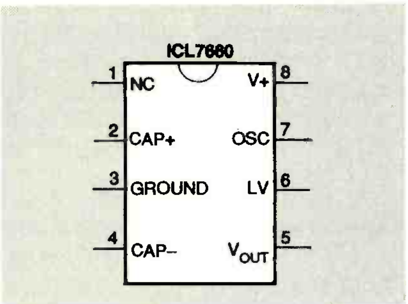


FIG. 10—PIN CONFIGURATION for an ICL7660 in an eight-pin miniDIP.

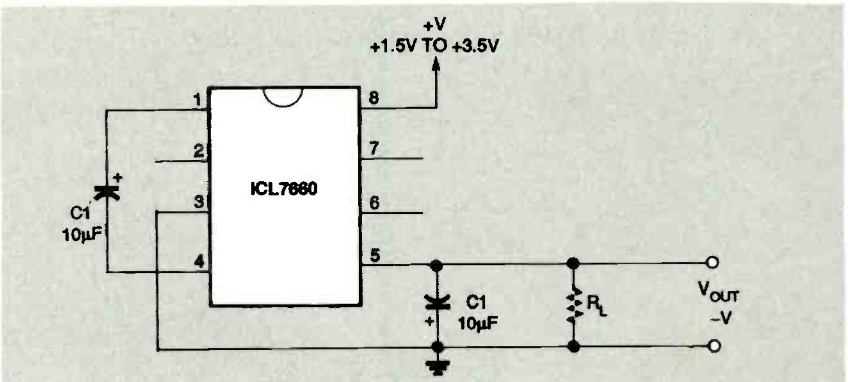


FIG. 11—NEGATIVE VOLTAGE CONVERTER for a 1.5- to 3.5-volt supply.

simple rectifier-filter network, if required. Figures 6, 7 and 8 show schematics for low-power, high-voltage generation circuits based on of this principle.

Figure 6 is a DC-to-DC converter circuit that can generate a 300-volt DC output from a 9-volt DC power source. In this circuit, transistor Q1 and its associated circuitry form a Hartley inductive-capacitive (LC) oscillator. The voltage on the primary winding that swings between zero and 9-volts is applied to 250-volt transformer T1. The inductance of the primary is the inductive element in the LC oscillator, which is tuned by capacitor C2.

The supply voltage is stepped up to about 350 volts peak at the secondary of T1. This output is half-wave rectified by diode D1, and it charges capacitor C3. Without a permanent load on C3, the capacitor can deliver a powerful but non-lethal electrical shock. With a permanent load, the output drops to about 300 volts at a load current of a few milliamperes.

The Fig. 7 circuit can either drive a neon lamp or generate a low-current DC voltage of up to several hundred volts from a 5- to 15-volt DC supply. The 555 is configured as a 3-kHz astable multivibrator whose square-wave output is fed to the input of transformer T1 through the resistor R3.

In this circuit, T1 is a small audio transformer with a turns ratio necessary to give the desired output voltage. In this circuit, a 10-volt supply and a transformer with a 1:20 turns ratio will give an unloaded DC output of 200 volts peak. This AC voltage can easily be converted to DC with a half-wave rectifier and filter capacitor, as shown in Fig. 7.

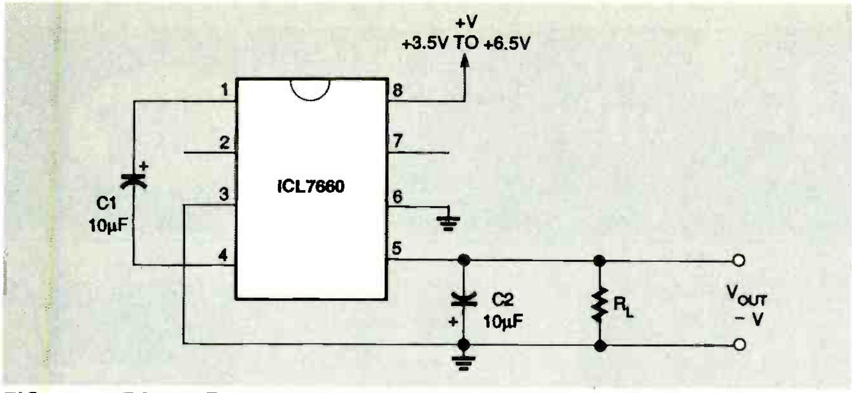


FIG. 12—NEGATIVE VOLTAGE CONVERTER for a 3.5- to 6.5-volt supply.

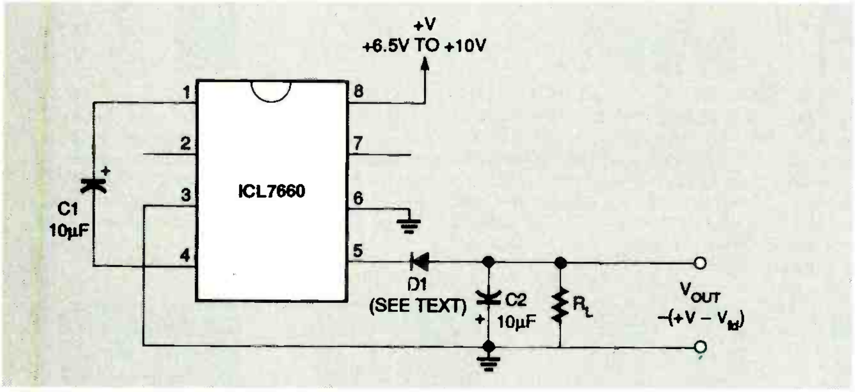


FIG. 13—NEGATIVE VOLTAGE CONVERTER for a 6.5- to 10-volt supply.

CMOS voltage converter

The Harris ICL7660 is a monolithic CMOS voltage converter that converts its supply voltage from positive to negative for an input range of +1.5 volts to +10 volts. This results in complementary output voltages of –1.5 volts to –10 volts. For example, if powered from a +5-volt source, the device will generate a –5-volt output.

The ICL7660 has a typical open-circuit voltage conversion efficiency of 99.9% and a typical power efficiency of 98%. When the output is loaded, the ICL7660 acts like a voltage source with an output impedance of about 70 ohms. It can supply maximum currents of about 500 microamperes.

Only two external capacitors are needed to perform the charge pump and charge reservoir functions. The ICL7660 can also be configured as a voltage doubler andit will generate output voltages up to +18.6 volts with a +10-volt input.

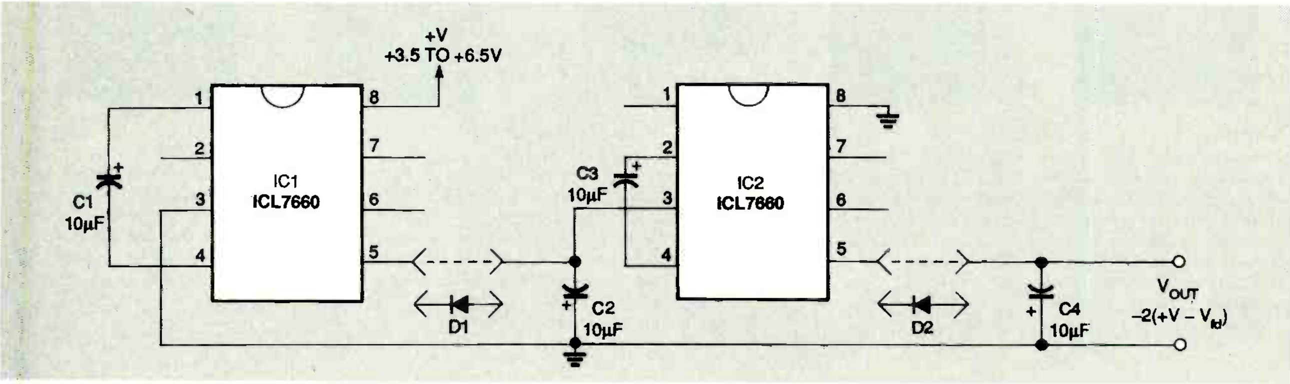


FIG. 14—METHOD FOR CASCADING voltage converter ICs for increased voltage.

The DC-to-AC inverter circuit in Fig. 8 will produce an AC output at line frequency and voltage. The 555 is configured as an astable multivibrator whose output frequency can be adjusted over a range of 50 to 60 Hz by trimmer potentiometer R5.

The output of the 555 is fed to the paired NPN and PNP bipolar transistors Q1 and Q2, and their output is fed into the low-voltage side of reverse-connected filament transformer T1. It has the necessary step-up turns ratio. Capacitor C4 and coil L1 filter the input to ensure that the transformer input is essentially a sinewave.

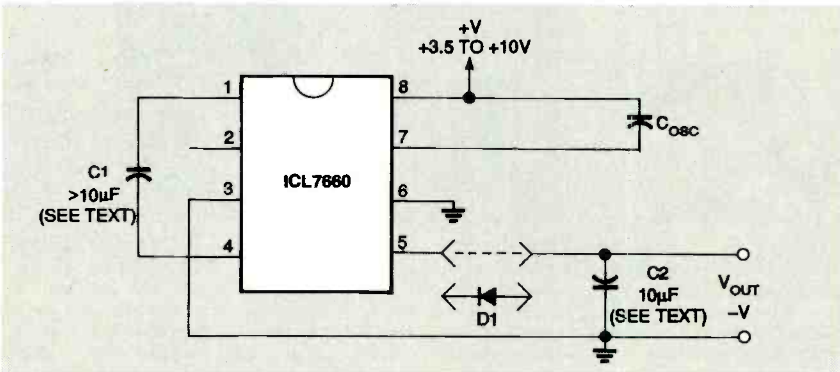


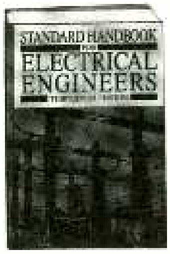
FIG. 15—CAPACITOR SUBSTITUTION for reducing the voltage converter's oscillator frequency.

Figure 9 is the functional block diagram of the ICL7660.

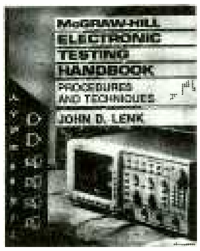
Get 3 Books for only $9.95

Values to $191.90

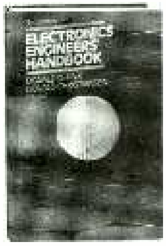
Plus 1 book free upon prepayment
when you join the ***Electronics Engineers' Book Club®***



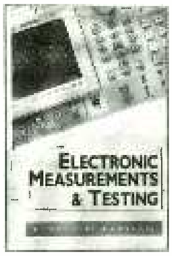
020984-XXX **$110.50**
Benefit from the collective expertise of more than 100 contributors in this book. It's the most current and comprehensive electrical reference available today. 2,208 pp., 1,421 illus.
Counts as 3



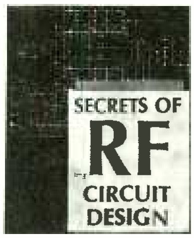
0376026 **$42.95**
Make testing hassle-free with the help of best-selling author John D. Lenk. He details the types of test equipment available, what the various types do, and how they operate. Plus, he offers procedures for testing electronic devices, circuits, and components. 416 pp., 526 illus.



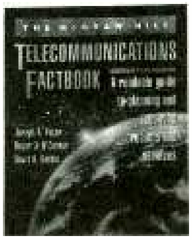
9255H-XXX **$105.50**
"Outstanding, extensive reference to current technology of electronics. Covers everything from principles to applications."
—Computer Book Review
2,528 pp., 1,800 illus.
Counts as 3



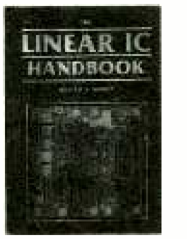
0039615 **$40.00**
Use available off-the-shelf test equipment with this guide to basic electrical measurements, component measurements, system tests, and performance verification. 224 pp., 180 illus.



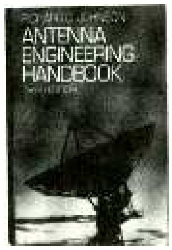
3710P **$21.95**
Understand the basics of receiver operation, the proper use and repair components in RF circuits, and principles of radio signal propagation from low frequencies—all with this guide. 416 pp., 411 illus., *Softcover*



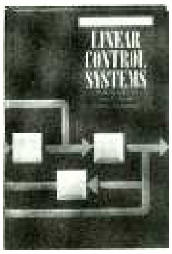
0491836 **$29.95**
Plan and implement telecommunications projects. Assess market trends for voice and data services. Procure a voice/data premises distribution system. You can accomplish these tasks and many more with the advice in this guide. 384 pp., 159 illus.
Softcover



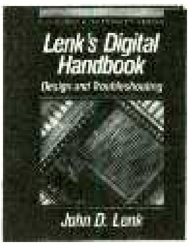
2672H **$49.50**
This book covers linear IC offerings from all the major manufacturers—complete with specifications, data sheet parameters, and price information.
624 pp., Illus.



032381-XXX **$119.50**
Newly revised, this bestseller provides detailed information on physical fundamentals, patterns, structures, and design techniques. Experts from RCA, Raytheon, Scientific-Atlantic, and other major firms and universities have contributed to this book. 1,520 pp., 800 illus. *Counts as 3*

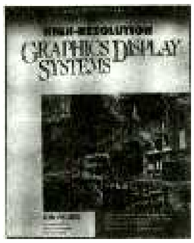


0415250-XX **$62.91**
Gain a firm understanding of the fundamentals of control theory with this authoritative guide. Plus, it will help you ensure stability and reduce the sensitivity of the system to disturbances and plant perturbations. 572 pp., Illus. *Counts as 2*

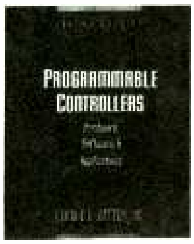


037516X **$39.50**
This helpful volume covers digital electronic devices and components and a simplified system of testing and troubleshooting that can be easily applied to any electronic system or equipment. 320 pp., 150 illus.

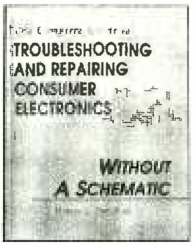
911525X-XX **$50.00**
Packed with sample circuit simulations that clearly illustrate a variety of common problems and their solutions, this in-depth guide shows you how to deal with the stumbling blocks of nonconvergence, numeric integration instabilities, and timestep control errors. 208 pp., 200 illus., 3.5" disk, *Counts as 2*



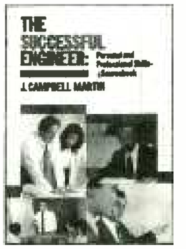
4320H **$49.95**
Get the most from all your graphics-intensive applications. This guide will help you choose the best software drivers and controller boards for your needs. Desktop publishing, multimedia, architectural, animation, and CAD/CAM are some of the display systems covered. 288 pp., 97 illus.



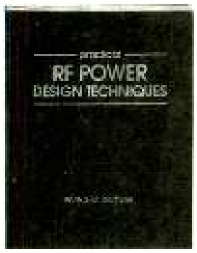
0042144 **$39.00**
This book provides a solid introduction to programmable controllers. You'll explore how to use personal computers with programmable controllers as well as how to compare and select process control schemes. 304 pp., 180 illus.



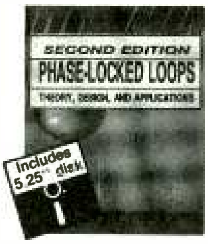
0156492 **$34.95**
Tackle troublesome circuits without the benefit of a schematic with these tricks of the trade by a veteran electronics technician. You'll see how to locate, test, and repair defective components in virtually every type of consumer electronics device imaginable. 304 pp., 250 illus.



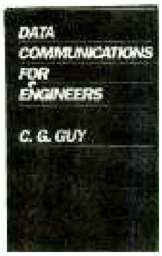
0407258 **$31.28**
Building on your background in mathematics and physics, as well as training in logical analysis, this self-improvement guide explores everything from time management to the legal and ethical aspects of engineering. 400 pp., Illus., *Softcover*



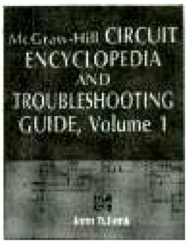
4228H **$32.95**
Get all the hands-on instruction you need to translate RF theory into functioning hardware and design working RF power circuits with this guide.
304 pp., 219 illus.



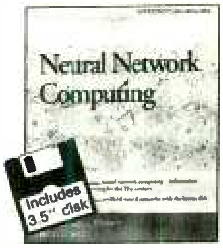
9113869-XX **$50.00**
Design efficient phase-locked loops for electronic devices. You get design and applications information for all four types of PLLs—linear, digital (an analog/ digital hybrid), all-digital, and software. 370 pp., 100 illus., 5.25" disk, *Counts as 2*



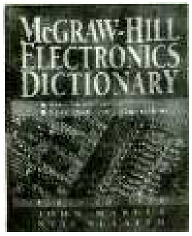
0253544 **$30.00**
Understand the latest data communications software systems and how they interface with hardware. This hands-on guide emphasizes the practical side of the field while keeping mathematical theory to a minimum.
192 pp., 30 illus.



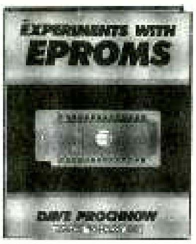
0376034-XX **$59.50**
This book provides both a collection of over 700 of the latest commonly used integrated and discrete-component circuits and authoritative testing and troubleshooting methods on each type of circuit. All circuits are grouped by function. Each functional group includes a practical guide to testing and troubleshooting that type of circuit.
664 pp., 703 illus. *Counts as 2*



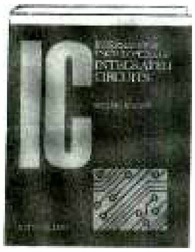
4473P **$29.95**
What if computers worked more like the human brain? Can computers "learn?" Here you'll explore these thought-provoking questions, and look at how experimental computers are being designed today to meet tomorrow's anticipated demand for unsupervised high-tech automation. 208 pp., 35 illus.,
3.5" disk, *Softcover*



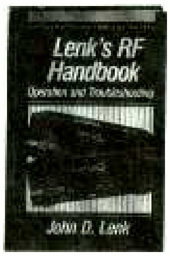
0404348 **$49.50**
More than 14,000 entries and 1,500 illustrations make up this A-to-Z reference. Its up-to-date definitions can not be found in general dictionaries. Plus, it focuses on terminology specific to the field of electronics.
608 pp., 1,500 illus.



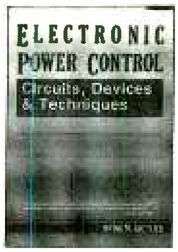
2962P **$18.95**
This complete EPROM instruction manual provides a detailed explanation of underlying theory, plus 15 different projects—including programmers, erasers, and EPROM-based circuits.
240 pp. *Softcover*



3802H-XX **$84.95**
The most thorough coverage of foreign and domestic integrated circuits is available today in this giant resource. Seven separate sections detail thousands of ICs and their applications, including charts, and tables. 1,168 pp., 4,605 illus., *Counts as 2*



0375046 **$39.50**
Packed with simplified, circuit-by-circuit troubleshooting examples, this handbook provides the practical know-how you need to operate and troubleshoot modern RF equipment.
352 pp., 150 illus.



3837H **$27.95**
This guide focuses on the specific digital circuits used in electronic power applications. It presents state-of-the-art approaches to analysis, troubleshooting, and implementation of new solid-state devices.
272 pp., 197 illus.

As a member of the Electronics Engineers' Book Club...

... you'll enjoy receiving Club bulletins every 3-4 weeks that contain exciting offers on the latest books in the field—at savings up to 50% off regular publishers' prices. If you want the Main Selection, do nothing and it will be shipped automatically. If you want another book, or no book at all, simply return the reply form to us by the date specified. You'll have at least 10 days to decide. If you ever receive a book you don't want, due to late delivery of the News, you can return it at our expense for a full refund. Plus, you'll be eligible for *FREE books* through the Bonus Book Program. Your only obligation is to purchase 3 more books during the next 2 years, after which you may cancel your membership at any time. ©1995 EEBC

All books are hardcover unless otherwise noted. Publishers' prices shown. If you select a book that counts as 2 choices, write the book number in one box and XX in the next. If you select a Counts as 3 choice, write the book number in one box and XXX in the next 2 boxes.
A shipping/handling charge & sales tax will be added to all orders.

If card is missing, write to:
Electronics Engineers' Book Club, A Division of McGraw-Hill, Inc.
Blue Ridge Summit, PA 17294-0860

ELECTRONICS ENGINEERS'® BOOK CLUB

Blue Ridge Summit, PA 17294-0860

YES! Rush me the following title(s), billing me just $9.95 (plus shipping/handling & sales tax). Enroll me as a member of the **Electronics Engineers' Book Club** according to the terms outlined in this ad. If not satisfied, I may return the book(s) within 10 days for a full refund and my membership will be cancelled. I agree to purchase just 3 more selections at regular Club prices during the next 2 years and may resign anytime thereafter.
■ Bill me (FREE book not available with this payment option.)

SPECIAL OFFER! Prepay your order by check, money order, or credit card and receive a 4th book of your choice FREE.

■ **YES!** I want the FREE BOOK indicated at right. My introductory payment of $9.95 plus $9.95 shipping/handling* and applicable sales tax is enclosed.

Code # of my FREE BOOK: SINGLE SELECTION ONLY

Code #'s of my book(s) for $9.95

If you select a book that counts as 2 choices, write the book number in one box and XX in the next.
If you select a Counts as 3 choice, write the book number in one box and XXX in the next 2 boxes.

■ Check or money order enclosed made payable to: McGraw-Hill, Inc.
Please charge my: ■ VISA ■ MasterCard ■ American Express ■ Discover

Acct. No. ________ Exp. Date ________

Name ________ Signature ________
(required on all credit card orders)

Address/Apt.# ________

City/State/Zip ________ Phone ________

Offer valid for new members only, subject to acceptance by EEBC. U.S. orders are shipped 4th Class Book Post. Canada must remit in U.S. funds drawn on U.S. banks. *Canadian orders are shipped International Book Post—add $12.50 shipping/handling. Applicants outside the U.S. and Canada will receive special ordering instructions. A shipping/handling charge & sales tax will be added to all orders. DRE495C

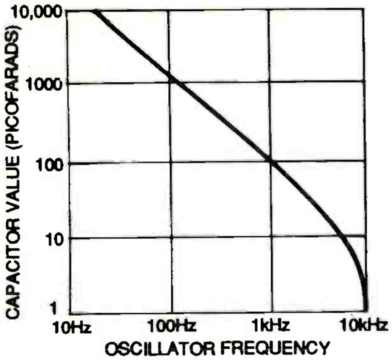


FIG. 16—FREQUENCY OF OSCILLATION as a function of external oscillator capacitor value ($+V = 5$ volts).

It contains an RC oscillator, divide-by-2 circuit, voltage-level translator, voltage regulator, four output power MOS switches, and an unusual logic network. The logic network senses the most negative voltage in the device and ensures that the output N-channel switch source-substrate junctions are not forward biased. This is intended to ensure latchup-free operation.

The unloaded oscillator oscillates at a nominal frequency of 10 kHz when the input supply voltage is 5.0 volts. This frequency can be lowered by the addition of an external capacitor to the OSC terminal, or the oscillator can be overdriven by an external clock.

The LV terminal can be tied to GROUND to bypass the internal series regulator and inprove low voltage (LV) operation. At medium to high voltages (+3.5 to +10.0 volts), the LV pin is left floating to prevent device latchup.

The ICL7660 is available in eight-pin miniDIP and small-outline IC (SOIC) packages as well as TO-99 cases. Figure 10 is the drawing of pin configurations for the eight-pin miniDIP package, the least expensive version. Power dissipation of this package is 300 milliwatts. The ICL7660S, an enhanced direct replacement for the ICL7660, is now available and can be substituted if desired.

The operation of the ICL7660 is similar to that of the oscillator and voltage-multiplier shown in Fig. 2, but it performs that function more efficiently. As stated earlier, the use of conventional silicon multiplier diodes causes the circuit's unloaded output voltage to drop by about 1.2 volts—the sum of the forward voltage drops of the two diodes.

The ICL7660 eliminates the voltage drop by replacing the diodes with MOS power switches. These switches are driven by the logic network so that each switch automatically closes when it is forward biased and opens when it is reverse biased. This feature accounts for its high operating efficiency.

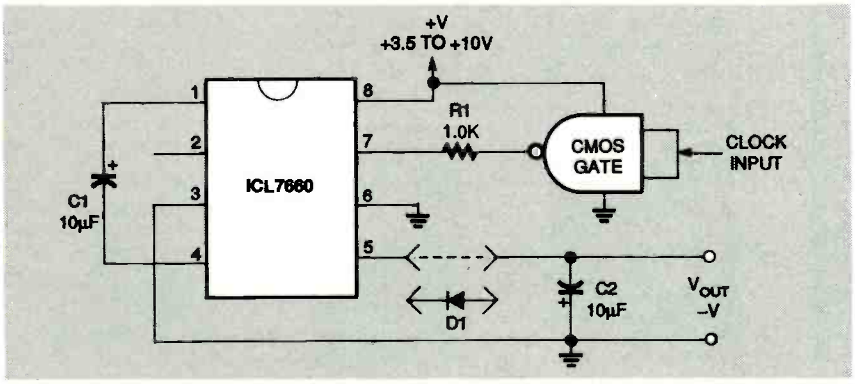


FIG. 17—EXTERNAL CLOCKING METHOD for reducing the internal oscillator frequency of the ICL7660.

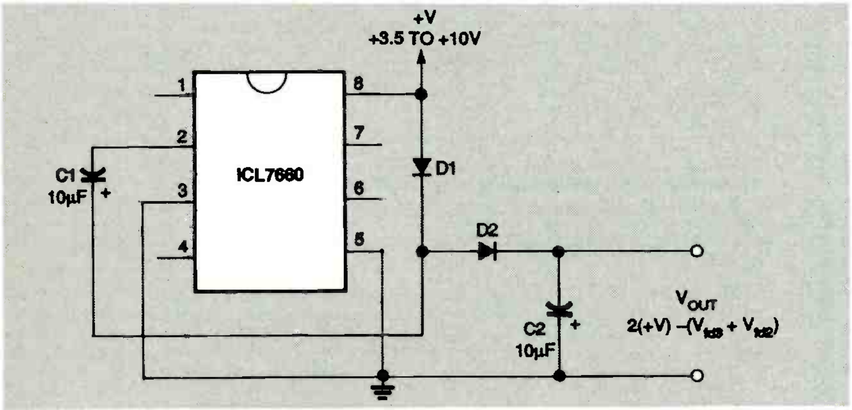


FIG. 18—POSITIVE VOLTAGE MULTI PLIER based on the ILC7660.

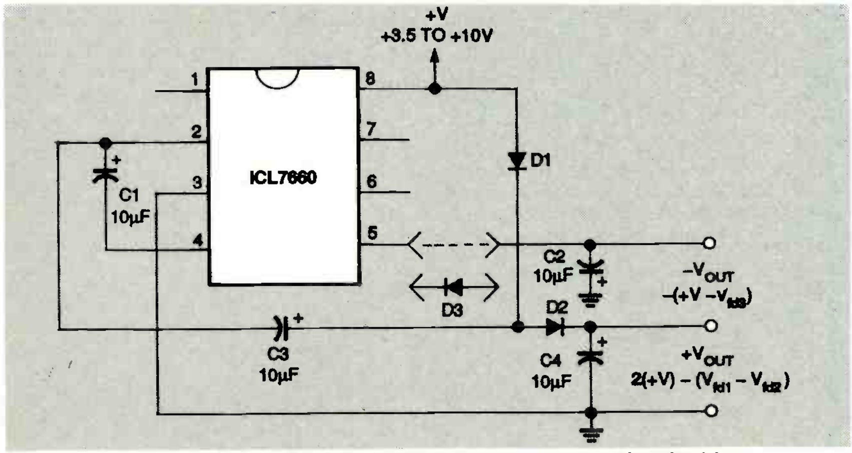


FIG. 19—COMBINED NEGATIVE VOLTAGE converter and positive doubler.

Do's and don'ts

The manufacturer recommends some *Do's and Dont's* to assure reliable device operation:

1. Do not exceed the device's maximum supply voltage.
2. Do not connect any pins to voltages greater than +V or less than ground.
3. If the IC is operating in the power supply range of 1.5 to 3.5 volts, ground the LV·SX pin 6; at supply values greater than 3.5 volts, leave pin 6 open circuited.
4. Do not short circuit the output to the +V supply for volt-

Continued on page 62

CUSTOM METER FACES

Customize analog meter faces with your PC and a laser printer.

SKIP WITHROW, WB0BBE

EVEN IN TODAY'S WORLD OF DIGITAL electronics there are still times when an analog meter is the better choice for displaying voltage, current, or other signal levels. With the use of a personal computer and a laser printer, this article shows how you can customize analog meters from your junk box or local surplus dealer to display almost any scale and units. Gone are the days of trying to draw meter scales by hand; you can make your computer and laser printer do the work for you.

Any laser printer that understands HPGL (Hewlett-Packard Graphics Language) commands is compatible with the techniques presented here. The BASIC programming language is used to assemble the commands which are then sent to the printer. The printer prints the new scale on a whole-page laser label and then the label is applied to the old meter. Figure 1 shows a meter, purchased for $2 at a surplus electronics outlet, before and after modification.

Finding the right meter

The first step to successfully making a newly labeled meter is to start with the right meter. Although many meters can be found for very reasonable prices in the surplus market, not every meter is a candidate for a new scale. Several specifications, such as the full-scale current and the meter movement's resistance, are critical in determining whether meter is a suitable choice.

To change the scale of a meter, the face must be accessible. Some inexpensive meter movements have cases that can't be opened, and these should be avoided. Generally the cover of a meter face can either be removed by simply prying it off, or by removing several small screws on the outside of the meter. The second task is to remove the meter face itself. Again, some inexpensive meters might have their faces mounted permanently, but the majority of meters have several small screws that hold the meter face in place. The ability to remove the meter face is essential.

Other things that must be known about the meter before it can be used in a circuit properly are its full-scale current and the resistance of its movement coil. For a new meter, these are easy to determine from the meter's specification sheet. Sometimes you will be lucky enough to find information printed on an old meter face that will help determine the full-scale reading.

If you know nothing about a meter's electrical specifications, they can be determined rather easily. Generally most meters have a full-scale current between 100 microamperes and 1 milliampere. Coil resistance generally varies between about 40 and 1000 ohms. The setup to measure full scale current and coil resistance is simple. The value of the power supply is not critical. A potentiometer between the supply and the unknown meter should be large enough to limit current to about 50 microamperes (about 200K). First set the potentiometer to its maximum value, turn on the power supply, then decrease the resistance until the meter reads full scale. Measure

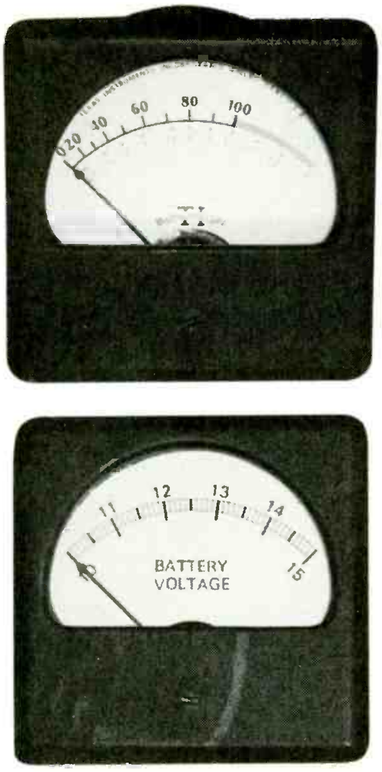


FIG. 1—A VOLTMETER, purchased for $2 surplus, shown before (top) and after modification (bottom).

the program that draws the new meter face.

The next step in putting a new face on your meter is to carefully remove the old meter face plate. After opening up the meter case it is usually just a mater of removing the small screws holding the face plate on. A set of jeweler's screw drivers can sometimes be helpful for particularly small meters. Once the face plate is loose it can be removed by very carefully sliding it from under the needle of the meter. Be careful not to bend or bump the needle.

Using HPGL

HPGL is a graphics language of short, simple statements that allows lines, arcs, and text to be drawn. Originally developed for plotters, this language has been incorporated into many of today's laser printers. By using just a few of the many HPGL statements, professional looking meter scales can be created with customized features.

The BASIC language can send HPGL commands to the printer for drawing the various features of the scale. Using a computer language to send the commands to the printer is helpful because many commands can be generated using program loops with an incrementing variable. This lets rather short programs generate many different individual graphic elements to compose the new meter face plate.

Listing 1 is the BASIC program that draws the meter face in Fig. 2. Only a few of the many HPGL commands are used in the program. Most are two-letter commands followed by arguments. In Listing 1 many of the arguments are calculated by the BASIC program. The program plots points on a graph that has

the voltage of the supply and the value of the variable resistance. The voltage divided by the resistance will then give you the current required to deflect the meter full scale.

Another potentiometer can determine the meter coil resistance. With the meter indicating full-scale current, place a 1K potentiometer across the meter and adjust until the meter reads exactly ½ scale. Remove this potentiometer and measure its value. This will be the value of the coil resistance of the meter. The meter in Fig. 1 had a full-scale current reading of 229 microamperes and a coil resistance of 819 ohms.

Making faces

A protractor is the best tool for measuring the total angle of movement of the meter needle, which generally runs from 90 to 120 degrees. Also measure the distance from the pivot point to the scale of the old meter face and the location of the face-plate mounting holes with respect to the pivot point. Those measurements will be input to

LISTING 1

```
REM - PUT THE ORIGIN IN THE MIDDLE OF THE PAGE.
REM - THIS IS THE NEEDLE PIVOT POINT
XORG = 4000
YORG = 5500

REM - CONSTANTS USED FOR PLOTTING
IRAD = 1.4 * 1016
ORAD = 1.5 * 1016
IIRAD = 1.33 * 1016
ANGLE = 90
K = .0174533
MAJORDIV = 5
MINORDIV = 50

REM - CLEAR THE PRINTER
LPRINT CHR$(27); "E"
REM - PUT THE PRINTER INTO HPGL MODE
LPRINT CHR$(27); "%0B"
REM - INITALIZE HPGL MODE
LPRINT "IN;"

REM - SELECT A PEN SO IT WILL PRINT AND SET THE WIDTH
LPRINT "SP1;"
LPRINT "PW0;"

REM - DRAW THE UPER AND LOWER ARCS FOR THE METER SCALE
LPRINT "PA"; XORG - SIN(ANGLE / 2 * K) * ORAD; ","; YORG + COS(ANGLE / 2 * K)
* ORAD; ";PD;"
LPRINT "AA"; XORG; ","; YORG; ","; -ANGLE; ";"
LPRINT "PU;"
LPRINT "PA"; XORG - SIN(ANGLE / 2 * K) * IRAD; ","; YORG + COS(ANGLE / 2 * K)
* IRAD; ";PD;"
LPRINT "AA"; XORG; ","; YORG; ","; -ANGLE; ";"

REM - PUT IN THE 50 TICK MARKS FOR TENTHS OF VOLTS
FOR I = -ANGLE / 2 TO ANGLE / 2 STEP ANGLE / MINORDIV
LPRINT "PU;"
LPRINT "PA"; XORG + SIN(I * K) * IRAD; ","; YORG + COS(I * K) * IRAD; ";"
LPRINT "PD;"
LPRINT "PA"; XORG + SIN(I * K) * ORAD; ","; YORG + COS(I * K) * ORAD; ";"
LPRINT "PU;"
NEXT I

REM - PRINT THE VOLT MARKS USING HEAVIER LINES AND EXTENDING BELOW THE ARC
LPRINT "PW.5;"
FOR I = -ANGLE / 2 TO ANGLE / 2 STEP ANGLE / MAJORDIV
LPRINT "PU;"
LPRINT "PA"; XORG + SIN(I * K) * IIRAD; ","; YORG + COS(I * K) * IIRAD; ";"
LPRINT "PD;"
LPRINT "PA"; XORG + SIN(I * K) * ORAD; ","; YORG + COS(I * K) * ORAD; ";"
LPRINT "PU;"
NEXT I
```

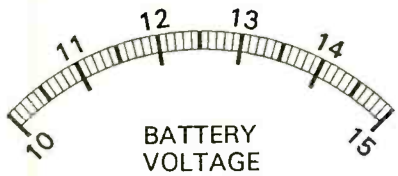


FIG. 2—THIS METER FACE is the result of the BASIC program in Listing 1.

1016 points (pixels) per inch in both the X and Y directions.

Here's a list of the commands that are used and short descriptions:

IN—Initialize
SP—Select Pen
PW—Set Pen Width
PA—Plot Absolute
AA—Arc Absolute
PU—Pen Up
PD—Pen Down
SD—Standard Font Definition
DT—Define Label Terminator
SS—Select Standard Font
LO—Label Origin
LB—Label

The syntax of those commands is explained in the technical reference section for the HPGL language in your printer manual. Since some commands take X and Y coordinate locations, some simple trigonometry is used to calculate the arguments from the index angle in the program of Listing 1.

Developing your own meter face is a simple matter of running the program and printing the resulting graphics on the printer. You probably won't get it right the first time, but making modifications is easy. Writing the program in blocks that add a new graphic after each iteration works best. Printing locating marks on the new face for the mounting holes helps to align the new face properly on the old face plate.

Once everything looks the way you want it to on paper, print the results on a full-page laser label. It's best to apply the new label on the reverse side of the old face plate since it's usually a nice clean surface. Punch pinholes in the location marks to help locate them from the back side of the label. Peel off the backing of the new scale label and place the label face down. Then stick the face plate to the label, lining up the locator holes in the center of the face plate mounting holes. After applying the label use a modeling knife to trim the excess paper from around the meter face plate and mounting holes. Figure 3 shows the new label applied to the old meter.

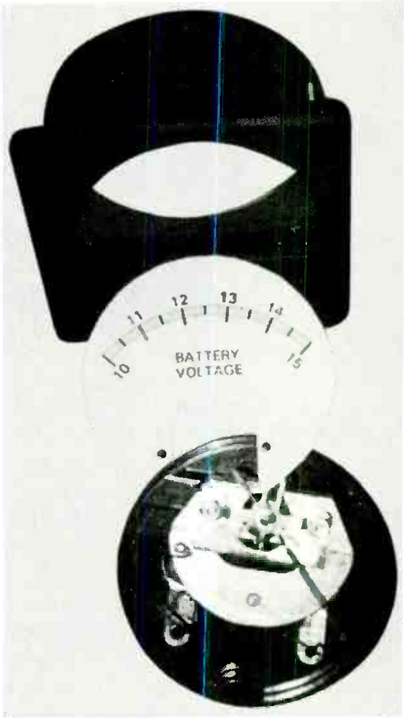


FIG.3—HERE IS THE NEW LABEL pasted onto the surplus meter.

Reassembly finishes the job. Carefully slide the face plate under the meter needle and replace the mounting screws. Next, replace the meter cover.

Creativity is the key to adding an exciting meter display to your next project. Expanded-scale voltmeters are an ideal application for this technique. Power supply current meters are also nice to have. This technique can also create non-linear meter scales such as decibel meters for audio or RF applications. Meter recycling can enhance your projects with just a small investment in time. Ω

```
REM - PRINT THE HALF VOLT MARKS USING A HEAVY LINE BETWEEN THE TWO ARC LINES
LPRINT "PW.5;"
FOR I = -ANGLE / 2 TO ANGLE / 2 STEP ANGLE / MAJORDIV / 2
LPRINT "PU;"
LPRINT "PA"; XORG + SIN(I * K) * IRAD; ","; YORG + COS(I * K) * IRAD; ";"
LPRINT "PD;"
LPRINT "PA"; XORG + SIN(I * K) * ORAD; ","; YORG + COS(I * K) * ORAD; ";"
LPRINT "PU;"
NEXT I

REM - SET UP TO LABEL THE METER AND PRINT "BATTERY VOLTAGE"
LPRINT "SD1,21,2,1,4,10,7,4148;"
LPRINT "DT*,1;"
LPRINT "SS;"
LPRINT "PA"; XORG; ","; YORG + 900; ";"
LPRINT "LO4;"
LPRINT "LBBATTERY*;"
LPRINT "PA"; XORG; ","; YORG + 750; ";"
LPRINT "LBVOLTAGE*;"

REM - PUT THE LOW AND HIGH VALUE BELOW THE SCALE ARC
LPRINT "LO16;"
LPRINT "PA"; XORG + SIN((-ANGLE / 2) * K) * IIRAD; ","; YORG + COS((-ANGLE /
2) * K) * IIRAD; ";"
LPRINT "DI"; COS(ANGLE / 2 * K); ","; SIN(ANGLE / 2 * K); ";"
LPRINT "LB10*;"
LPRINT "PA"; XORG + SIN(ANGLE / 2 * K) * IIRAD; ","; YORG + COS(ANGLE / 2 * K)
* IIRAD; ";"
LPRINT "DI"; COS((-ANGLE / 2) * K); ","; SIN((-ANGLE / 2) * K); ";"
LPRINT "LB15*;"

REM - PUT THE INTERMEDIATE VALUES ABOVE THE SCALE ARC
LPRINT "LO14;"
FOR I = -(ANGLE / 2) + ANGLE / MAJORDIV TO ANGLE / 2 - ANGLE / MAJORDIV STEP
ANGLE / MAJORDIV
LPRINT "PA"; XORG + SIN(I * K) * ORAD; ","; YORG + COS(I * K) * ORAD; ";"
LPRINT "DI"; COS(-I * K); ","; SIN(-I * K); ";"
LPRINT "LB"; INT(I / (ANGLE / MAJORDIV) + 12.5); "*;"
NEXT I

REM - PUT IN THE LOCATION DOTS FOR THE MOUNTING HOLES
LPRINT "PA"; XORG - 508; ","; YORG; ";"
LPRINT "PD;"
LPRINT "PU;"
LPRINT "PA"; XORG + 508; ","; YORG; ";"
LPRINT "PD;"
LPRINT "PU;"

REM - RESET THE PRINTER
LPRINT CHR$(27); "%0A"
LPRINT CHR$(27); "E"
END
```

LASER SHOW

continued from page 38

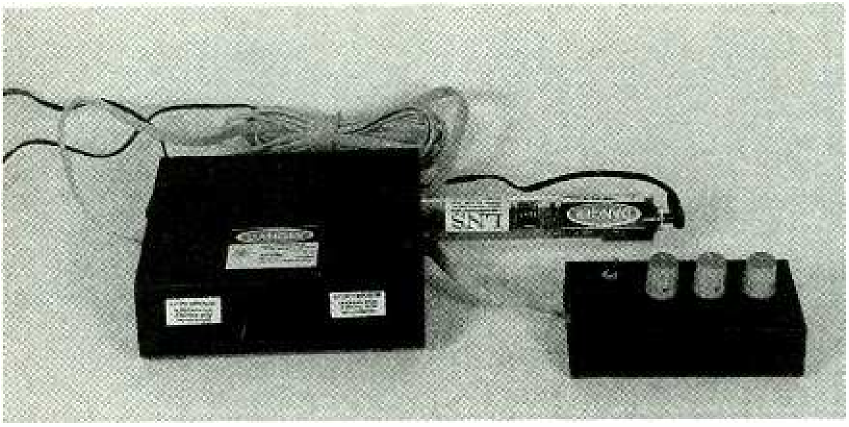


FIG. 10—THE LASER LIGHT SHOW consists of a wired remote control and the laser base unit that holds the rotating mirrors.

comes with a plastic mounting bracket that fits the two mounting holes for it on the aluminum base plate. If you are substituting a different laser, solid-state or otherwise, you must provide a suitable power supply and mounting bracket for it. Figure 8 shows the inside of the finished base unit, and Fig. 9 shows the inside of the remote control unit. Figure 10 shows the completed assembly.

Alignment and operation

Do not attach the cover to the base unit until you have checked the operation of the motors and have finished the alignment of the mirrors. During check-out and alignment, follow all laser safety precautions and *never* let the beam shine into anyone's eyes. Wear eye protection when running the motors without the enclosure cover in place.

Connect the handheld remote to the base unit with a 6-conductor modular cord. Next, plug the wall outlet adapter into an outlet and into J1. The toggle switch on the remote turns the unit on and off, and the motors will spin with varying speeds as you adjust the three potentiometers.

With the laser device positioned as shown in Fig. 7, and without the motors running, apply power to the laser and make sure that the beam strikes the first mirror as shown, and make sure that the mirror cannot accidentally hit the laser when it does turn. Loosen the bracket-to-base mounting screws and adjust the position of each motor so that the laser beam is reflected from the first mirror to the second mirror and then to the third mirror and out the side.

Next, fine tune the beam alignment by slowly turning each mirror by hand. As the mirror turns, the beam will be deflected. Adjust the position of each motor so that the deflected beam never leaves the surface of any mirror.

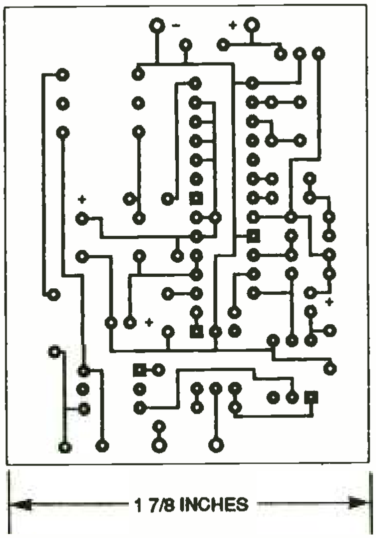
Adjust the last motor so that the laser beam will correctly exit through the hole in the enclosure cover when it is installed over the base.

Once everything is aligned, aim the laser light show at a blank wall or screen. As you vary the speed of each motors you'll see the endless variety of spiral forms that are created. If something was not assembled correctly, stop the motors before you try to adjust anything. When you are satisfied with the light show's alignment and operation, shut both the unit and the laser off and install the cover on the base unit.

This project should provide hours of fun and excitement. Everyone who sees it will want to take a turn at the remote control unit. Use your imagination in a dark room—with some background music and a little smoke you can create some truly sensational shows! Ω

PHONE ON HOLD

continued from page 41



FOIL PATTERN for the universal hold circuit's single-sided board.

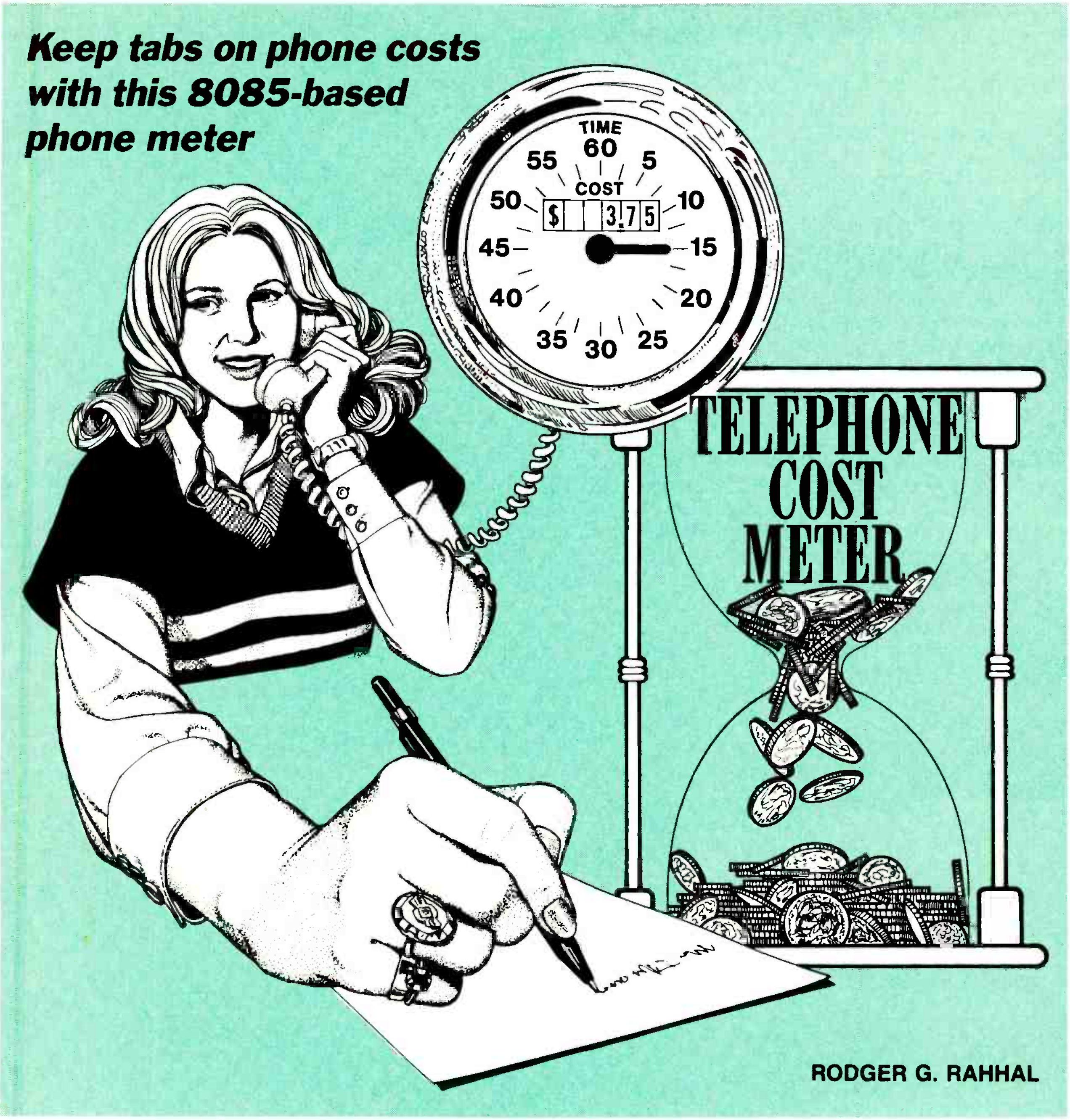
the case.

Before closing up the case, connect the hold circuit to the telephone line and plug the wall transformer into an AC outlet. Pick a phone up, press the # key, and hang it up within five seconds; the LED should light. Pick a phone up and the LED should go out. Press the # key, wait about eight seconds, and hang the phone up; the LED should not light.

Operation

The power supply, DTMF decoder, and timing circuits are isolated from the telephone line by the optoisolators and transformer. The five-second timing cycle that starts after the # key is released gives ample time to hang up a phone with a keypad on the handset. If the keypad is on the telephone base, the # key can be pressed while the phone is hung up.

If the # key is pressed for reasons other than to place a call on hold, such as to signal the end of a number entry after using a fax-back service, the timing cycle will end after five seconds and will probably not be active when the phone is hung up. To be sure that the line is not on hold after using the # key, just pick the phone up and hang up again. Ω



RODGER G. RAHHAL

HAVE YOU EVER BEEN SHOCKED BY an excessive phone bill? If so, PhoneMeter's for you. This low-cost, "intelligent" device allows you to monitor the cost of your phone calls—as you make them. In addition, it also provides useful clock and alarm functions.

During its operation, PhoneMeter displays, on a four-digit LED display, the minute-by-minute charge of each phone call as it accrues. And when a phone conversation is not taking place, the LED display gives the present time. You can review and update the alarm time as needed.

The PhoneMeter works by maintaining a list of as many as 150 telephone numbers, each with an associated per-minute cost. A default rate allows you to estimate the cost of calls to non-listed numbers. Alternatively, the default rate can be set to a value of one to display the time in minutes of each call.

Other features include:

- After the unit is calibrated, all setup is done with the telephone keypad. You'll need a Touch-Tone—not a pulse—phone with this project.
- You can disable and reset the phone cost summing function as desired.
- You can increase or decrease all rates by a specific value (measured in cents).
- Per-minute cost varies according to the telephone rate schedule. Calls between 8 AM and 5 PM Monday through Fri-

day are charged the full rate. After 5 PM, calls are discounted 30%, and after 11 PM, 50%. Calls are also discounted 50% on weekends. Of course, you can adjust those values to match the values charged by your local phone company.

The PhoneMeter begins timing from the moment the call begins ringing on the receiving end. The display is updated on a one-minute basis: charges are not displayed for calls shorter than one minute.

Dual-tone multiple frequency (DTMF) decoders in conjunction with an 8085A microprocessor provide the required "smarts." Setup and calibration are simple, and although there isn't room to print it here, complete assembly-language source code is available from the Gernsback BBS (516-293-2283, v.32, v.42bis); look for file PHONMET.ZIP. The file also contains an object-code file suitable for most EPROM programmers.

How to use it

PhoneMeter has three modes of operation: normal, function, and data. Normal mode displays time and ongoing call charges. Function mode allows you to enter times and default values. Data mode allows you to enter telephone number and rate data. Enter data mode by pressing the asterisk key ("*"), and enter function mode by pressing the pound key ("#").

On entering function mode, the display reads "000." To aid data entry, the display always shows the last digit entered in the right position, and the total number of keys pressed in the left two positions. Enter time in a 24-hour format, most-significant digit first, and include leading zeros. Table 1 lists the available functions.

On entering data mode, the display reads "E000." To aid data entry, the display always shows the last digit entered in the right position, and the total number of keys pressed in the left two positons.

Enter each phone number as you would dial it. After entering the complete telephone number, press the pound key, then enter the two-digit base rate associated with that number, using a leading zero, if necessary. After the two cost digits have been entered, the display shows "E000" to indicate that the

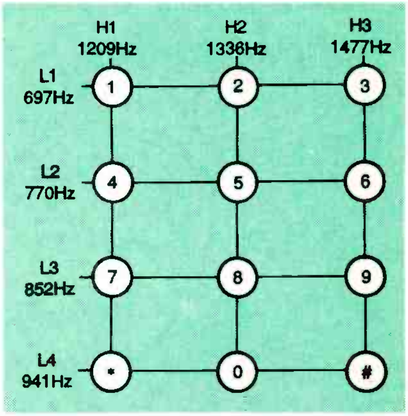


FIG. 1—STANDARD TELEPHONE keypad: A connection at any junction produces the two tones associated with the corresponding row and column.

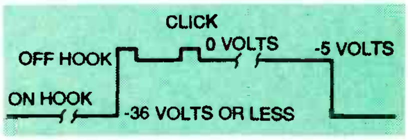


FIG. 2—STANDARD TELEPHONE voltages: When on-hook, voltage is at least −36 volts. When it is off-hook, voltage rises to about −5 volts. The "click" is caused by a temporary transition to 0 volts when the phone initially goes off-hook.

TABLE 1—SETUP FUNCTIONS

Key	Function	Description	Example
#0	Disable cost monitoring function	Meter functions only as a clock and alarm	
#1	Enable cost display	Meter displays time and cost information	
#2	Enter current time and day	Time in 24 hour format, including leading zeros if necessary. Day numbering: Mon=1, Tue=2, Wed=3, Thur=4, Fri=5, Sat=6, Sun=7	For Wednesday, 9:14 AM, enter 09143
#3	Set alarm time	Time in 24 hour format, including leading zeros if necessary	For 9:34 PM, enter 2134; for 8:56 AM, enter 0856
#4	Display alarm time	Display alarm time in 24 hour format as long as "4" key is pressed	
#5	Enter default cost	Cost per minute, two digits	For 6 cents, enter 06; for 19 cents, enter 19
#6	Increase all rates	Increase or decrease the cost of all telephone numbers by the specified amount. Enter two digits including leading zeros if necessary. Default rate not affected. Decrease by entering tens complement	To increase all rates by 5 cents, enter 05. To decrease all rates by 5 cents, enter 95 (100+mi5)
#7	Reset database	Erase all phone numbers in memory	

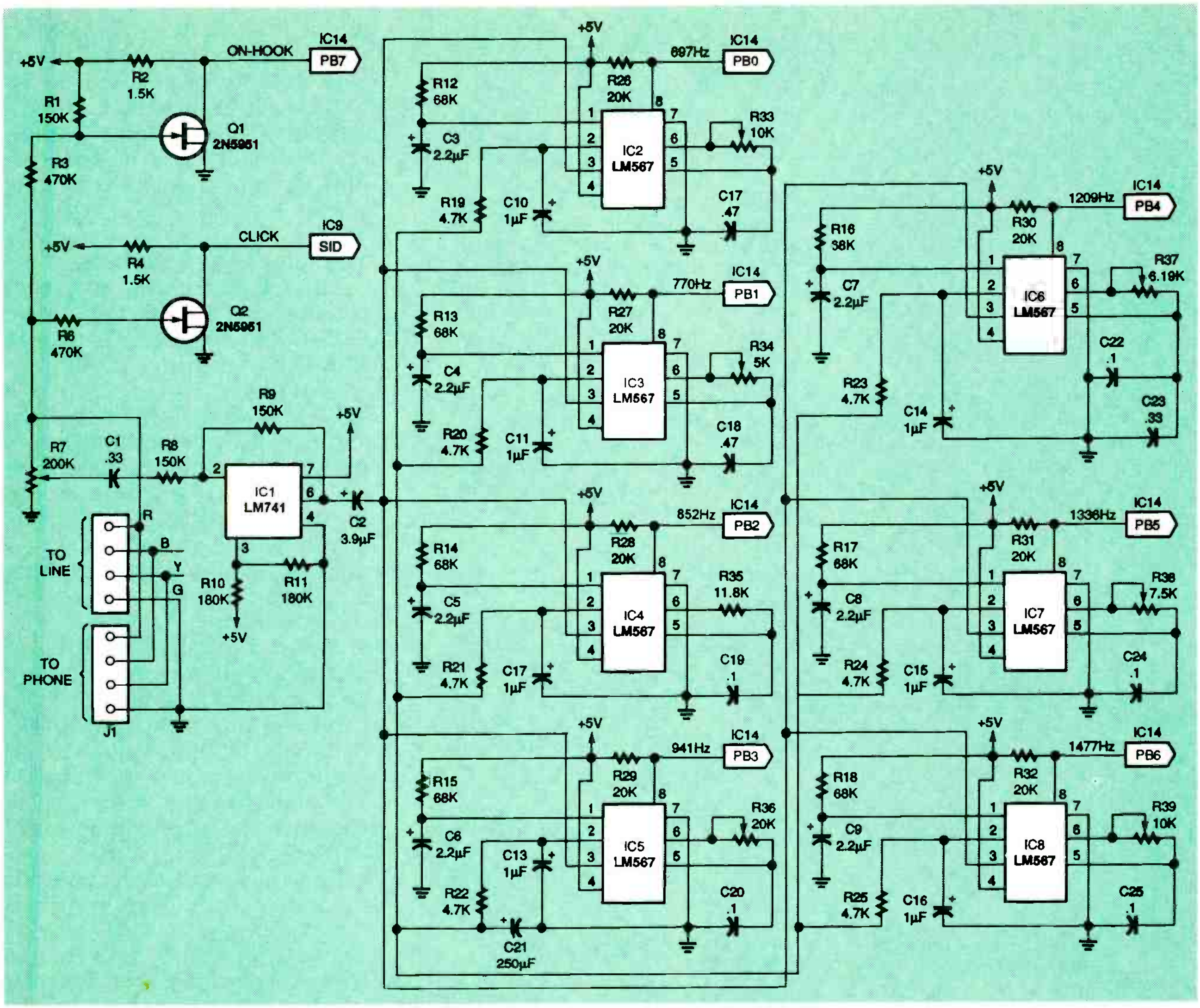


FIG. 3—AN OP-AMP BUFFERS THE INCOMING SIGNAL for decoding by the seven DTMF decoders. Junction FETs Q1 and Q2 provide on-hook and click detection, respectively. The outputs of all the DTMF decoders drive Port B of an 8255 programmable peripheral interface IC.

meter is ready for the next number. You do not have to press the asterisk key to enter another number. For example, to set a six-cent base rate for (212) 123-4567 the complete data entry sequence would be "*12121234567#06." If you make a mistake while entering a telephone number, press the asterisk key to start over. Once data has been entered into the PhoneMeter, it remains in memory until it is cleared by Function 7.

How it works

To understand how the PhoneMeter works, it's necessary to review some background on telephone line operation.

A standard phone cable has four wires: red, green, black, and yellow. Voice communication occurs on the red and green wires, yellow is for the ringer, and black is the common connection. The phone meter uses only the red and green wires, with the green wire connected to circuit ground.

Modern telephones use a dual tone multiple-frequency signaling scheme to generate unique frequency-pair combinations for each element of a 4×3 array of keys, as shown in Fig. 1. Whenever a key is pressed, the DTMF circuitry generates the pair of tones represented by the row and column headings of that element of the matrix. For example, pressing the "4" key causes 770- and 1209-Hz tones to be generated.

Now consider the signaling voltages. When the phone is on-hook (not in use), the voltage on the red wire is −36 volts or less. When the phone is off-hook (in use), that value drops to about −5 volts. The click heard when the phone initially goes off-hook occurs because of a momentary 0-volt signal, as shown in Fig. 2.

Voice-signal amplitude varies in proportion to sound strength. It can reach 4 volts peak-to-peak when someone yells into the phone. Synthesized DTMF tones typically have values of approximately 4 volts p-p.

With that background in mind, look at the circuit. First look at the analog portion of the circuit, which includes the tele-

SOFTWARE

There is insufficient space to print the entire 8085A assembly-language source code, so a brief overview of the software will be provided. It consists of a start-up process, a main program loop, an interrupt-service routine for handling the real-time clock, various utility functions, and variables. Table 3 describes key variables, and Table 4 describes major subroutines.

Program Initialization. At power-up, the microprocessor begins execution at address 0000. That address contains a jump to the initialization routine, which sets up the stack (at RAM address 47FFH), enables interrupt 5.5 (for the real-time clock), and performs other initialization chores.

Real-time Clock Interrupt. The multivibrator circuit generates a 70-µs pulse at a 60-Hz rate. Each pulse triggers the microprocessor's RST 5.5 interrupt, which in turn calls the clock routine. The clock increments a set of time-keeping counters (seconds, minutes, hour, day).

Main Loop. The main program loop displays present time and checks whether the alarm should be turned on or off. It then checks to see whether the phone is on- or off-hook. If the phone is off-hook, the program then determines whether a key has been pressed. If the "#" or "*" keys were pressed, the software jumps to the appropriate function code loop. If the phone remains off-hook for 60 seconds and no function keys are pressed, the program goes into the charge recording mode, in which rates are summed, discounts applied, and the results displayed. Ω

TABLE 3—KEY PROGRAM VARIABLES

Name	Description
ALARMIN AND ALARHR	Alarm time setting.
COUNT	Tracks number of keys pressed during current function.
COUNT—SEC	Number of seconds since phone went off hook. If greater than 20, further key receipt inhibited.
COST	Base rate cost associated with current phone number, or default value if not match.
COST—ACCUM	Accumulated by-minute cost of current call.
DATA	Start of telephone number and base rate cost data list.
DATA—END	One byte beyond telephone data.
DAY	Current day of week (Monday=0, Tuesday=1, ...Sunday=6)
DATA—AT	Address of current field in DATA.
DEFAULT	Pointer to address that contains default rate, in high, low order.
DIG0–DIG3	Address of current display data.
DISPLAY—SW	If 1, displays ongoing cost; if 0, does not.
HOUR	Current hour.
INITSEC AND INITMIN	Time of most recent key press.
KDIG0–KDIG12	Keypad buffer.
KEY	Last key pressed. Contains 88H If decode error. 7FH if no key pressed and phone off-hook, or FFH if phone on-hook.
MIN	Current minute.
SEC	Current second.
SIXSEC	Counts 1/60 second interrupts from real-time clock.

TABLE 4—MAJOR SUBROUTINES

Name	Description
COLONOFF	Turns colon by writing 1 to bit 0 of Port C.
COLONON	Turns colon off by writing 0 to but 0 of Port C.
CONNECTED	Inhibits key detection. Called after connect click detected.
COST—OUT	Sums next cost increment into cost-accumulation register.
DISPLY—DE	Displays low-order nibble of E register on digit 3, high-order nibble on digit 2, low-order nibble of the D register on digit 1, and high-order nibble on digit 0.
DISPLAY	Display values stored in DIG0–DIG3.
DIV	Divides BCD value in A register by BCD value in D register. Result goes to E and remainder to B. D is first converted to tens complement. Division then performed by multiple addition of tens complement.
FCDISCD	Disenables display of phone costs.
FCENCD	Enables display of phone costs.
GET—COST	Searches phone data to find match between values in KDIG0–KDIG12. If match, low-order nibbles of next two addresses combined and saved at address specified by COST. If no match, address DEFAULT saved at address specified by COST.
GET—KEY	Buffers keypresses into phone keyboard buffer.
INIT	Configures 8255 to make ports A and C outputs, port B input. Initializes data and display.
KEYSAV	Saves each key in key buffer, displays last key entered in display digit 3, displays keystroke count in digits 0 and 1.
PHLBL2A	Determines cost of next minute, adds to current cost, displays.
PMOFF	Turns PM indicator off.
PMON	Turns PM indicator on.
WAITKEY	Calls GET—KEY until phone is off-hook and no key is pressed.
ZERO—DISPLAY	Loads zeros in DIG0–DIG3.
ZERO—KDIG	Loads zeros in KDIG0–KDIG12.

phone-line interface, DTMF-decoding, and phone-state detection (on-hook, off-hook, or "clicking"). Then look at the digital side, including the basic microprocessor circuit, the display driver, and the real-time clock.

The telephone interface

The telephone-line interface consists of a 741 op-amp, seven LM567 tone decoders, and two 2N5951 N-channel JFETs, as shown in Fig. 3.

The op-amp buffers the line signal to provide optimal amplitude to the tone decoders. The op-amp's input and output both are AC coupled. The op-amp has a gain of one; potentiometer R7 adjusts the input signal so that a 1.75-volt p-p signal drives the tone decoders.

Obtaining class A output (an unclipped signal) from the op-amp requires biasing the non-inverting input of the amplifier to 2.5 volts, midway between the +5-volt supply and ground. The bias voltage is generated by the voltage divider consisting of R10 and R11.

Each tone decoder responds to one of the seven required DTMF signals (H1–H3, L1–L4). The output of a given tone decoder goes to logic low whenever it detects the presence of the desired frequency. That frequency depends on the value of the resistor connected between pins 5 and 6 of the IC, and on the capacitor connected between pin 6 and ground. The center frequency of the tone decoder is determined by the frequency equation:

$$F_O \approx 1/(1.1\ RC)$$

For some frequencies, fixed RC combinations give the desired results. The generation of other tones such as 697, 770, 941, and 1477 Hz, requires variable resistors.

The JFETs provide on-hook and click detection. When the phone is on-hook, the red-wire voltage varies from −36 to −50 volts. On-hook detection requires that the gate of Q1 be biased to +5 volts. That is accomplished via 150-kilohm resistor R1. The biasing arrangement lets the JFET begin conducting when the red-wire voltage is greater than −9 volts (i.e., between −9 and 0 volts).

Click detection is accomplished in a similar manner, except that the JFET (Q2) has no positive bias, so it does not begin conducting until voltage approaches 0. The −5-volt level that is present when the phone is off-hook suffices to keep the JFET off. The click detection output drives the serial input data (SID) input of the 8085A. The serial input data input functions as a one-bit port on the microprocessor.

Microprocessor and company

The "brain" of the project consists of an Intel 8085A microprocessor, 2 kilobytes of 8-bit RAM, an 8-kilobyte EPROM, an address latch, and a 4-to-10 line decoder, as shown in Fig. 4. One unusual feature of the circuit is that part of what is normally RAM address space, rather than the separate I/O space, is used for addressing its I/O devices. This permits the use of non-Intel bus-compatible peripherals.

The microprocessor runs at a clock rate of about 1 MHz, as supplied by a 20 pF capacitor (C26) and a 10-kilohm resistor (R40). Crystal control is not required because the 60-Hz AC power line provides suitable accuracy for time-keeping.

The 8085A multiplexes the data bus with the low-order address lines. Hence IC10 latches the low-order address lines for addressing RAM and ROM. Latching occurs when the microprocessor's address latch enable (ALE) line goes high. At that point, the low-order address lines are available at the outputs of IC10.

The 74LS42 (IC11) decodes the upper nibble of the address bus to provide 10 unique 4-kilobyte regions of address space; of those the circuit uses three. The EPROM begins at address 0000H, the 8255 programmable peripheral interface (PPI) discussed next begins at 2000H, and the RAM begins at 4000H. Because the address space is not fully decoded, only half the EPROM is accessible, half the RAM's address block is wasted, and the PPI uses only four of the 4096 available slots. The circuit has no need for additional address space.

I/O control

When the microprocessor accesses memory addresses 2000–2003H, it is addressing the 8255 PPI, as shown in Fig. 5. The PPI has three eight-bit ports, A, B, and C, which are addressed at 2000–2002H, respectively. Location 2003H is the PPI's control register; it determines the operating modes of the three ports.

Port A provides address and

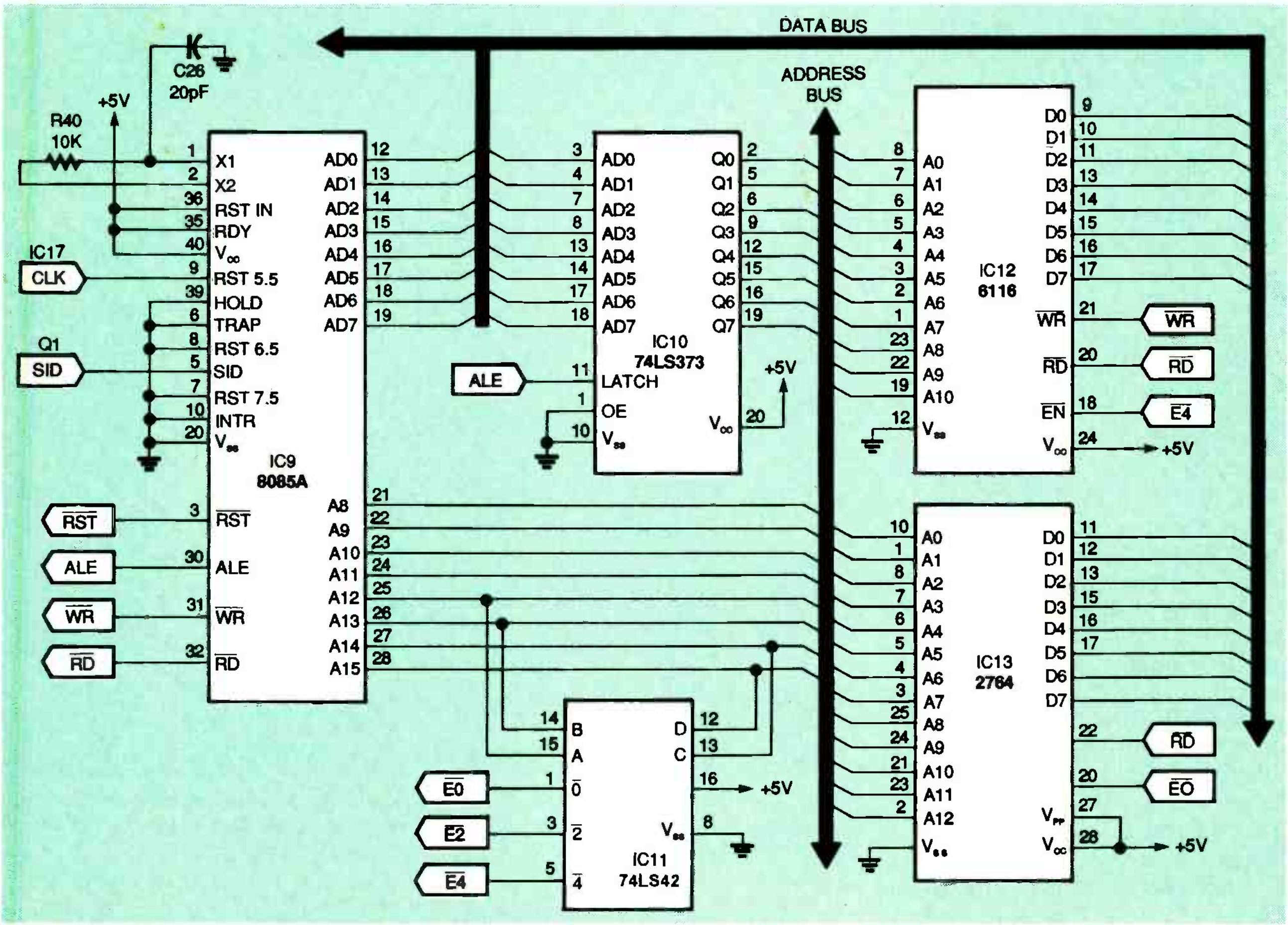


FIG. 4—THE MICROPROCESSOR AND MEMORY INTERFACE appears here. Decoder IC11 breaks the address space down into ten 4-kilobyte blocks; in this circuit, the 8255 is memory-mapped.

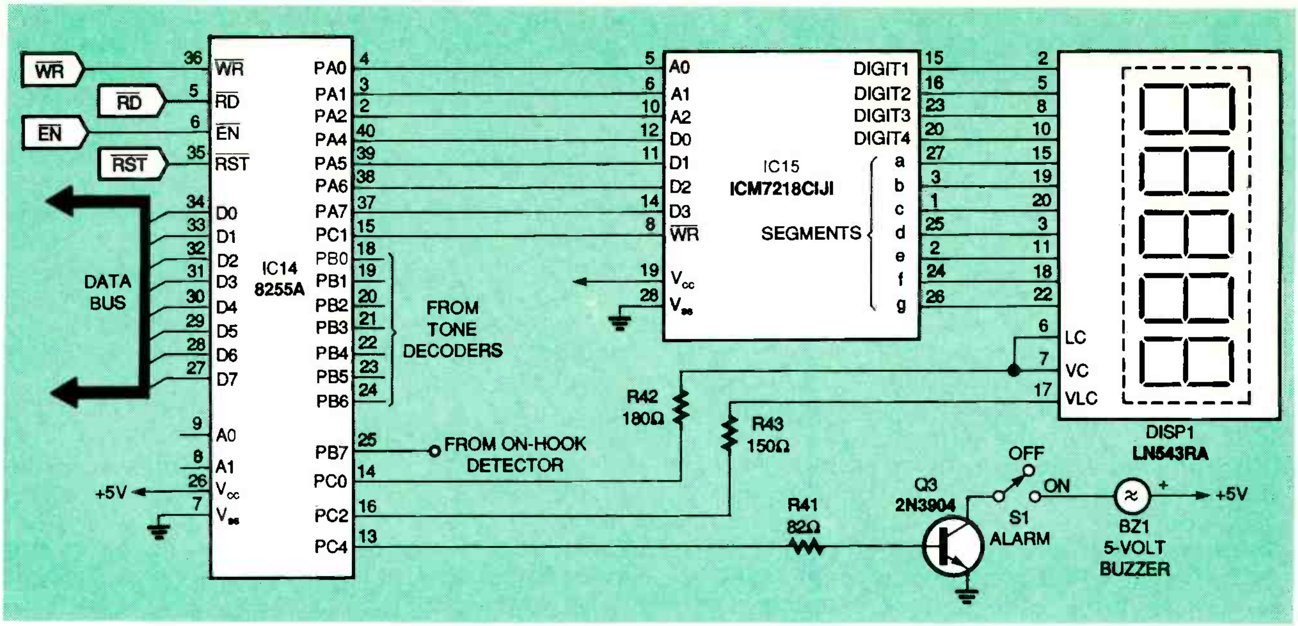


FIG. 5—THE 8255 PPI drives the LED driver via Port A, reads the decoder outputs via Port B, and uses several lines of Port C to control the display, the alarm, and the display controller.

TABLE 2—8255 PPI ADDRESSING

Binary	Hex	Bit Addressed	Value	Function
0000 0001	00	0	1	Turn on colon
0000 0010	02	1	0	Write data to ICM7812
0000 0011	03	2	1	Turn PM indicator on
0000 1001	09	4	1	Turn alarm on

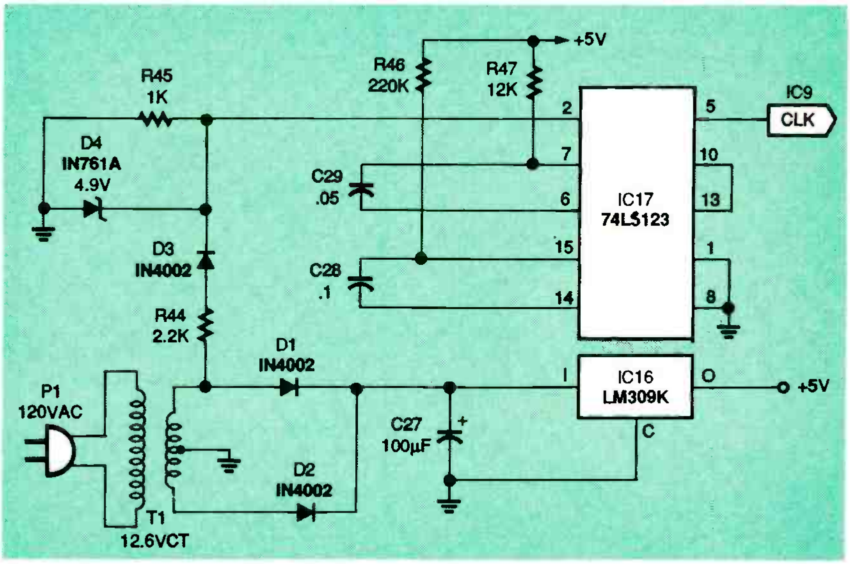


FIG. 6—POWER SUPPLY AND CLOCK CIRCUIT: IC17 is a dual monostable multivibrator that pulses 60 times per second. That clock signal drives the microprocessors RST 5.5 input.

data information for LED decoder/driver IC15. Three address bits allow each of the four LED digits to be addressed separately. The PPI provides those three bits via the low three bits of Port A. The four high bits of Port A provide the values that the LED digits display.

Port B accepts the inputs from the analog circuitry. The seven tone decoders drive bits 0–6 of port B; the on-hook detector (Q1) drives bit 7. When the phone is on-hook, all Port B inputs are high.

By setting bit 7 of the command register (address 2003H) to 0, each bit of port C can be individually set or reset. One bit of Port C provides the write function that latches data into LED driver (IC15). Several other bits control auxiliary display functions and the alarm driver (Q3). Table 2 shows several sample values and the corresponding actions taken by the circuit.

The LED display is a four-digit, common-anode type, with colon and PM indicator. The display driver interprets digits numbered 0 to 3 from left to right.

The last section of hardware that will be discussed is the real-time clock. The clock circuit appears in Fig. 6, along with the power supply via a clipping network, the 60-Hz power line drives a pair of 74123 monostable multivibrators arranged to generate a 70-microsecond pulse. That pulse, in turn, directly feeds a hardware interrupt (RST 5.5) that is on the microprocessor.

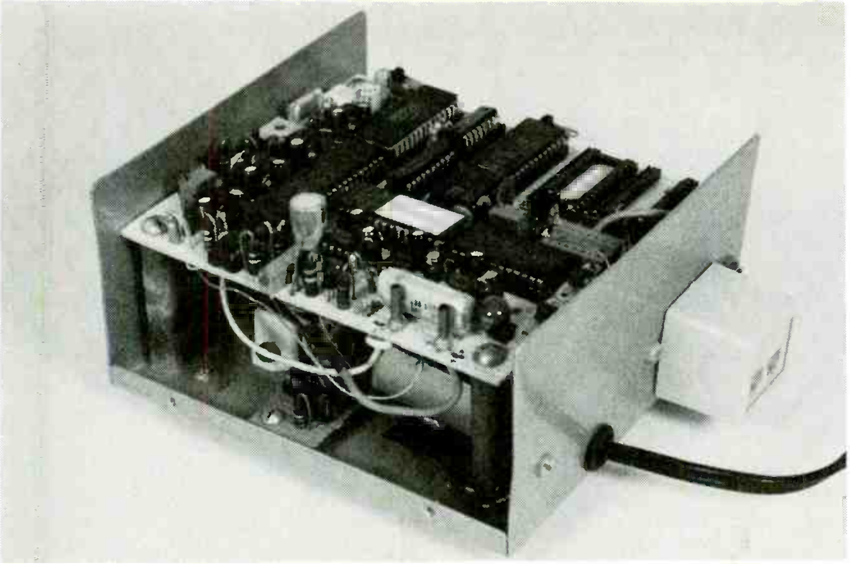


FIG. 7—THE AUTHOR'S PROTOTYPE fit in a case measuring approximately 5.5 × 5.125 × 2.875 inches.

PARTS LIST

All resistors are $\frac{1}{4}$-watt, 5%, unless otherwise noted.
R1—150,000 ohms
R2, R4—1500 ohms
R3, R6—470,000 ohms
R5—not used
R7—200,000 ohms, potentiometer
R8, R9—150,000 ohms
R10, R11—180,000 ohms
R12–R18—68,000 ohms
R19–R25—4700 ohms
R26–R32—20,000 ohms
R33, R39—10,000 ohms, potentiometer
R34—5000 ohms, potentiometer
R35—11,800 ohms
R36—20,000 ohms, potentiometer
R37—6190 ohms
R38—7500 ohms
R40—10,000 ohms
R41—82 ohms
R42—180 ohms
R43—150 ohms
R44—2200 ohms
R45—1000 ohms
R46—220,000 ohms
R47—12,000 ohms

Capacitors
C1—0.33 µF, 50 volts, mylar
C2—3.9 µF, 16 volts, electrolytic
C3–C9—2.2 µF, 16 volts, electrolytic
C10–C16—1 µF, 16 volts, electrolytic
C17, C18—0.47 µF, mylar
C19, C20, C22, C24, C25, C28—0.1 µF, mylar
C21—250 µF, 16 volts, electrolytic
C23—0.33 µF, mylar
C26—20 pF, disk, ceramic
C27—1000 µF, 16 volts, electrolytic
C29—0.05 µF, mylar

Semiconductors
IC1—LM741 op-amp
IC2–IC8—LM567 DTMF decoder, National Semiconductor or equiv.
IC9—8085A microprocessor, Intel or equiv.
IC10—74LS373 Octal D latch
IC11—74LS42 BCD to decimal decoder
IC12—6116 2K static RAM, Hitachi or equiv.
IC13—2764 8K EPROM, Intel or equiv.
IC14—8255A programmable peripheral interface, Intel or equiv.
IC15—ICM7218CIJI LED display driver, Harris or equiv.
IC16—LM309K 5-volt regulator, TO-3 case, National Semiconductor or equiv.
IC17—74LS123 dual retriggerable monostable multivibrator
DISP1—LN543RA multiplexed 4-digit LED display, Matsushita or equiv.
D1–D3—1N4002 50-volt rectifier diode
D4—1N761A 4.9-volt Zener diode
Q1, Q2—2N5951 JFET
Q3—2N3904 NPN transistor (or equivalent)

Other components
BZ1—Buzzer (5-volt DC)
J1—Dual RJ11 telephone jack
P1—117 VAC plug with cord
S1—SPST toggle switch
T1—12.6 volt center tapped transformer
Miscellaneous: Case, display bezel, circuit board, mounting hardware, IC sockets, etc.

Construction and setup

The author wired the prototype point-to-point, as shown in Fig. 7. A 4.5 × 5-inch piece of perforated construction board was big enough to mount most of the electronics. In the photo you can see several empty IC sockets. During development, those held a UART (universal asynchronous receiver transmitter), a baud-rate generator, and a direct memory access port (DMA), to download test programs into RAM.

Several other components are not mounted on the main board. The exceptions include the LED display, the alarm buzzer, a duplex phone jack, the power transformer, the voltage regulator, the power supply and time-base circuit. The author built the time-based circuit on a separate piece of perforated circuit board.

All components fit into a small "U"-shaped aluminum case measuring 5-$\frac{1}{8}$ × 5$\frac{1}{2}$ × 2$\frac{7}{8}$ inches. The author mounted the power supply board, the LM309, and the alarm to the base of the case. The alarm switch, phone jack, and transformer are mounted on the rear, and the LED display on the front wall of the case. Three 1$\frac{7}{8}$-inch high standoffs hold the perforated board above the case-mounted components.

When building the circuit, observe all device polarities, and try not to form any solder bridges or open-circuits.

Setup calls for tuning the four tone decoders (IC2, IC3, IC5, and IC8), and verifying that each responds to the correct telephone keys. A convenient method of tuning the decoders is to dial your own number. During the busy signal, you can freely press keys and measure outputs without inadvertently dialing an undesired number.

Tune each of the variable tone decoders by pressing the corresponding telephone key and varying the associated potentiometer while monitoring pin 8 of the tone-decoder IC. The voltage at that pin will drop to zero when the keypad signal matches the tuned frequency.

After tuning all adjustable decoders, as a precaution, go back and monitor the output of each decoder while sequentially pressing all telephone keys. Be sure that output goes to logic low only when the associated key is pressed. There should be no spurious oscillation. The decoders are very sensitive to small changes in tuning resistance, but after correct adjustment, they remain stable. Ω

VOLTAGE CONVERTERS

continued from page 50

ages above 5.5 volts for extended periods.

5. When installing polarized capacitors, connect the positive lead of the capacitor to the CAP + pin 2 and the negative lead to the CAP – pin 4 of the ICL7660. Connect the positive terminal of capacitors to V_{OUT} pin 5 to ground.

6. Be sure that pin 5 does not swing more positive than GND pin 3 to prevent latchup

7. If the supply voltage is greater than 6.5 volts, put a protective diode in series with pin 5.

Practical ICL7660 Circuits.

The most popular application for the ICL7660 is as a negative voltage converter. Figures 11, 12, and 13 are three basic negative converter circuits. In each circuit, capacitors C1 and C2 are *multiplier* capacitors with a value of 10 microfarads.

The negative voltage converter circuit in Fig. 11 is designed to be powered from a 1.5- to 3.5-volt supply, and it requires only two external electrolytic capacitors, C1 and C2. The circuit in Fig. 12 is similar, but it is designed to be powered in the 3.5- to 6.5-volt range and its LV pin 6 grounded.

The negative voltage converter circuit in Fig. 13 is designed for a 6.5- to 10-volt supply. Diode D1 is in series with $+V_{OUT}$ pin 5 to protect the IC from excessive reverse biasing by C2 when the power supply is removed. Diode D1, which should be a Schottky diode, reduces the available output voltage by V_{fd}.

Up to ten cascading ICL7660s will give increased output voltage. For example, if three ICs are cascaded, their final output voltage will be -3 volts. Figure 14 shows how to make the connections for cascading two of these stages. Connect all additional stages in the same way as shown in the schematic.

Output frequency change

In some applications there might be a reason for reducing the operating frequency of the IC's RC oscillator. This can be done by inserting an external oscillator capacitor C_{OSC} between OSC pin 7 and +V pin 8, as shown in Fig. 15.

The relationship between the value of C_{OSC} in picofarads and the oscillator frequency f_{OSC} is shown in Fig. 16. For example, a C_{OSC} of 100 pF reduces the operating frequency by a factor of ten, from 10 kHz to 1 kHz.

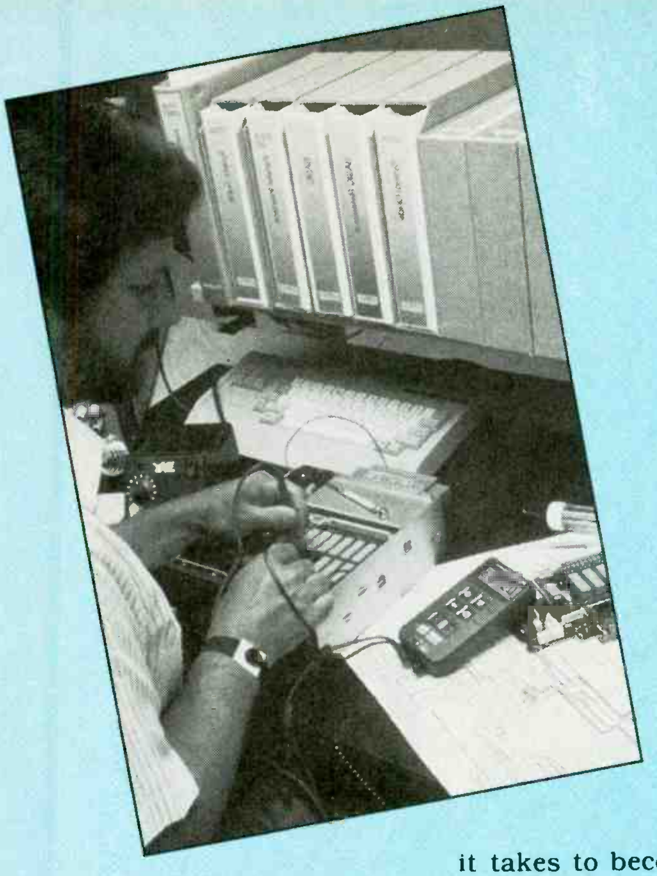
However, it will be necessary to alter the values of capacitors C1 and C2 to compensate for this 10 to 1 reduction of frequency if circuit efficiency is to be kept high. Increase the values of C1 and C2 (both 10 microfarads) by the inverse of the reduction function. For example, if the oscillator frequency is to be 1 kHz, both C1 and C2 should have values of about 100 microfarads.

Oscillator frequency can also be reduced by connecting OSC pin 7 as shown in Fig. 17 so that an external clock input overdrives the internal oscillator. Feed the clock signal to pin 7 through 1-kilohm series resistor R1. The clock signal should switch fully between the two power supply values. The CMOS NAND gate is connected as an inverting buffer stage to ensure reliable switching between those values.

The ICL7660 can also be a positive voltage multiplier. It can produce a positive output voltage that is nearly double the initial supply voltage value when set up as shown in Fig. 18. The oscillator output signal at CAP+ pin 2 drives a capacitor-diode voltage-doubler network. It is the same network as the one shown in Fig. 2.

The two diodes, D1 and D2, reduce the available output voltage by an amount equal to their combined forward volt drops. Consequently, both D1 and D2 should be low-loss germanium diodes.

Figure 19 shows how the circuits of Figs. 12, 13, and 18 can be combined to form a positive voltage multiplier and negative voltage converter that provides dual output voltages. Each voltage source has an output impedance of about 100 ohms. Ω



A HIGH-TECH CAREER FOR THE '90s

Your skills as an electronics technician can give you a never-ending source of job opportunities.

RONALD A. REIS

BILL HANSEN COULDN'T HAVE BEEN happier, as well as being surprised. At 28, and only three years out of a two-year technical college in Los Angeles, he had just landed a lucrative electronics technician's position at Advanced Electronics, Inc., winning out over a dozen other candidates. "Why me," he wondered out loud? "Why was I the chosen one?"

John Parry, one of the twelve applicants who didn't make it, was speculating, too. With 18 years of experience as an electronics technician, the last 12 working for Hughes Aircraft Co. as a high-frequency antenna specialist, "Surely I should have had the edge for that job," he mused.

Why had Bill succeeded where John and the other applicants failed? Because, as we shall see later, Bill possessed what it takes to make it as an electronics technician in the 1990s. He had the knowledge, the skills, and, most important, the attitude required for success. Unfortunately, many of "yesterday's" highly specialized electronics technicians do not.

This article will update you on what it means to be—and what it takes to become—a professional electronics technician in the 1990s. Are you a hobbyist or experimenter thinking about parlaying your interest in electronics to the career level? Or perhaps you're a seasoned electronics technician who wants to keep up on how your profession is changing and what you can do to broaden your opportunities?

The times, they are a-changing

Global competition and major transformations in the electronics industry are combining to inject significant change into the career of the electronics technician. Automation, fierce business competition, and corporate downsizing are the principal causes of that change. They make the immediate post World War II era of job stability, predictability, and specialization in all fields seem a dim memory.

At the same time, the electronics industry is seeing enormous increases in the demand for electronic products and services, unparalleled technological innovation resulting in a continuous flood of new hi-tech products, and a downward pricing spiral that makes such products affordable.

Together, these influences are expanding the role of today's electronics technician. At a time when it is often cheaper to replace than to repair electronic products, technicians have seen their activities extend outward from component replacement to systems maintenance. As a consequence of these new challenges, new opportunities are opening up to the astute and enterprising electronics technician who is ready to take charge of his or her career.

Replacement to maintenance

Before electronic products, especially in the consumer field, became relatively inexpensive to produce, and back when their costs were high and their reliability low, technicians spent most of their time repairing equipment. The typical technician would troubleshoot down to the component level. He, and it was almost certainly a he, would spread out a schematic drawing, grab a few instruments (meter, generator, scope), and search for a faulty diode, transistor, or SCR. Once discovered, he would remove the defective component and replace it with a good one.

This is still done today, especially for expensive products. One rarely tosses out a $500 motherboard from a big-screen

TV set. Yet, for some time now, troubleshooting has retreated from component-level to board- and modular-level. This is especially true for field technicians who must get a customer's product up and running as quickly as possible. As a consequence, technicians are required to understand product and process operation at a higher level. The technician must survey the entire operation, be it that of a VCR or a sophisticated industrial control process.

To be sure, today's electronics technician is still likely to fall into one of the traditional 10 subfields shown in Fig. 1. But within a given field, he or she must think at the systems level.

For example, Byron Munoz works as a microcomputer technician for TEAM LA. He is responsible for restoring and installing personal computers in non-profit agencies throughout the city. "When I first got here," he said, "I thought I would be concentrating on what's in the box [computer]. Actually, I've become what is known as a systems analyst. Working with both hardware and software, I must constantly take a systems approach, where I tie everything together. With local area networks and all manner of data communications exploding like crazy, the 'system' keeps getting bigger."

Or, take Norm West, working at the Los Angeles Times Olympic printing plant. "I'm what they call an 'electrotech,' although I was trained many years ago as an electronics technician. Now I'm responsible for maintenance on the complete system, a system that off-loads one-ton rolls of newsprint from railroad boxcars at one end and sends a finished product out as a printed, stuffed, and folded newspaper at the other. I have to keep the entire process (system) in mind all the time."

In the job-subfield wheel in Fig. 1, notice that the spokes unite at a center hub; the various subdivisions in electronics are not islands unto themselves. Increasingly, electronics technicians are crossing into allied fields as they take the systems approach to even higher levels of integration.

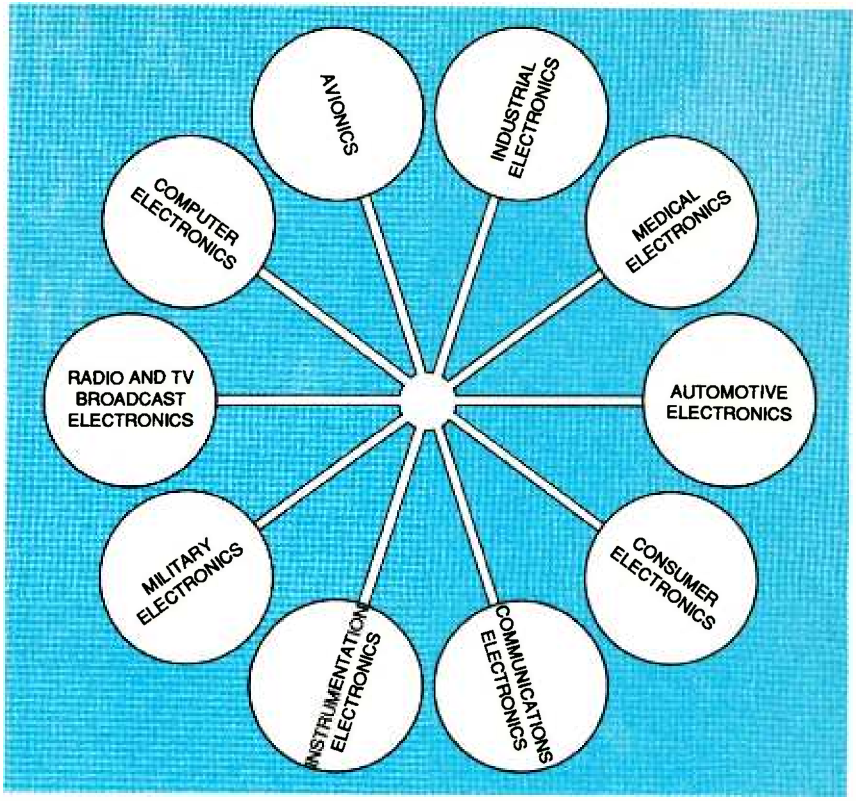


FIG. 1—TODAY'S ELECTRONICS TECHNICIAN is likely to fall into one of the traditional 10 subfields.

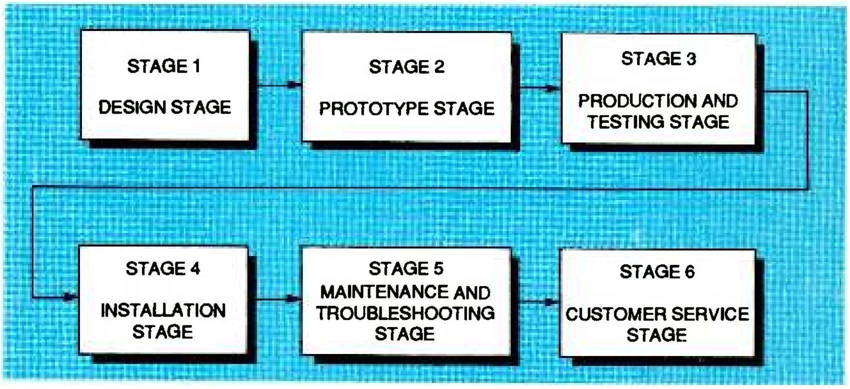


FIG. 2—TECHNICIANS ARE BECOMING MORE INVOLVED in the entire product cycle, beginning with product design and culminating in customer service.

Beyond product repair

Electronics technicians are also becoming more involved in the entire product cycle, beginning with product design and culminating in customer service (see Fig. 2).

True, electronics technicians have always found themselves fabricating engineering prototypes, "tweaking" production lines, and performing product tests (stages 2 and 3). And, of course, their strengths are the installation, maintenance, and troubleshooting of electronic devices and systems (stages 4 and 5). But today, new opportunities are emerging for the technician at the product-design stage, too. You don't have to be a graduate electrical engineer with a B.S.E.E. (bachelor of science in electrical engineering) to do design work. Electronics technicians, with their hands-on product familiarity, can often contribute to circuit modification, packaging, and production facilities layout.

Another design area open to the technician is printed circuit board design and artwork generation. Traditionally, individuals working in this field have been drawn from the drafting profession. However, such designers often lack an in-depth background in electronics. Take an electronics technician, though, and give him or her CAD (computer-aided design) training, and you have what many consider to be the winning combination of skills necessary to design printed circuit boards.

Though design possibilities are opening up for electronics technicians, it is at the end of the product cycle, in customer service, where the greatest opportunities for technicians are rapidly emerging. As anyone in the personal-computer field can tell you, customer service is the fastest growing—and most demanding—part of the business. Customer service isn't just troubleshooting customer problems over the telephone. Specifically, there are growing opportunities for technicians in the three related "T's": technical writing, technical training, and technical sales.

The three T's

Technical writers, who document product repair, operation, and assembly procedures in data sheets, pamphlets, manuals, and even books, are in strong demand—especially for writers with a technical background. Traditionally, technical writers have emerged from the ranks of college English majors. While their writing skills are fine, these individuals often lack the technical savvy that would heighten their effectiveness. "What is desperately needed," according to John Giesler, documentation manager at Transaction Technology Incorporate, in Santa Monica, California, "is a person with a capital T. In other words, someone with strong technical skills first and writing ability second. We'll settle for the lower case w. With enough exposure and encouragement, a good technical writer will surface."

If you have a proclivity for writing, why not consider technical writing as a adjunct to your work as an electronics technician? One way to get started is by freelancing. Just let the word out that you're interested. You'll be surprised at the number of small companies, and even giant corporations, that will give you an assignment. That's exactly how I got started, writing two-sheet assembly manuals for an electronic kit company, part-time.

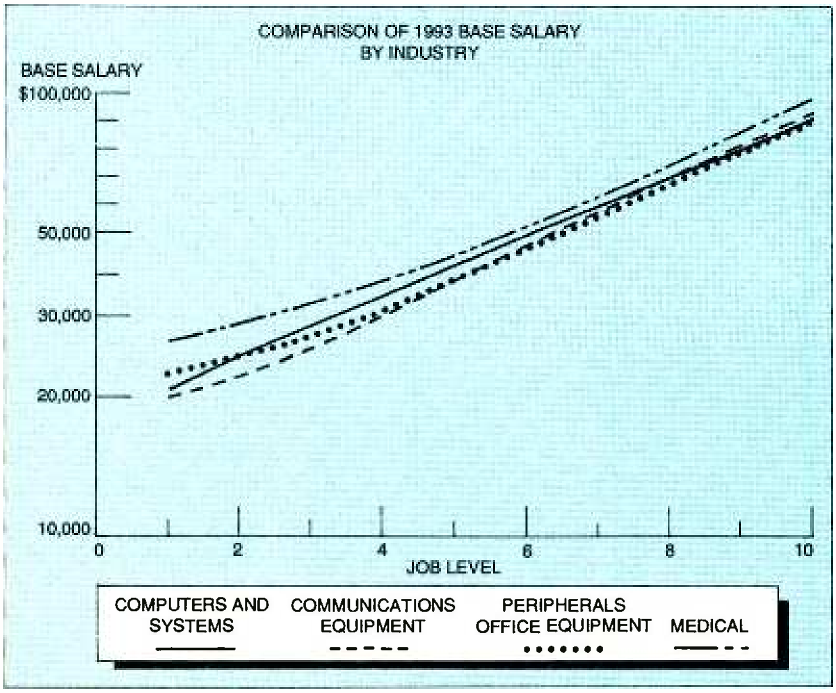


FIG. 3—SALARY COMPENSATION depends on what subfield you're in. Salaries within the medical equipment sector tend to be highest at the lower job levels. Salaries within the communications equipment sector are among the lowest at lower job levels and highest at the higher job levels.

Technical trainers, those that explain to customers the operation and maintenance of electronic equipment, or put on in-house or vendor seminars, are also in high demand. Again, a strong technical background is the first priority. As a technician, you'll already have that. Can you also teach or explain things to others? If you itch to get in front of a class or a company-sponsored training seminar, it's never too late to consider becoming a technical trainer.

To develop the skills necessary to teach, first watch others in action. The next time you are in a college class or are receiving training from a product vendor, observe the instructor's style and techniques closely. To get started yourself, volunteer to tutor other students or take new technicians under your wing. Any direct contact with customers, providing customer support, is invaluable experience. Soon enough you'll be ready to work as a valued technical trainer.

If you are an electronics technician who is often in contact with customers, what you say and do can have a significant impact on company sales. Why not expand such experiences into full-time technical sales? As with technical writing and technical training, the key is to first possess technical expertise. There is no way anyone can sell today's complex electronic equipment by bluffing the technical details. Potential customers won't stand for it. If you're already technically strong and have the personality and drive to sell, here, again, is an allied field that will allow you to go beyond the strictly technical and expand your career opportunities.

To get started, start selling. When out in the field, you might suggest that users purchase various equipment upgrades

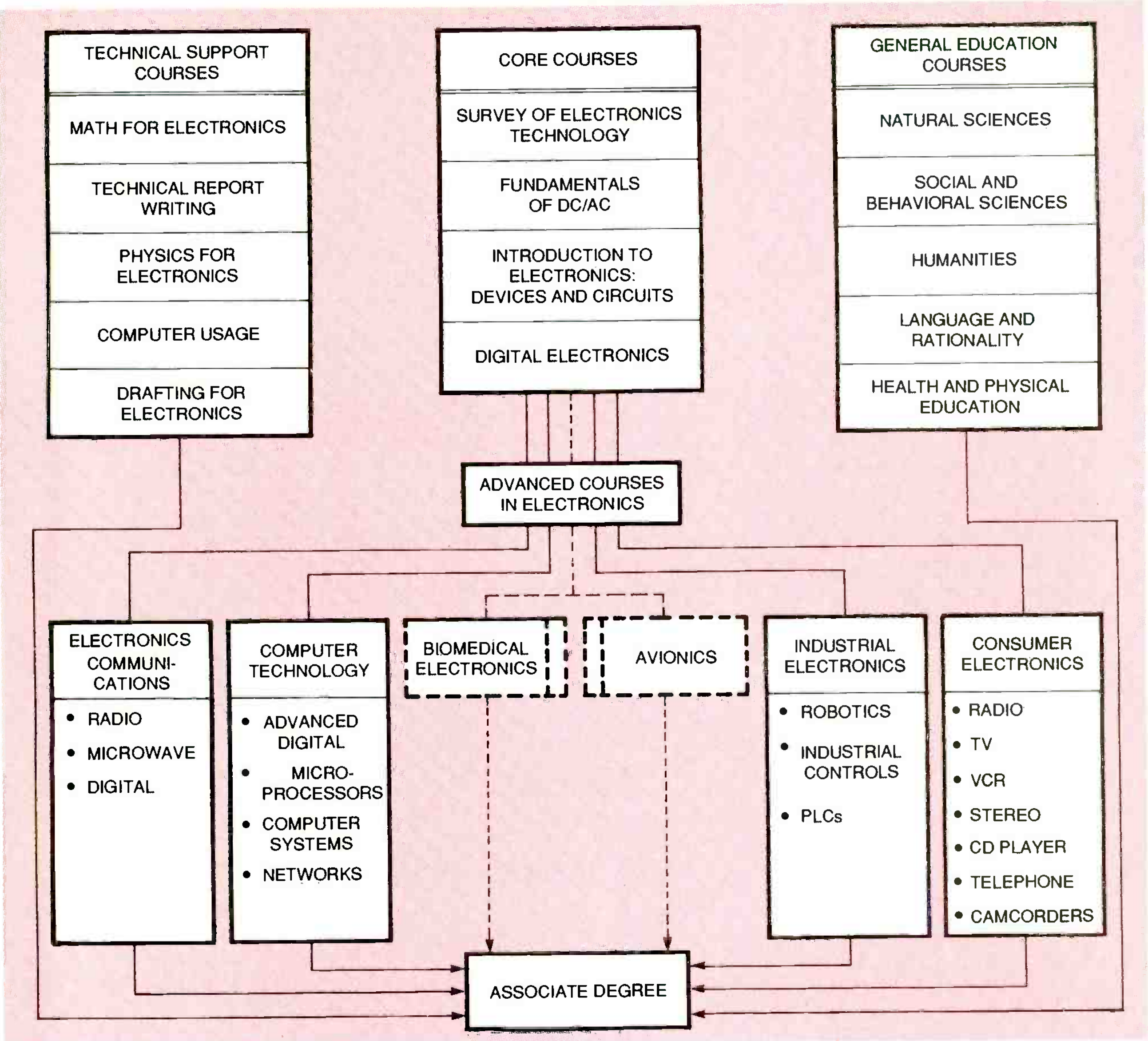


FIG. 4—A TYPICAL ASSOCIATE DEGREE PROGRAM will not only contain core courses in electronics, but technical support and general education courses as well.

your company is offering. If you are successful in convincing them to buy, your boss will notice. Soon you'll have the opportunity to sell all the time.

Demand and compensation

Today's electronics technicians are finding renewed job strength and opportunity by moving from the more narrow focus on product repair to systems maintenance. Furthermore, they are finding openings in allied fields of design and technical writing, training, and sales. But what, in this challenging job market, is the demand for these skilled and knowledgeable individuals? And what kind of salary can they expect to earn?

According to Robert B. Reich, U.S. labor secretary, the demand is strong: "The cause for real optimism," he declared recently, "lies in a trend just emerging from the occupational statistics. Look closely and you'll find a growing demand for technicians—people with the skills to test, repair, upgrade, and sell complex products. The Bureau of Labor Statistics predicts that these jobs will increase 37% from 1990 to 2005."

Of course, with regard to job demand, much depends on where you are located. Things are still pretty tight in Los Angeles, but they are booming in Salt Lake City and Tucson.

What about compensation? As shown in Fig. 3, it depends to some extent on what subfield you're in (see Fig. 1). It also depends on whether you're at the job entry level (for example, field service trainee), or at the higher job levels well beyond that of the traditional electronics technician (director of technical services, for instance). As seen in the graph, salaries within the medical-equipment sector tend to be highest at the lower job levels. Salaries within the communications equipment sector are among the lowest at lower job levels and highest at the higher job levels. The average annual salary for an electronics technician, according to 1990 Department of Labor figures, is $23,028. The minimum is $14,244, while the maximum is $39,180. Figures for 1995 are estimated to be approximately 17% higher in all three categories.

Becoming a 1990's technician

To become an electronics technician you will need formal training and education. While some old timers will tell you they learned everything on the job, today a certificate (not to be confused with certification, which will be discussed shortly) or a two-year associate degree is the recognized "ticket" to an entry-level position.

Certificate programs are offered by correspondence schools, trade, vocational, or technical schools, and many community colleges. They are designed to recognize a student's satisfactory completion of an organized program of vocational study. Certificate programs for technicians can take from a few months to 1 or 2 years to complete, depending upon the course of study and type of institution offering the program.

One problem with certificate programs is that courses required to earn the certificate are almost entirely in the major field of study. This is fine for a short-term, focused program, such as one for CAD expertise or quality assurance testing. In a broader sense, however, certificate programs are inconsistent with the kind of training you'll need to become today's electronics technician. If you choose the certificate route, try to supplement your technical education with various courses in English, psychology, speech, and technical writing.

You won't have to go searching for such courses when seeking a 2-year associate degree, be it at a public community college or proprietary technical institute, such as Cleveland Institute of Electronics, Grantham College of Engineering, ICS Computer training, ITT, and NRI schools. A typical associate degree program will not only contain core courses in electronics, but technical-support and general education courses as well (see Fig. 4).

Your core program usually begins with a survey course designed to get you excited about the field of electronics. From there it's on to the fundamentals of DC and AC circuits, or basic electricity. Then you'll take a course on devices and circuits, or basic electronics. A digital electronics course is also part of most core curriculums.

At some institutions, such as ITT, you will not be able to choose a second year advanced course sequence for specialization. At ITT, every student takes every course, core and advanced. It is a program that produces generalists. At most community colleges, though, some form of specialization is encouraged. As shown in Fig. 4, various subspecialties, paralleling the subfields shown in the wheel of Fig. 1, are offered. Of course, no one institution will offer all subfields. Check your local institution to see what subdisciplines, if any, are emphasized.

As mentioned a moment ago, an array of technical support courses will also be part of any 2-year curriculum. Not only do these courses "support" your work in electronics, they "supplement" it. They will round out your technical training as an electronics technician.

Rounding out your education will be the function of your general education courses. Don't fight against these courses, embrace them. A class or two in language and psychology or in the behavioral sciences will mark you as an educated electronics technician.

FURTHER READING

For a more in-depth discussion of what it means to be and what it takes to become an electronics technician, you might want to pick up a copy of the author's book, *Becoming an Electronics Technician: Securing Your High-Tech Future*, Prentice Hall Publishing, Inc., 445 Hutchinson Ave., Columbus, Ohio 43235. Also contact ISCET, 2708 West Berry St., Ft. Worth, TX 76109, and ETA, 602 N. Jackson St., Greencastle, IN 46135.

Beyond formal education at a technical school or community college, you should consider electronics certification. The purpose of such certification is to distinguish the highly skilled and knowledgeable technicians from those with less experience. Many employers encourage—and some require—their technical employees to be certified.

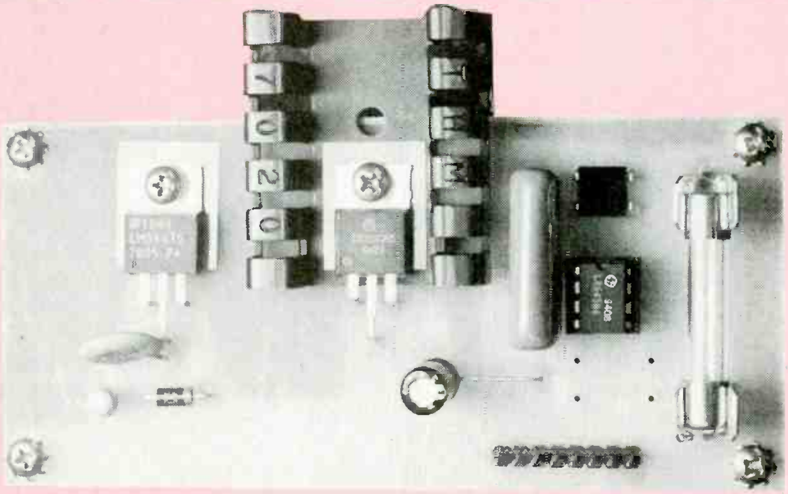
There are a number of private-sector certification organizations, two of which are prominent. Both the International Society of Certified Electronics Technicians (ISCET) and the Electronic Technician Association (ETA) offer certified electronics technician (C.E.T and CET, respectively) certificates. The ISCET even offers two levels of certification: Associate Level and Journeyman Level. The Associate Level is designed for electronics technicians with less than 4 years experience and students studying electronics. Think of what having that Associate Level Certificate as a student would mean on your resume? Bill Hansen did.

Bill's first, entry-level position, straight out of college, was at Micree Corporation, an electronic contract manufacturing firm in Torrance, California. He started as a test technician. But rather than just do "his job," Bill made it a point to investigate what others were doing as well.

At the time, Micree was installing a new surface-mount technology (SMT) production line. Bill let it be known that he wanted to be involved with this new packaging technology. When an opening came up, he jumped at it.

On the SMT line, Bill learned all aspects of SMT production, from PC board inspection to final test. Since Micree assembles boards for clients under contract, Bill found himself interfacing with customers and explaining to them the new technology. Soon he was representing the company at trade shows and conventions. Eventually, Bill even gave seminars on surface-mount technology and wrote a paper on SMT solder-paste applications. Ω

OFF-LINE REGULATORS



These off-line voltage regulators produce adjustable DC outputs of 8 to 12 volts at as much as 100 milliamperes.

J. DANIEL CONNELL

THIS ARTICLE EXPLAINS HOW TO build two lightweight, miniature power supplies. One will provide an adjustable output between 8 and 12 volts DC at as much as 100 milliamperes. The other will provide a precision 5-volt DC output.

Off-line linear voltage regulators permit the regulation of 120-volt, 50/60 Hz AC line voltage down to DC voltage levels suitable for powering logic-level semiconductor circuits that include integrated circuits.

An attractive feature of off-line regulators is that they can be made with a small number of components and they require neither transformers nor large aluminum electrolytic capacitors. They offer long life and occupy only a fraction of the circuit board space required for conventional linear power supplies.

One of the off-line linear regulator circuits discussed here can be built on a circuit board that measures only 4 by 2 inches (8 square inches) and the other can be built on a circuit board with an area of less than 4 square inches. One circuit provides 8 to 12 volts DC and the other provides a precise 5 volts DC. A conventional 5-volt, 100-milliampere linear DC supply typically occupies about 18 square inches of board space.

Linear power supplies occupy larger board areas because they include bulky 50/60-Hz transformers and large aluminum electrolytic capacitors. By eliminating those components, both weight and space can be saved. Moreover, the possibility of damage to the circuit by chemical leakage from large electrolytic capacitors has been eliminated.

If the proper safety precautions about isolation from the 120-volt AC line are observed, off-line power supplies can be economical and space- and weight-saving power sources, and might be perfect for your next circuit design.

LR6 linear regulators

The key components in the off-line regulator supplies explained in this article are monolithic members of the LR6 family of high-input voltage, low-output current linear regulators from Supertex. One version is a three-terminal, fixed output device that can be purchased in TO-92 plastic, TO-220 plastic, or SOT-89 plastic packages. Adjustable voltage versions of these regulators are available in eight-pin plastic DIP and small-outline IC (SOIC) packages.

The three-terminal fixed regulators permit input voltages up to 450 volts AC, and they have fixed 10-volt DC outputs. The adjustable voltage regulators in eight-pin DIPs have outputs that can be trimmed over the range of 8 to 12 volts DC. Moreover, their output current can be increased with an external depletion-mode MOSFET.

The circuits in this article are based on two versions of the LR6 regulator—LR645N4 and LR645N3. The LR645N4, an adjustable eight-pin DIP, was selected for its higher power rating and ability to control higher current than some of the other LR6 devices. The LR645N3, in a TO-92 package, serves as a preregulator stage in the second circuit that will be discussed here, a precision voltage source. Table 1 summarizes

TABLE 1
LEADING FEATURES OF REGULATOR CIRCUITS

Characteristic	Values	Units
Input voltages	15 to 450	volts DC
Outputs current (1)	to 150	milliamperes
Supply current	50 (Typical)	microamperes
Line regulation (2)	0.1	millivolts per volt
Ripple rejection	60 (Typical)	decibels (dB)
Output trim range	8 to 12	volts DC
(1) With external FET installed		
(2) On adjustable type		

the leading features of LR6 regulators.

LR6 applications

Off-line linear regulator circuits are suitable for many different applications. Some examples of them are:

- Low- to moderate-power off-line DC regulation.
- Regulators for noisy inputs.
- Proximity-controlled switches and alarms.
- Start-up circuits in switch-mode power supplies (SMPS).
- Power supplies for double-insulated products such as consumer entertainment products or power tools.

How the LR6 works

Figure 1 is a functional diagram for all LR6 series linear regulator ICs. They all include a comparator to control a field-effect transistor (FET). Input voltage is applied directly to the FET. A reference voltage is set by the Zener diode and it's associated resistor. The Zener voltage is applied to the noninverting terminal of the device's internal comparator.

Another voltage, derived from the ratio of the two internal trim resistors, is applied to the inverting terminal of the internal operational amplifier. The noninverting terminal always has the same potential, regardless of input or output voltage. Because the voltage at the inverting input will change in proportion to the source applied, the output of the comparator will swing between the input voltage (V_{IN}) and ground.

That output then commands the FET to supply more or less current, causing the variation in the output voltage (V_{OUT}).

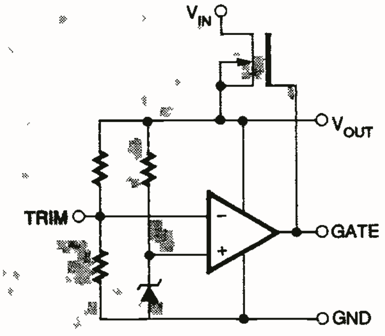


FIG. 1—FUNCTIONAL DIAGRAM for LR6 series voltage regulators

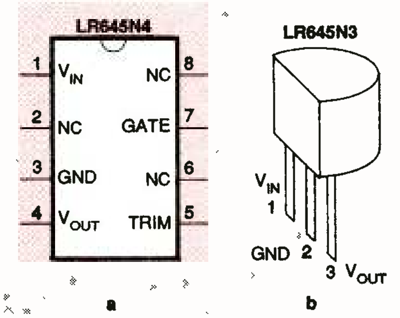


FIG. 2—PIN FUNCTIONS of LR6-family voltage regulators.

This change in output voltage repeats the process, and the result is a regulated voltage.

Adjustable supply

The ability to trim the output voltage of some LR6 linear regulators is useful for powering circuits or devices with unusual voltage requirements. By connecting a pair of selected resistors between V_{OUT}, TRIM, and the GROUND pins of the LR6, any voltage between 8 and 12 volts DC can be obtained at the output terminals.

Figure 3 is a graph of typical output-voltage vs. resistor ratio. The ratio of the resistors determines the output voltage. The best value for R1 plus R2 is 250 kilohms, although the data sheet allows values between 200 and 300 kilohms. The 250-kilohm value minimizes loading, permitting the circuit to provide more accurate output voltage. The power supplies described here do not have trimmed input, although they could be trimmed.

After building an off-line regulator, you might want to modify it to include a trimmed input. (The printed circuit board shown in this article has provision for mounting resistors R1 and R2.) Figure 4 shows a typical adjustable voltage circuit.

Warning: *There is no AC isolation at the final 5-volt DC regulated outputs of the circuits described here. Potentially lethal voltages are present on off-line regulators when they are operated from 120-volt, 50/60-Hz line voltage.*

Provide adequate protection from line voltage when adjusting the regulator for powering a device. A discussion of how to provide adequate protection when working on or with off-line voltage regulators is beyond the scope of this article and is the responsibility of the builder/user.

It is strongly recommended that the builder/user become familiar with safe AC isolation practices and the principles of *double-insulated electrically-powered* devices, circuits, and appliances.

Devices or appliances with double-insulation will have a metal chassis or frame connected to an electrical ground installed in an insulating plastic enclosure that has no ex-

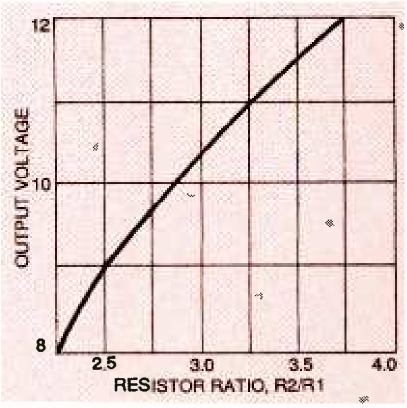


FIG. 3—RESISTOR RATIO chart for trim settings

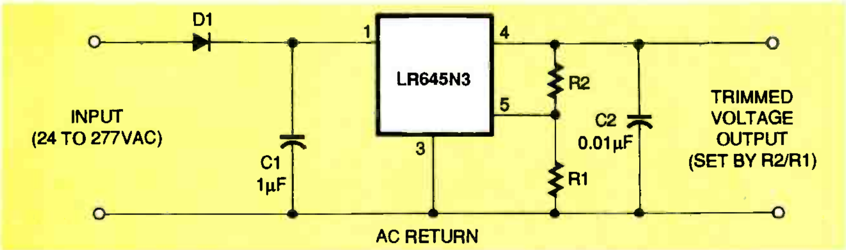


FIG. 4—TRIM VOLTAGE example circuit

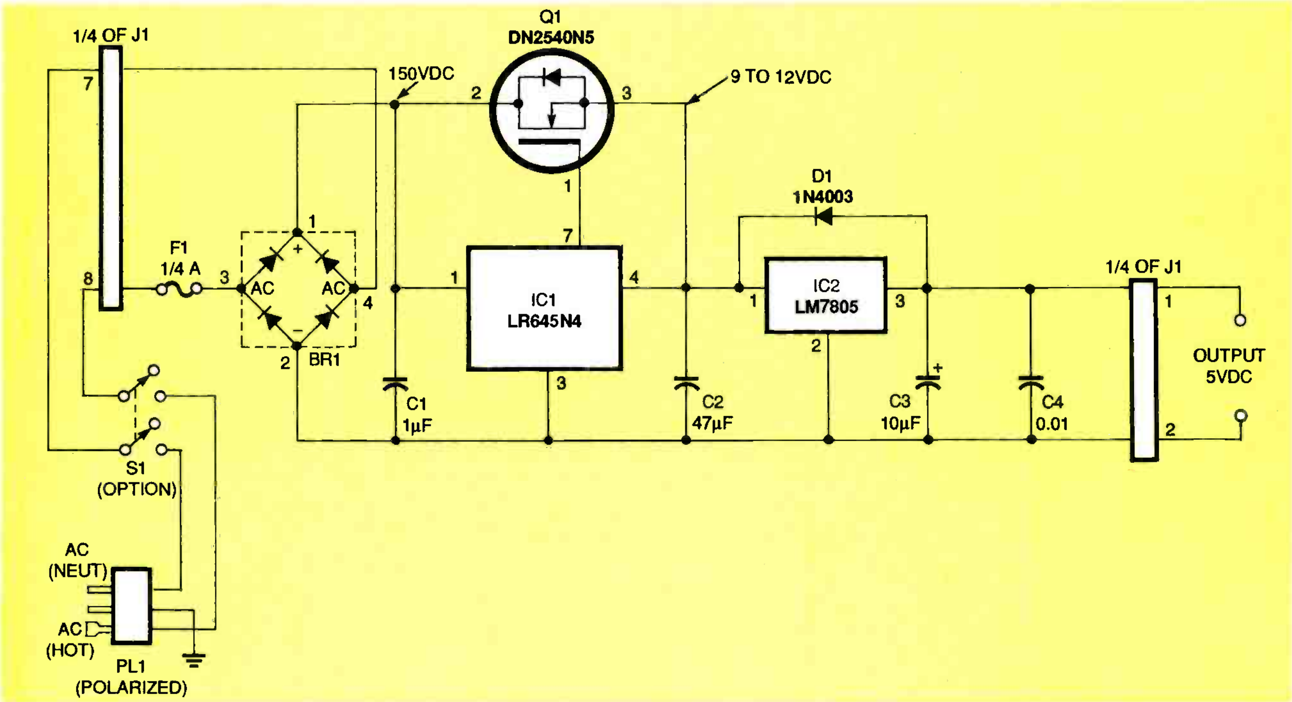


FIG. 5—Off-LINE REGULATOR rated at 5 voltsDC, 100 milliamperes

posed metal parts that could be touched or contacted by the user. Double insulation construction is commonly found in television receivers, computer monitors, power tools, and appliances that are powered directly from the AC line.

Adjustable voltage regulator

The schematic Fig. 5 shows the adjustable off-line regulator, the first of the two discussed here. An input from 12 to 120 volts AC is applied to pins 7 and 8 of the eight-pin circuit-board-mounted header J1. Although the LR645N4 (IC1) can accept voltages up to 450 volts, the input of this circuit is limited by the 200 PIV (peak inverse voltage) rating of the bridge rectifier BR1. The full-wave rectified input is applied to the 1µF filter capacitor C1.

The filtered 150 volts DC is applied directly to pin 1 of IC1. Filter capacitance is unusually low because IC1 has a ripple rejection ratio (V_{IN}/V_{OUT}) of 60 dB at 120 Hz with no load.

The filtered input DC is also applied to pin 2 of N-channel, depletion-mode MOSFET Q1, also made by Supertex. It was designed to be compatible with LR6 linear regulators. MOSFET Q1 conducts up to 100 milliamperes from the high-voltage source through the gate control line of the IC1, thus bypassing it. The combined regulated voltage and current source from Q1 and IC1 is then filtered through capacitor C2 to stabilize the regulated output.

The regulated output of IC1 is applied to the LM340 (7805) voltage regulator (IC2) that regulates the output voltage of the combination of IC1 and Q1 to a logic-compatible 5-volts DC. The total available current at the 5-volt DC output is 100 milliamperes, more than adequate current for most logic circuitry. The 5-volt DC is also filtered by 10µF tantalum capacitor C3 for additional circuit stability under full current load.

Building the first regulator

The discussion of construction practice and precautions will be limited to this first off-line regulator. It can be built with any conventional assembly method. If you plan to wire-wrap the regulator point-to-point, use No. 28 AWG wire-wrap wire. (No. . 30 AWG is not recommended because of the high currents and voltages in the circuits.)

The foil pattern for the prototype regulator circuit board was drawn manually and etched as shown in this article. If you make your own circuit board, pay careful attention to the spacing between conductive traces. Following good design practice, at least 1/16-inch spacing has been left between the high-voltage and low-voltage traces.

There is wider spacing between Q1 and IC2 to allow for the installation of the heatsink. After you have etched the circuit board, "tin" the exposed copper traces with a thin layer of soft

Continued on page 87

HARDWARE HACKER

The DNA computer language, some wavelet book references, magic digital sinewave codes, an engineering economics review, and a hot new FM RBDS tuner.

DON LANCASTER

My incoming letters tell me that some readers ought to get back to the fundamentals of efficiency and economics before they write me letters—either to praise or condemn me. Several recent letters gave me the idea that the time was right to do a little review of those subjects for those who never studied them—or those who have forgotten what they once knew about them.

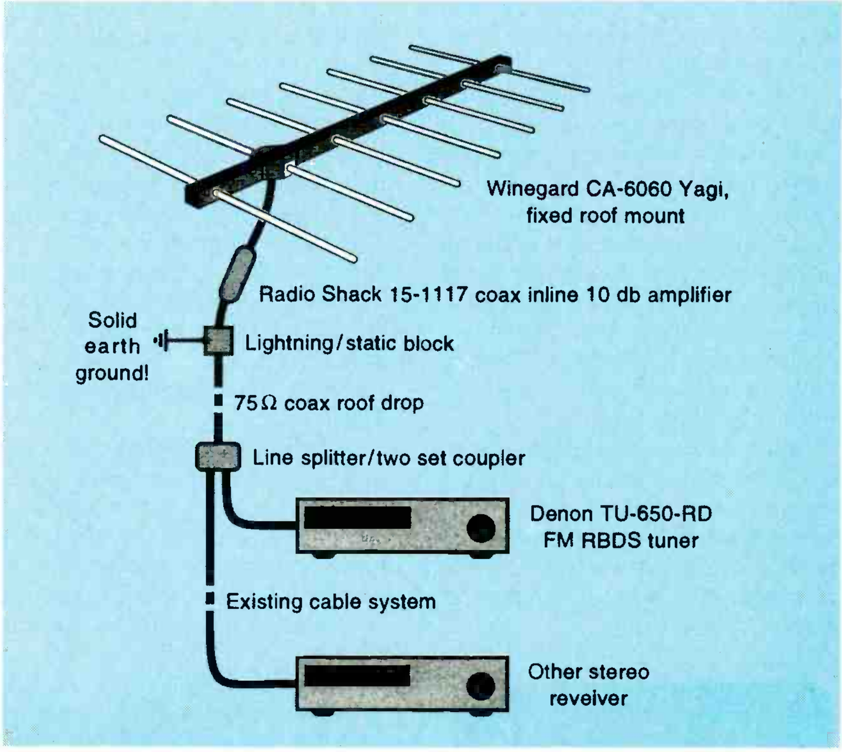


FIG. 1—MY TEST SETUP for ultra-fringe FM and RBDS reception.

Efficiency and economics

Efficiency, otherwise known as "bang-for-the-buck," is simply how much of something you get back compared to what you put in. This can be stated in terms of power, dollars, or other variables. However, physical systems *never* return more than is put into them.

Paradoxically, an enterprise or a technical venture might have an *apparent* efficiency well above 100%. That's the case if the rearrangement of the financial and material investments and the personal value added of the entrepreneur or management causes the *perceived value* of the products shipped (or services provided) to exceed the value of materials, time, overhead, and sweat equity that went into them.

Engineering economics is simply the study of finding out exactly what the bang for the buck is. If you get more than one buck back, you have a profit or will be a winner. On the other hand, if you get less than a buck back, you probably should have been doing something else.

Efficiency and engineering economics explains why solar cells that are only 6 % efficient are useless electric power generators at any price—even if free! Those same principles explain why thermoelectric coolers simply don't work at power levels beyond about eight watts. They also tell us why solar space heating is impractical in much of a state like Arizona.

Zoom in on details

Suppose you want to start a technical venture. The first thing you do is borrow $1000 for tools and materials. Today, the true *time value of money* of those dollars will be somewhere around 10%. Thus, just to break even, your venture must generate more than $100 per year—and do it forever!

But your tools and materials won't last forever. If they last only for ten years, your venture must generate more than $270 per year to *amortize* your initial expense and the time value of money over its effective life. With a five-year lifetime, your venture must generate more than $329 per year just to break even!

Just try to break even

If your total costs are less than your returns, you will have an economic loss. The total costs must include all parts, labor, overhead, and the time value of your money. Add to that the cost of a lot of intangibles. Even this makes no mention of taxes and inflation. Paying cash will not make much difference because there are many other things you ought to be doing with that money to give you better returns.

Sadly, any "hacker economy" that substitutes time and energy for cash will only shift the viability of the breakeven points. But this shift is likely to be a lot less than you might first guess, even when you factor in entertainment, ego, and enjoyment. A hacker economy in no way gets around the fundamentals of engineering economics. Moreover, there are likely to be both subtle and obvious subsidies involved.

Consider some examples of really bad engineering economics. The amount of electricity per unit area that a six-percent efficient solar cell produces can't ever pay for all the expenses of the power station installation, interest, land, and operating expenses. The energy recovered is simply inadequate. The longer you run the station, the more it will cost you!

Their lack of reliability makes amorphous solar cells dismally poor performers. Their low level of efficiency holds them perilously close to the economic breakeven point. This is also the reason why commercial solar electric power plants are being dismembered and their components are being sold to hackers at yard sales. There's a lot more profit to be made selling junk than there is in selling solar power.

In the Arizona desert, for example, there are too few winter degree-days to make solar space heating economical. It's hard for solar space heating to compete with $10 worth of propane or a few branches of mesquite tree.

Thermoelectric coolers are so grossly inefficient that its heatsink typically has to handle six or more times its cooling power. At high power, the heat rise across the heatsink exceeds the cooling drop provided by the Peltier modules.

Million dollar ideas

Why does patenting your million dollar idea make no sense? The answer is simply because you will never earn enough profit from a million-dollar idea to begin to cover the costs of obtaining the patent and successfully defending it in court from challenges and copy cats. Your breakeven point is approximately $12 million in gross sales. At that level, its a matter of chance whether a patent is or is not worth all of the struggle it takes to make it profitable. There is a discussion of this subject in my WHEN2PAT.PS on *GEnie* PSRT.

Is there any time when efficiency and engineering economics are not of crucial importance? Only if nobody else can come up with a good answer to "Uh... compared to what?" For example, inefficient solar cells are wonderful for calculators but useless as economical power generators.

Peltier thermoelectric circuits are great for cooling microscope slides or infrared detectors, but they are worthless for making ice. Water heated by solar power is great in the Arizona desert, but solar space heating does not cut it in that desert climate.

Wavelet update

There has been a lot of interest expressed in *wavelets* recently. These can be a superior performing replacement for the older Fourier analysis techniques related to time and frequency. Wavelet concepts apply to everything from video compression schemes to human vision and seismography. The field is maturing and there are now dozens of books available on the subject. I have listed several of the more popular books in my resource sidebar.

In my view, the best tutorial paper on wavelets was written by Rioul and Vetterli in the *IEEE Signal Processing Magazine*, Volume 8, Number 4, October 1991 on pages 14 to 38. Also review the December 1993 issue of IEEE's *Transactions on Signal Processing*. Be aware that these are two different IEEE publications. For your information, there is wavelet shareware on *GEnie* PSRT. File No. 365.

Hot new FM tuner

In past *Hardware Hacker* articles and reprints, I have discussed ultra-fringe frequency-modulation reception as well as new FM RBDS data services. The folks at *Denon* were kind enough to loan me one of their superb new TU-650-RD FM tuners. It has a list price of $375 but is available on the street for about $299.

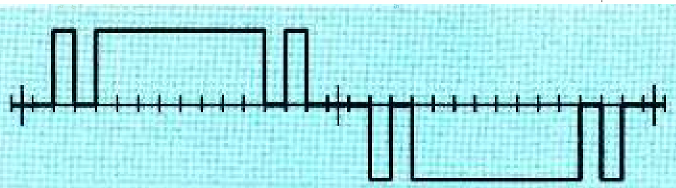
RBDS is a 1200-bit-per-second (bps) data subcarrier service. I gave some information on it as HACK73.PS on *GEnie* PSRT along with some do-it-yourself circuits. The most common application for RBDS today is for the display of station call letters and station format on receivers.

However, RBDS is also used for traffic, weather, and emergency alerts on radio and broadcasting *differential* Global Positioning System (GPS) position corrections for vehicles, services, and individuals requiring more accurate position information than is available from the commercial-grade signals available to ordinary citizens directly from the satellites.

Unfortunately, most FM stations have not yet adopted RBDS services, although they are all provided inexpensively. The latest *Radio World* listing shows that only about 220 stations have adopted it.

In addition to showing the station call letters, the *Denon* receiver lets you search format. For example, you can ask it to scan only for classic rock. There are now only a few stations in Arizona offering RBDS, but the reception on several is excellent. However, most provide only the format and call letters.

This is an example of a typical chicken-and-egg problem. Listeners don't want RBDS if only a few stations have it, and the stations do not want to spend money on a service if nobody is using it. Nevertheless, the benefits are there, especially for car radios.



Code: 0,0,1,0,1,1,1,1,1,1,1,1,0,1,0,0,0,-1,0,-1,-1,-1,-1,-1,-1,-1,-1,0,-1,0

Shorthand Code: 0x2,1x1,0x1,8x1,0x1,1x1,0x3,-1x1,0x1,-1x8,0x1,-1x1,0x1

The fundamental peak amplitude is 1.0545 times the "1" amplitude.

Fundamental:	(1.0000)	11th Harmonic:	0.2230
2nd Harmonic:	0	12th Harmonic:	0
3rd Harmonic:	0	13th Harmonic:	0.2285
4th Harmonic:	0	14th Harmonic:	0
5th Harmonic:	0	15th Harmonic:	0
6th Harmonic:	0	16th Harmonic:	0
7th Harmonic:	0.1184	17th Harmonic:	0.1183
8th Harmonic:	0	18th Harmonic:	0
9th Harmonic:	0	19th Harmonic:	0.1301
10th Harmonic:	0	20th Harmonic:	0

FIG. 2—A MAGIC 30-BIT WAVEFORM for generating power sinewaves.

Scottsdale, Arizona's KSLX (100.7 MHz), Kingman, Arizona's KZZZ (94.7 MHz), and Cottonwood, Arizona's KZGL (95.9 MHz) broadcast the differential GPS corrections. These can upgrade the listener's position accuracy to within several feet of true position.

The theory behind differential GPS is that the radio transmitting station has a known and fixed location. At ranges of several dozen miles, the errors in radio station position will be about the same as the error in your handheld GPS receiver. You just subtract the two values to increase the accuracy of your position data.

More information on differential GPS is given in *GPS World*. Two principal information sources for RBDS are *Differential Corrections Inc.* and *Coupon Radio*.

The Denon receiver would have to be modified slightly to receive GPS signals. This is a custom and encrypted fee-based commercial service. Several unique features make Denon's TU-650-RD receiver good for ultra-fringe reception: A fully shielded high-performance front-end design and an optional narrow-band IF filter that blocks most co-channel interference. Yes, you can still receive stereo and RBDS in the narrow mode.

Figure 1 shows my test setup for receiving ultra-fringe FM and RBDS. I mounted a Winegard CA-6060 Yagi antenna high on my roof and pointed it due west. A ten-decibel Radio Shack 15-1117 amplifier is in the transmission line between the antenna and a grounded lightning/static blocker.

A 75-ohm coaxial cable couples the blocker to a line splitter/two-set coupler in my living room. One line drives the Denon TU-650-RD, and the other line drives my second lower quality receiver.

What about performance? First and foremost, FM station KDKB comes in like a champ. You can practically arc weld with the power of its signal! That's all that really matters to me. There are about 40 FM station signals of listenable quality available to me at an average distance of over 105 miles from my antenna.

The Denon's IF filter is incredible. The weak Tucson, Arizona station KXCI broadcasting at 91.3 MHz is easily separated from the much stronger signal from the Phoenix station KJZZ broadcasting at 91.5 MHz. Try out the bandpass filter. If the station changes, or noise increases, you have co-channel problems. However, keep in mind that any weak signal might be received better without the filter. In general, the filter makes a difference only for a few stations.

Does it make sense to add a lower quality booster at the antenna ahead of a high-performance receiver? A modest 10-dB boost at the antenna gives the antenna a fixed impedance to work into and compensates for both line and distribution losses. The slightly higher signal level is enough to override the "no stereo on weak signal" feature. This permits manual switching rather than having to depend on the factory setting. Mono is cleaner for marginal signals.

However, any preamplifier also adds to cross-modulation and can cause overloading. This is only observable at a half channel away from a nearby station. If you use a preamplifier, be sure to get an in-line coaxial version that is totally shielded. It will provide only the bare minimum gain needed. Does a fixed antenna make sense? Yes, it is cheaper and more rugged.

But Bee can't receive her classic Tucson, Arizona, FM station KUAT very well despite the strong signal on the car radio in the driveway. Some experiments with an unboosted, inexpensive fringe Radio Shack 15-1636 FM antenna surprised me. Many FM stations seem to use vertical or circular polarization. Their apparent objective is to improve nearby automobile reception at the cost of distant coverage. Our reception of station KUAT improved dramatically here in Thatcher when I flipped the Yagi antenna to its vertical position.

The ultimate solution seems to lie in raising antenna height. I can take a $4 pocket FM receiver to the top of the two-mile high mountain in my front yard and tune it to 93.3 MHz. By pointing the whip antenna in one of three directions, I can receive KDKB in Phoenix, KKOB in Albuquerque, New Mexico, or a Mexican station from the south.

Tuning graduations on the Denon TU-650-RD are at 100-kHz intervals, giving one stop between channels. This can reduce co-channel interference, and it can be useful for receiving some homebrew wireless broadcaster who is off frequency. It also helps to receive the audio from TV channel 6 near 87.8 MHz.

However, there is a strange restriction here: this tuner is so hot that I must activate the internal RF attenuator to prevent an overload on cable systems. For some reason, this can only be done from the remote. I suspect this might have been an afterthought before the receiver design was completed.

Because there is a microcontroller chip inside, the tuner has many unusual features. For example, you can manually store any non-RBDS station call letters and format or store other messages of 13 or fewer characters. You can also scan for all of the classic rock stations, all the news stations, or any of 20 other formats. Because it has no keyboard, selection of 66 characters is made with a single up/down button.

There are 30 station presets. These are "intelligent" enough to remember the RBDS or manually entered data, AM vs. FM, the RF attenuator setting, and the filter bandwidth. The tuner has a panel light dimmer. All presets are saved when the power is shut off, and power consumption is only 12 watts. Because it is a component tuner, an external stereo amplifier is required.

However, I'd like to see a "raw" RBDS output jack on the tuner. Other improvements I'd like to see are a monthly updated plug-in card, chip, or modem line that stores all of the stations in North America with all of their formats and their operating hours. This would come in handy on long auto trips.

More magic waveforms

High power sinewaves have become a hot hardware hacker topic. They have applications in car battery power inverters, uninterruptible (UPS) computer power supplies, telephone ringers, electric-powered automobiles, power-line conditioning, and variable-speed induction motor drives.

Most of these applications require well formed sinewave outputs. Square or other sloppy waveforms could cause circuit inefficiencies, heating, resonances, cogging, or severe audio whine.

Analog solutions based on power

WAVELET BOOK RESOURCES

C.K. Chui, *An Introduction to Wavelets*, Academic Press, 1992.

C.K. Chui, *Wavelets*, World Scientific Pub, 1992.

C.K. Chui, *Wavelets: A Tutorial in Theory & Applications*, Academic Press, 1992.

C.K. Chui, L. Montefusco & L. Puccio, *Wavelets, Theory, Algorithms, & Applications*, Academic Press, 1994.

J.M. Combes, *Wavelets*, Spr-Verlag, 1989.

I. Daubechies, *Ten Lectures on Wavelets*, Soc Indus-Appl Math, 1992.

G. David, *Wavelets & Singular Integrals on Curves & Surfaces*, Spr-Verlag, 1992.

M. Farge, *Wavelets, Fractals & Fourier Transforms*, 1993.

E. Foufoula-Georgiou, P. Kumar, *Wavelets in Geophysics*, Academic Press, 1994.

Frazier, *Wavelets, Mathematics & Applications*, CRC Press, 1993.

Jawerth, *Practical Guide to Wavelets*, CRC Press, 1994.

G. Kaiser, *A Friendly Guide to Wavelets*, Birkhauser, 1993.

T.H. Koornwinder, *Wavelets: An Elementary Treatment of Theory & Application*, World Scientific Pub, 1993.

W. Light, *Advances in Numerical Analysis*, V2, OUP, 1992.

Y. Meyer, *Wavelets: Algorithms & Applications*, Soc Indus-Appl Math, 1993.

Y. Meyer, *Wavelets*, Cambridge University Press, 1993.

Y. Meyer, *Wavelets & Applications*, Spr-Verlag, 1992.

R.L. Motard & B Joseph, *Wavelet Applications in Chemical Engineering*, Kluwer Ac, 94.

D.E. Newland, *An Introduction to Random Vibrations, Spectral & Wavelet Analysis*, Halsted Press, 1993.

Ruskai, *Wavelets & Their Applications*, Jones & Bartlett, 1992.

L.L. Schumaker & G. Webb, *Recent Advances in Wavelet Analysis*, Acad. Pr., 1993.

G.G. Walter, *Wavelets & Other Orthogonal Systems with Applications*, CRC Press, 94.

G. Wornell, *Wavelet-Based Signal Processing with Fractals*, P-H, 1994.

R.K. Young, *Wavelet Theory & Its Applications*, Kluwer Ac, 1992.

NAMES AND NUMBERS

Coupon Radio
10 Rockefeller Plaza
New York NY 10020
(212) 595-1313

Crystal Semiconductor
PO Box 17847
Austin TX 78744
(800) 888-5016

Dallas Semiconductor
4401 South Beltwood Pkwy
Dallas TX 75244
(214) 450-0400

Denon
222 New Road
Parsippany NJ 07054
(201) 575-7810

Differential Corrections
10121 Miller Avenue #201
Cupertino CA 95014
(800) 446-0015

GEnie
401 North Washington Street
Rockville MD 20850
(800) 638-9636

GPS World
859 Willamette Street
Eugene OR 97440
(503) 343-1200

IEEE/Signal Processing
445 Hoes Lane
Piscataway NJ 08855
(908) 981-0060

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

Radio World
5827 Columbia Pk #310
Falls Church VA 22041
(703) 998-7600

Science/AAAS
1333 H Street NW
Washington DC 20005
(202) 326-6400

Synergetics
Box 809
Thatcher AZ 85552
(602) 428-4073

Whole Earth Catalog
27 Gate Five Road
Sausalito CA 94965
(415) 332-1716

Winegard
3000 Kirkwood Street
Burlington IA 52601
(319) 754-0600

amplifiers will not hack it because of their poor efficiency. A microcontroller-oriented digital solution is the only method to use these days, especially if stability, wide range, easily adjusted voltage, or a constant speed are requirements. Thus the trick is to find a "magic" single train of fixed amplitude ones and zeros that can imitate a respectable variable-voltage sinewave. You could pick an RZ, *ternary*, or pulse-width modulation (PWM) scheme that has states of +1, 0 and −1.

Figure 2 shows a "magic" 30-bit waveform for power sinewaves. When one examines *all* possible binary sequences for 36 or less bits per word, there is *no* other code that even comes close. The "top" half of the waveform is 001011111111010. The "bottom" half is repeated with −1 values. Notice that the top-to-bottom are mirrored but *not* the right-to-left. This produces the 30-bit word or a 1800-Hz clock for 60-Hz line power. The 30-bit length nicely taps out by tens for three-phase power.

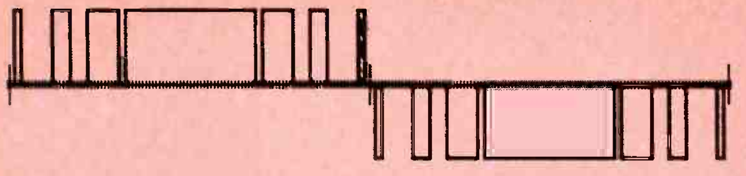
This elegantly simple "magic" word has a zero DC term. It has zero second, third, fourth, fifth, sixth, eighth, ninth, and tenth harmonics. The peak fundamental is about five percent above the "1" value for well behaved switching currents. The seventh harmonic ends up at about 11.8 % amplitude. This translates to 1.39 % power.

However, there are a few caveats. There is no way to get all those fancy square corners with nothing but a fundamental sinewave and a weak seventh harmonic.

As a result, all the 11, 13, 17, and 19 harmonics are gruesome, but they are no worse than the third in any squarewave. They end up in the mid-audio range with 60-Hz power. But these are usually easy to filter out.

The winding inductance of a motor acts as a low-pass filter. Nevertheless, some low-pass filtering will definitely be needed, and one must watch for system resonances.

Notice that the "−1" state can be a reversed current. With a bridge driver, only a single supply is needed to supply current in both directions. Another option is to the use of a pair of oppositely phased



Shorthand Code: 0x2,1x2,0x9,1x5,0x5,1x9,0x2,1x38,0x2,1x9,0x5,1x5,0x9,1x2, 0x3,-1x2,0x9,-1x5,0x5,-1x9,0x2,-1x38,0x2,-1x9,0x5,-1x5,0x9,-1x2,0x1.

The fundamental peak amplitude is 1.0281 times the "1" amplitude.

Fundamental:	(1.0000)	11th Harmonic:	0.0108 (!)
2nd Harmonic:	0	12th Harmonic:	0
3rd Harmonic:	0	13th Harmonic:	0.0891
4th Harmonic:	0	14th Harmonic:	0
5th Harmonic:	0	15th Harmonic:	0
6th Harmonic:	0	16th Harmonic:	0
7th Harmonic:	0	17th Harmonic:	0.2892
8th Harmonic:	0	18th Harmonic:	0
9th Harmonic:	0	19th Harmonic:	0.2613
10th Harmonic:	0	20th Harmonic:	0

FIG. 3—AN EVEN MORE MAGIC power sinewave with 210 bits.

windings.

Details vary with use.

The general purpose PostScript computer language is the quick and fun way to analyze waveforms interactively. I have written a new FOURIER.PS tutorial exploration utility and a ZEROHARM.PS code finder to *GEnie* PSRT. I am now evaluating 210-bit words using nothing more than PostScript. One interesting 210-bit example is shown in Fig. 3. Its first nasty harmonic is its seventeenth.

A library of low harmonic codes with listings of different fundamental amplitudes can provide background on variable output voltage from a fixed supply. Call me for details.

NEED HELP?

Phone or write your Hardware Hacker questions to:

Don Lancaster
Synergetics
Box 809-EN
Thatcher, AZ, 85552
(520) 428-4073

For fast PSRT access, modem (800) 638-8369. On prompt, enter JOINGENIE. When asked for the keyword, enter DMD524.

Internet email access link: SYNERGETICS@GENIE.GEIS.COM.

At longer bit lengths, you must think smarter rather than harder to get useful answers in a hurry. But PostScript explores any high-bit count words with aplomb. The secret to its efficient operation is to represent words by ones and zeros in a string and then manipulate the strings. I'd like to thank mathematician Jim Fitzsimons for his help on this subject.

New tech lit

Three new data books are available: *Crystal Semiconductor* is offering its new *Audio Databook* on digital audio products with particular attention given to low-distortion, delta-sigma analog-to-digital converters; Dallas Semiconductor is offering a *System Extension Data Book* that includes data on digital potentiometers and electronic thermostats; and *National Semiconducto* is offering a *Power IC's Databook* full of information on linear and switching regulators, motion controls, and power drivers. This should be of interest to readers.

The November 24, 1994 issue of *Science* proves something that has been obvious to me for some time. It pointed out that 97 percent of so-called "junk" DNA is really a sophisticated computer language! At the very least, the DNA passes all of the tests that have been applied to human and computer languages. The details on this finding are found on page 1320.

If you want to make a real quick buck on this concept, just publish the pocket reference card for the DNA language. Then maybe you can show us how to access a utility subroutine or two.

At long last, the *Millenium Whole Earth Catalog* is being shipped. It is a "must have" essential resource on access to tools. Don't miss this resource.

I've just reissued my classic *Active Filter Cookbook* and have a lot of autographed copies on hand. Moreover, I still have scads of classic Apple computers, monitors, cards, and drives on hand. They are cheap enough to be put together as programmable controllers. I also have rare and collectible Apple III's. Write, call, or E-mail me for more details.

I want to remind you that unique downloads, "freebie" insider secrets, catalogs, and technical help are available to *GEnie* subscribers on my PSRT. How about a ten-hour free trial per the *Need Help?* box. As usual, I've mentioned most of these resources in the *Names & Numbers* or *Wavelets* sidebars. Be sure to check the sidebars for information first before you call our no-charge technical helpline. Let's hear from you. Ω

Build a super-simple audio/video cable tester for under $10.

LARRY KLEIN

I'm departing from my usual column format to share with you a gadget that I built to alleviate a personal problem I had with shielded connecting cables. The problem, of course, is that they don't always stay that way—shielded and connected, that is. Remember the last time you spent a frustrating half hour or so trying to track down the specific shielded cable that was causing the intermittent hum or signal loss in a system—and which seemed to fix itself every time you touched or switched anything? (Defective cables sometimes short circuit or open up seemingly at random due to vibration, contact oxidation, and bad solder connections.)

The only sure way to test for an intermittent cable is to plug it in, put a signal through it, and try to provoke the problem. A standard ohmmeter isn't very helpful unless the cable is permanently shorted or open—assuming you're not an octopus, it's difficult to hold the test probes firmly on the plug elements while simultaneously flexing the cable in an effort to make it misbehave.

The audio/video cable tester tests cables in the same way they are used: plugged in and with a voltage going through them. And since they are plugged in, you can flex them vigorously while keeping an open ear on the built-in buzzer—which responds faster and more definitely than an ohmmeter. The inexpensive, easy-to-build, battery-powered cable tester will make a welcome addition to any electronics toolbox or test bench.

Construction

The parts layout is not critical, and the tester can be built into any convenient box. However, I suggest that you use a plastic case (such as the one specified in the Parts List) since the normally grounded sections of the test jacks do not all connect to a common ground. The circuit is embarrassingly simple and would make a good practical first project for a beginner. In fact, I'm considering using it for just that purpose in a basic electronics course I'm conducting for our local middle-school students.

Referring to the schematic in Fig. 1, the "B" jacks (J3 and J4) are shorted to themselves and to each other—this is not a schematic error.

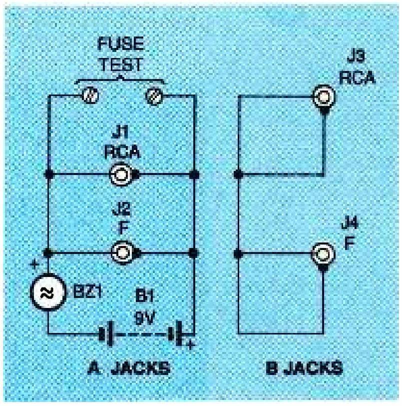


FIG. 1—AS SIMPLE AS IT LOOKS, the audio/video cable tester tests cables while they are plugged in. You can flex them vigorously while listening to the built-in buzzer.

The $\frac{3}{4}$-inch spacing between the fuse-test screw heads will accommodate type 3AG and smaller fuses. Unlike the phono jacks (J1, J3), some F-connector jacks (J2, J4) do not come with grounding lugs, so before installation, a loop of thin, bare wire must be placed under each mounting nut to serve as a ground soldering point. Each pair of phono and F-connector jacks is wired in parallel. Of course, other jacks such as BNC, phone, etc., that you encounter in your work can be installed in the tester and wired in parallel with the existing jacks. The connection between J3 and J4 allows cables with a phono plug on one end and an F connector on the other to be tested for continuity.

Proper polarity must be observed in wiring the piezoelectric buzzer (BZ1); its terminals are marked appropriately. The buzzer is mounted in a $\frac{7}{8}$-inch hole cut in the front panel and fixed in place with a couple of drops of hot-melt glue. (Although the Japanese call anything that generates a sound a "buzzer," BZ1's generated tone is around 3 kHz and fairly pure.)

The optional test probe shown in the photo is made up of a 2-foot shielded phono lead with an RCA-plug on one end and a test probe and ground clip on the other. The lead's inner conductor is soldered to the probe tip, and the shielding braid is twisted, brought out through the rear of the probe, and soldered to a foot or so of flexible lead with an insulated alligator tip installed on its end.

Using the tester

The short test should always be made first. Plug either end of the cable under test into the appropriate phono or F-connector "A" jack. Only one end of the cable need be plugged in for a complete short test; the other end is left free. If the buzzer sounds, there is a short circuit somewhere in the cable. If nothing is heard, test for an intermittent short by flexing the cable several times, particularly in the plug area of both the free and plugged-in ends.

The continuity test will indicate an open circuit in the inner signal-carry-

PARTS LIST

J1, J3—RCA-type panel-mount phono jack
J2, J4—Female panel-mount F connector
BZ1—PC-mount piezo buzzer
B1—9-volt battery
$4\frac{3}{4} \times 2\frac{1}{2} \times 1\frac{1}{16}$ inch plastic case, 9-volt battery snap and holder, 6-32 × $\frac{3}{8}$ nuts and bolts, test probe, alligator clip, shielded lead with phono plug on one end.

ing conductor and/or its shielding. For the test, leave one end of the cable plugged into an "A" jack and plug the free end into the matching "B" jack. A continuous tone indicates continuity in both the inner conductor and shield plug connections. As before, flex the cable several times, particularly in the area where it joins the plugs. If there's static in the tone, or if it quits altogether, the cable has an intermittent open circuit.

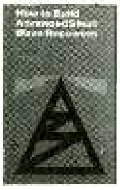
ANYONE CAN AFFORD to build this simple cable tester.

The fuse test is simplicity itself. A good fuse touched across the screw-head Fuse Test terminals "C" will produce a tone; a bad fuse won't. You can also check whether the tester's battery is good by touching a coin or paper clip across the Fuse Test terminals on the bottom of the unit.

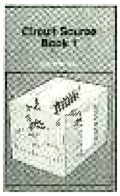
The continuity test probe is plugged into an "A" jack. When the circuit under test has continuity, the tone sounds. The lower the resistance, the louder the tone. The tone will sound (albeit weakly) for resistances up to about 50,000 ohms. You'll find the test probe handy for quick continuity checks of household fuses, electric light bulbs, appliances, and more.

I must admit to a slight embarrassment at the simplicity of the tester's circuit. But just because life has gotten more complicated over the years, there is no reason for our test instruments to go the same route. Ω

Electronics Paperback Books

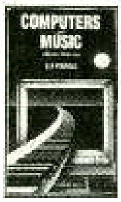


☐ **#226—How to Build Advanced Short Wave Receivers...$5.75.** Practical construction details of a number of shortwave receivers which should have levels of performance at least equal to that of commercially built sets of similar complexity. Also included are a number of add-on circuits, such as, Q-multiplier, S-meter, noise limiter, etc., which can be used to aid and improve the listener's shortwave reception.

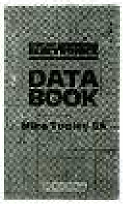


☐ **BP321—Circuit Source-Book 1...$6.50.** A collection of over 150 analog-signal circuits on audio signal and power amplifiers, DC amplifiers, signal filters (high-pass, low-pass, band-pass and notch), tone controls, voltage-controlled amplifiers and filters, triggers and voltage comparators, gates and electronic switching, bar graphs, mixers, phase shifters, sensors, digital circuits, etc. (See BP322 at right)

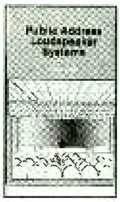
☐ **BP322—Circuit Source-Book 2...$6.50.** Contains over 170 circuits on signal generation, power supplies and digital electronics. A continuation of BP321. Topics are: 555 oscillators, sinewave and function generators, CMOS oscillators, voltage-controlled and RF oscillators, (555, TTL and CMOS) monostables, precision long timers, power supply and regulator circuits and many other useful circuits. (See BP321 at left.)



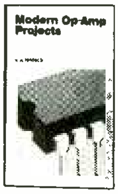
☐ **PCP108—Computers and Music...$9.95.** The text leads you through the topics on computers and music software. Learn how to choose the right components for a system to suit your personal needs and fully equip yourself to exploit that system.



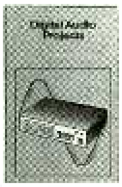
☐ **PCP109—Everyday Electronics Data Book ...$10.00.** An invaluable source of electronics information—the text contains many sections that deal with the underlying theory of electronic circuits and a wide range of practical electronic applications.



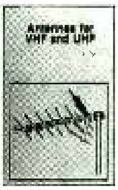
☐ **BP292—Public Address Loudspeaker Systems...$6.95.** Covers the moving-coil loudspeaker, baffles, the basic requirements of a PA system, sound patterns, line-source, horn loudspeakers, low-impedance matching and much more.



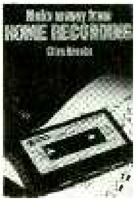
☐ **BP106—Modern OpAmp Projects...$5.75.** Various projects that make use of operational amplifiers available to hobbyists. Text includes low-noise, low-distortion, ultra-high input impedance, low slew-rate and high current types.



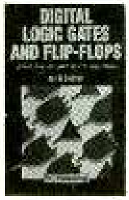
☐ **BP245—Digital Audio Projects...$5.95.** Practical details of how to construct a number of practical projects. All should be of interest to most audio and electronic music enthusiasts. Some of the projects are: oscilloscope storage circuit, A/D converter, negative supply, input amplifier, low-noise microphone preamp, compressor and expander circuits, input mixer, echo effect circuit, and others.



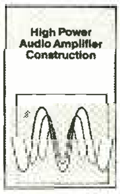
☐ **BP301—Antennas for VHF and UHF...$6.00.** From installing a TV or FM antenna to setting up a multi-antenna array for shortwave listening or amateur radio, this book explains the essential basics of antenna operation and installation. The text describes in easy-to-understand terms the necessary information about how antennas work, the advantages of different types, and how to get the best performance.



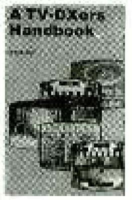
☐ **PCP105—Make Money from Home Recording...$10.00.** Start earning money after you spent a "fortune" on all that professional recording gear, MIDI and all. Here's the book that tells you how! Whether you have a fully fledged recording studio at home, or just a couple of stereo cassette recorders and a microphone, you'll be able to put the ideas presented in this book into immediate practice and make money.



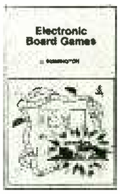
☐ **PCP107—Digital Logic Gates and Flip-flops...$10.00.** Establishes a firm foundation in digital electronics by covering gates and flip-flops thoroughly. Topics such as Boolean algebra and Karnaugh mapping are explained, demonstrated and used.



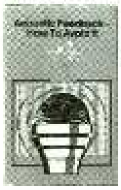
☐ **BP277—High Power Audio Amplifier Construction...$6.25.** Practical construction details of how to build a number of useful audio power amplifiers ranging from about 50 to 400 watts rms. Text includes MOS-FET and bipolar transistor designs.



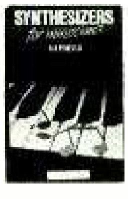
☐ **BP176...TV-DXers Handbook...$7.95.** The text includes many units and devices that have been designed and used by active enthusiasts, and often, considerable ingenuity and thought have gone into the development of such units to overcome problems.



☐ **BP350—Electronic Board Games...$6.00.** Complete plans for 20 novel electronic board games that you can build with ease. Some projects are: Motor racing, searching for buried treasure or gold at Ft. Knox, wheel of fortune, a musical quiz—plus others.



☐ **BP310—Acoustic Feedback—How to Avoid It...$6.25.** Feedback is the bane of all PA systems. Much of the trouble is often the hall itself, not the equipment, but there is a simple and practical way of greatly improving the acoustics. Determine which microphone to use. Select the correct loudspeaker system. Includes info on equalizers, frequency-shifters and notch- and twin-notch filters.



☐ **PCP106—Synthesizers for Musicians...$10.00.** Written especially for musicians, the book explains all current popular forms of synthesis, covering LA, additive, phase distortion, FM and sampling. The theoretical side of synthesis is treated in an easy to understand way; the technical information being restricted to what you need to know to use your instrument effectively. Ideal for beginners and muscians.

☐ **BP108—International Diode Equivalents Guide...$5.95.** Discover direct or possible substitutes for a popular user-oriented selection of diodes including rectifier and signal types, including Zener diodes, LEDs, diacs, triacs, thyristors, OCIs, photo diodes, display diodes and others. Wherever possible material type, function or type of diode and country of origin data are shown and foreign equivalents.

COMPUTER TOPIC BUY-OUTS

- ☐ **BP109—The Art of Programming the 1K ZX81—$3.95**
- ☐ **BP114—The Art of Programming the 16K ZX81—$4.95**
- ☐ **BP119—The Art of Programming the ZX Spectrum—$4.95**
- ☐ **BP129—An Introduction to Programming the ORIC-1—$2.50**
- ☐ **BP128—20 Programs for the ZX Spectrum and 16K ZX81—$4.75**
- ☐ **BP143—An Introduction to Programming the Atari 600/800 XL—$4.95**
- ☐ **BP154—An Introduction to MSX (Universal Japanese) BASIC—$4.95**
- ☐ **BP156—An Introduction to QL Machine Code—$3.95**
- ☐ **BP157—How to Write ZX & Spectrum+ Games Programs—$3.95**
- ☐ **BP158—An Introduction to Programming the Commodore 16 & PLUS4—$4.95**
- ☐ **BP161—Tinto the QL Archive (database program)—$2.95**
- ☐ **BP187—A Practical Reference Guide to Word Processing on the Amstrad PCW 8256 & PCW 8512—$9.95**

ELECTRONIC TECHNOLOGY TODAY INC.
P.O. BOX 240, Massapequa, NY 11762-0240

Name ______________________________

Address ____________________________

City______________ State ___________ Zip__________

EN1

SHIPPING CHARGES IN USA AND CANADA

$0.01 to $5.00	$1.50
$5.01 to $10.00	$2.50
$10.01 to 20.00	$3.50
$20.01 to 30.00	$4.50
$30.01 to 40.00	$5.50
$40.01 to 50.00	$6.50
$50.01 and above	$8.00

SORRY No orders accepted outside of USA & Canada

Number of books ordered ☐

Total price of merchandise .... $________
Shipping (see chart) .... $________
Subtotal .... $________
Sales Tax (NYS only) .... $________
Total Enclosed .... $________

All payments must be in U.S. funds!

OFF-LINE REGULATORS

continued from page 73

solder to improve solder "wetting" to component leads and prevent corrosion of exposed copper traces.

Take precautions to prevent damage to semiconductor devices from electrostatic discharge (ESD) when handling them. Handle those parts on a conductive surface, and attach a grounded wrist strap to your wrist. Do all soldering with a 20 to 40-watt, grounded-tip soldering iron.

Refer to the parts placement diagram Fig. 6. Begin circuit board assembly by inserting and soldering bridge rectifier BR1, observing the correct pin orientation. Then insert and solder swamping diode D1, observing its correct cathode location. Next, install and solder an eight-pin DIP socket for IC1 (LR645N4), observing the correct pin locations.

Locate a square mica electrical insulator on the drilled hole for mounting the LM7805 voltage regulator IC2 and fasten the heatsink tab of its TO-220 package with a screw through the insulator and circuit board and a lockwasher and nut. Solder the three pins. It is recommended that a heatsink be placed on IC2 when the total current drawn exceeds 30 milliamperes.

Caution: MOSFET Q1 must be insulated from the copper-foil traces and external heatsink because up to 170 volts will be present on Q1 when it's powered from the 120-volt line.

Position the external heatsink (rated at 8.3° C/watt) on the circuit board at the location for MOSFET Q1, place a square mica (polyester) insulator on the heatsink and fasten the TO-220 heatsink tab of Q1 with a screw though the tab, insulator, external heatsink and circuit board with a screw, lockwasher and nut. Solder the three pins.

After installing Q1 and IC2, verify that there is no electrical continuity between the mounting tab with a digital multimeter. **Caution:** If you do not electrically isolate Q1 from IC2 the supply will be destroyed!

Insert and solder the electrolytic capacitors C2 and C4, after verifying that their polarity and pin orientation are correct. Then insert and solder film capacitor C1 and ceramic disc capacitor C4. Insert and solder the eight-pin in-line header J1. Insert and solder the two separate clips for the fast-blow, ¼-ampere fuse F1. Insert IC1 in its socket.

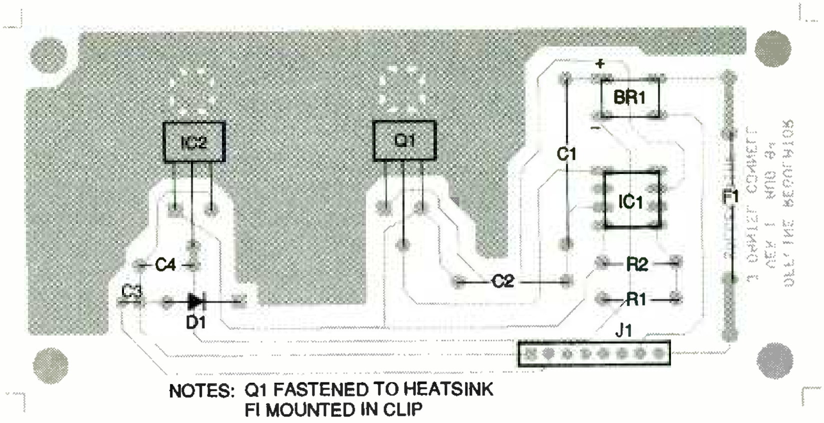


FIG. 6—PARTS PLACEMENT for the 8- to 12-volt, 100-milliampere off-line regulator

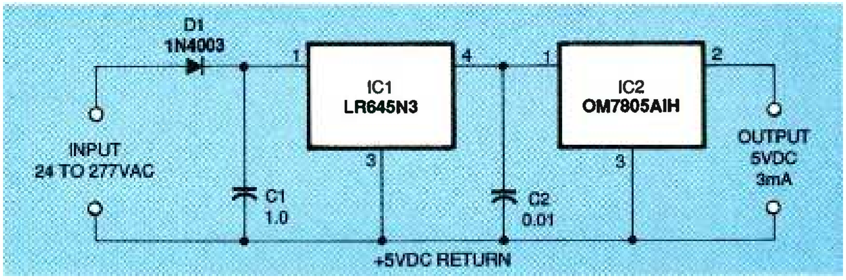
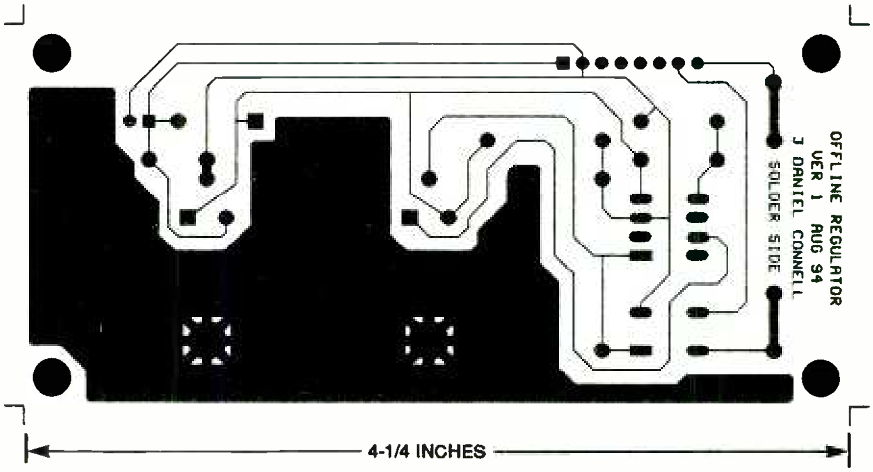


FIG. 7— PRECISION 5-VOLT off-line regulator.



FOIL PATTERN for the 5-volt, 100-milliampere off-line regulator

Power-up and check-out

Warning: If you do not obtain the correct voltage readings as specified, disconnect AC power to the off-line regulator immediately. Failure to do so promptly could result in injury to you and destruction of the circuit. Troubleshoot and make all needed repairs before reapplying AC power. Do not use a reversible line cord or a line cord whose ground pin has been removed because of their potential shock hazard.

Connect a polarized AC line cord and at pins 7 and 8 of the board mounted header J1. (An optional DPDT switch S1 can be inserted as shown in Fig. 5. Ver-

PARTS LIST

Voltage regulator, 8 to 12 volts (See Fig. 5)

Capacitors

C1—1µF, 250 volts
C2—47µF, 35 volts
C3—10µF, 35 volts
C4—0.01µF, 500 volts

Semiconductors

BR1—bridge rectifier, 1 amp, 200 PIV, DIP style
D1—1N4003 silicon diode, 200 PIV
IC1—LR645N4 linear regulator, DIP, Supertex
IC2—LM340T5 (7805) 5-volt, TO-220, National Semiconductor or equiv.
Q1—DN2540N5, MOSFET, TO-220, Supertex

Other components

J1—header, vertical, 8-pin, single row, 0.10-inch centers, AMP or equiv.
S1—switch, DPDT, (optional) 125 VAC, 10 amps
T1—transformer 120 VAC to 24 VAC, standard, 25.2 center tap secondary, 450 mA
F1—fuse, ¼ amp, fast-acting

Precision voltage regulator (See Fig. 7)

Capacitors

C1—1µF, 250 volts
C2—0.01µF, 35 volts

Semiconductors

D1—1N4003 silicon diode, 200 PIV
IC1—LR645N3 linear regulator, TO-92 plastic, Supertex
IC2—OM7805AIH precision voltage regulator, Omni or equiv.

Miscellaneous: circuit board; project enclosure (optional, see text); heatsink (Thermalloy No.7020 or equiv.); mica or fiberglass insulators for semiconductors; 120-volt AC polarized line cord with 3-pin plug; PC-mount fuse clips, nuts, bolts and lockwashers, solder. **Note: Sample LR6 linear regulators and MOSFETs, data sheets, application notes, and information can be obtained from Supertex, Inc., 1350 Bordeaux Drive., Sunnyvale, CA 94089**

ify that the AC "hot" side is connected to Pin-8. With an isolation transformer between the AC line and the plug, power-up the assembly.

The article "Build An Isolation Transformer" by Doyle Whisenant, January 1995 *Electronics Now*, page 62, explains how to build an isolation transformer that meets all the requirements for testing off-line voltage regulators.

If you do not have a 120-volt AC to 120-volt AC isolation transformer, locate one that has a 120-volt AC primary and a minimum 24-volt AC secondary rated for 300 milliamperes. The transformer specified in the parts list can be purchased from electronics parts distributors or retail stores. Apply the AC to the polarized plug as shown in Fig. 5.

Carefully measure and verify the voltages with a DC voltmeter referenced to pin 2 of bridge BR1 at the following points with a 120-volt- to-120-volt isolation transformer in place:

- Approximately 150 volts DC at pin 1 of BR1
- 9 to 10 volts DC at pin 4 of IC1
- Approximately 5 volts DC at pin 3 of IC2

With a 120-volt-to-24-volt AC transformer the voltage at pin 1 of BR1 should be approximately 30 volts DC. The voltages measured at pin 4 of IC1 and pin 3 of IC2 should be the same as those measured with the 120-volt-to-24-volt transformer.

If all voltage measurements are correct, disconnect the AC power, and allow adequate time for C1 to self-discharge. If you are unable to obtain the correct voltages, remove the input AC and examine the circuit board for improperly located or soldered components and make any corrections necessary.

Regulating the output

MOSFET Q1 (DN2540N5) is rated for 15 watts. The input to Q1 at 120 volts, 60 Hz AC is about 150 volts DC. The output of Q1 should be between 9 and 10 volts DC. Therefore, by applying the values given, the power drop across Q1 can be calculated for any current drain when 120-volt AC line power is applied. The power dissipated by Q1 at 100 milliamperes is determined as follows:

$$P_D = (V_{IN} - V_{OUT} \times I$$
$$P_D = (150 - 9 \times 100)$$
$$P_D = 14.1 \text{ watts}$$

Where: P_D equals power dissipated, voltage is in volts DC, and current is in milliamperes

This represents the worst case situation for the regulator. If a lower voltage were applied (i.e., 24 volts AC) the result would be a lower power dissipation across Q1:

$$P_D = (V_{IN} - V_{OUT}) \times I$$
$$P_D = (30 - 9) \times (100)$$
$$P_D = 2.1 \text{ watts}$$

The author tested MOSFET Q1 to verify its ability to operate to 100 milliamperes with an input voltage of 150 volts DC. This was done by placing a 50-ohm, 1-watt resistor across the 5-volt DC output and operating the regulator for one hour. The regulator functioned satisfactorily.

However, if the regulator is to operate under continuous full load current, it is recommended that the regulator be placed in an aluminum case with wall thickness of at least 0.090-inch with a solid, surface of less than 8 square inches. Heatsink MOSFET Q1 to the enclosure wall.

The metal enclosure must permit constant air exchange for ventilation and be grounded to the ground line of the three-prong power plug, as shown in Fig. 5. Consider improving the air circulation with a miniature tubeaxial cooling fan rated for at least 30 cubic feet per minute (cfm).

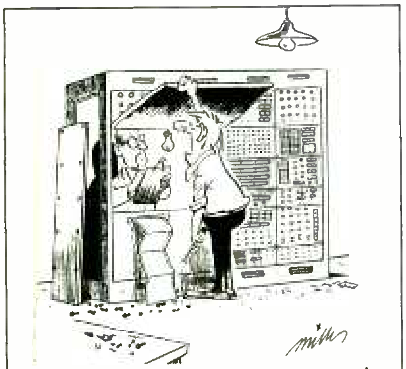
The final output of the regulator under no load was 4.96 volts DC. Under full load conditions (100 milliamperes) and after 1 hour of operation, the output was 4.83 volts DC. A 50.4-ohm load resistor was installed in the circuit.

Precision regulator

Refer to the schematic for the precision regulator, Fig. 7. The AC input is applied directly to diode D1. The half-wave rectified DC is then applied directly to filter capacitor C1 and then to the three-terminal LR645N3 fixed regulator IC1.

The 10-volt DC output of IC1 appears across stabilization capacitor C2. The 10-volt DC is then applied to the post-regulator IC, an Omni OM7805AIH precision regulator that will provide 5-volt DC output ±0.05 volts DC.

This circuit is useful for making transimpedance (current to voltage) measurements and providing precise offset references for single-ended operational amplifier buffer circuits. However, the circuit cannot supply more than 5 volts at 3 milliamperes. Verify that you have carefully calculated the total current demand of any circuitry you want to connect to this regulator. Ω



"If you expect us to get the contract you're going to have to work on your speed!"

VIDEO NEWS

continued from page 6

Thomson says it has back orders for 400,000 receivers. At that point, Sony becomes the second brand to offer receivers, and Thomson expects a shortage of receivers to last until them. After Sony, the second licensee, enters the field, Thomson concedes that the product will be subject to an "aggressive price curve."

The success of DSS has surprised some critics, because it competes directly with cable, which doesn't require the basic equipment investment. It was expected to succeed in areas without cable service. But in many areas where cable is available, cable subscribers are using the service as a substitute, praising the clarity of its digitally transmitted image and the service's ability to free them from the woes of dealing with their current cable companies. The DSS system delivers the same programming as cable, and it has a higher channel capacity than most cable systems. It also offers a near video-on-demand service for movies, as well as 28 channels of digital audio. However, although DSS carries the national feeds of ABC, CBS, NBC, and Fox, it doesn't necessarily carry the broadcasts of local affiliates or independents. So to have complete reception, viewers must have either a regular broadcast antenna or basic cable service in addition to DSS.

The DSS system currently is receiving 175 channels from two satellites, with a third bird scheduled for launch later this year. The system is being upgraded to MPEG-2 specifications this year, with Dolby AC-3 audio to be added as well. When Sony starts to offer competition, Thomson is expected to bring out new models—presumably under its ProScan and GE brands, as well as RCA—including at least one TV model with DSS built in.

Cable TV interests, eying the competition, have also fielded their own satellite system. Originally aimed at areas without cable service, the Primestar system is available nationwide. It employs medium-power satellites and 39-inch satellite dishes. At first the service was offered only by cable operators, but a retail effort is now being mounted as well.

• Commercial-killing VCR. Coming this spring: A VCR that really kills commercials. RCA has become the first licensee to build a unique system into VCRs that censors commercial. When the recorder makes a tape from a broadcast or cable program, it automatically rewinds it to the beginning and fast forwards to the start of the first commercial break (whose location has been memorized on the VCR's tape counter based on visual and audio cues). The VCR then encodes commercial-start and -end signals on the tape's control track. It continues to seek out and mark recorded commercials to the end of the tape, and then rewinds. On playback, the VCR goes into the forward search mode during the commercials, while a blue field masks the picture. The end signal puts the VCR back in the play mode. Thus, instead of a commercial, the viewer sees a blank blue screen for a maximum of 30 seconds, according to Arthur D. Little Enterprises, which developed the system. Ω

COMPUTER CONNECTIONS

Unauthorized Windows

JEFF HOLTZMAN

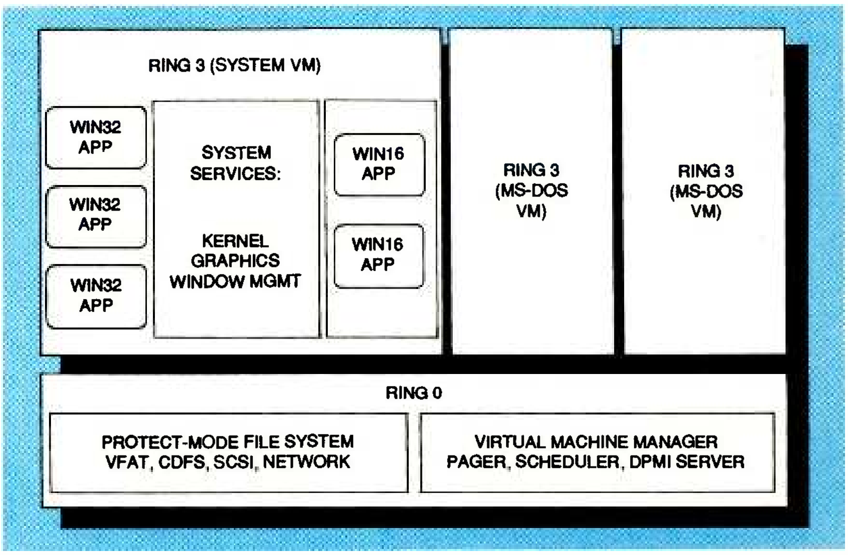


FIG. 1—EVEN UNDER WINDOWS 95, all GUI applications are multitasked in a single process, potentially against several independent DOS tasks. The good news is that device drivers now load as VxDs (Virtual Device Drivers) in protected mode, thus potentially providing better performance, better reliability, more conventional memory for legacy DOS programs, and no more juggling memory configuration to squeeze everything in!

Windows. Can't live with it, can't live without it. But what is it? What is its relationship to DOS? Is it an operating system, as Microsoft has in recent years started to claim? Or is it simply an oversized branch grafted onto that spindly old twig, DOS? And what about DOS, the 16-bit hanger-on in the emerging 32-bit world? Will Windows 95 really and truly and finally put DOS out of its misery—and ours?

A new book, *Unauthorized Windows 95* (UAW95), by Andrew Schulman provides the definitive answers to all those questions. The book is difficult to understand. It assumes the reader has knowledge about Intel CPU architecture, DOS interrupt services, other DOS internals—oh yes, and equal understanding of the Windows architecture and programming model. Shulman provides cursory coverage of some background material, but if you don't know what Int 21h is, or the various Intel CPU modes, this difficult book will be impenetrable.

The author, Andrew Schulman, is one of just a few recognized, independent (of Microsoft) DOS/Windows gurus. Schulman appeared as an expert witness in the Stac vs. Microsoft case. He has written other books on undocumented features of DOS and Windows. And he edits a column called the "Undocumented Corner" for a first-rate programmer's magazine called *Dr. Dobbs Journal*. Schulman knows his stuff. In fact, the January 1995 issue of *Dr. Dobbs* published a highly condensed summary of Schulman's argument by Schulman himself (p. 127f).

In the 600-page book, Schulman spells out in excruciating detail his vision of what constitutes DOS, what constitutes Windows, the relationship between the two, and how he arrived at the picture. I can't hope to do justice to UAW95 here. Nonetheless, I am going to devote this column to it. In so doing, I hope either to convince you of the merit of Schulman's argument, or to inspire you to read his book and decide for yourself.

What I will do is threefold: 1) Discuss his methodology, the *kinds* of thinking he does to arrive at his conclusions, although not the thoughts themselves, as they depend on highly technical and lengthy chains of logic; 2) Summarize the DOS/Windows picture that arises; and 3) Discuss the importance of his findings. For details, see the book.

By the way, there are actually two versions of the book. The one subtitled "Developers Resource Kit" comes with a floppy disk containing source and executable code for most of the monitoring programs in the book. It also contains a so-so CD full of trial and demo versions of various programming tools.

Methodology

Schulman's typical tactic is to write a program (in C, assembler, or both), "hook" it into the DOS interrupt-handling structure. He then monitors the output it produces in various environments, including both the unreleased Windows 95 (formerly known as Chicago), and several prior versions of Windows, including 3.0, 3.1, and 3.11 (Windows for WorkGroups). He also discusses how some architectural features date, in embryonic form, all the way back to Windows/386.

Will the real OS stand up?

Until publication of UAW95, most people, if they thought about it at all, considered DOS to be the operating system with Windows merely an application that ran on top of it. Looking a little closer, many said that DOS handled disk and file I/O, whereas Windows handled video, memory, and just about everything else.

UAW95 paints a totally different, yet highly compelling picture. This picture directly and deliberately contradicts the picture painted by both Microsoft and the computer press, which usually bases its descriptions on uncritical adoption of the Microsoft party line. There are two critical points to comprehend about the controversy:

- DOS is alive and well, and
- Windows is a real operating system.

DOS is not dead

First, contrary to what Microsoft and nearly everyone else is saying, DOS is not dead. The two system files (IO.SYS and MSDOS.SYS) that contain DOS have been combined and renamed (WINBOOT.SYS). This new system file has been given the ability to launch Windows automatically, so that under normal conditions, the user never sees a DOS prompt during a boot. However, it's easy to circumvent the auto-boot-to-Windows feature, and boot directly to a command line. Just add a PAUSE statement to the end of your AUTOEXEC.BAT, and when it prompts you to press a key, press Ctrl-C. You'll end up at the DOS 7/Windows 4.0 command line.

Of course, the presence or absence of a command-line interface does not, in and of itself, mean that DOS is either present or absent. However, it is a visible indication that things are changing. Less visible, but more relevant, are hundreds of DOS Application Program Interface (API) calls. Of course, they're still there; the question is whether Windows or DOS is what's on the other side of the "I" in that API. As we learn from UAW95, however, it's not a question of DOS *or* Windows; it's a question of both. The real questions are: which calls are handled by Windows, which by DOS" how does DOS handle them, and just what is DOS.

If Windows itself handled all those calls (as NT does), it would be fair to say that DOS was gone. But Shulman demonstrates conclusively that DOS still handles numerous calls, and for reasons of compatibility, that is a good feature of DOS.

Windows is the OS

Second, Windows really is the operating system; DOS plays only a subservient role, one that has been in steady decline since the 386 Enhanced Mode was introduced with Windows 3.0. To be more specific, a component of Windows called the Virtual Machine Monitor (VMM) is what assumes the lowest level of control over all system resources. In Schulman's words (p. 82), "VMM is the Windows operating system."

As shown in Fig. 1, the VMM is a piece of code that runs in Ring 0 of the microprocessor's protected mode. Recall that 386 and later Intel CPUs have three modes: Real, Protected, and V86. Real mode is what the original 8088/8086 CPUs ran. Real mode allows access to 1 MB of memory. Protected mode, introduced with the 286, provides access to more memory (16 MB on the 286; 4 GB on most later CPUs), has a different mechanism for accessing memory, and provides a much more sophisticated means of controlling what happens when interrupts occur, illegal opcodes are encountered, and I/O ports and memory are accessed. V86 mode is a form of protected mode that provides the same 1 MB address space as the original 8088, but with the advantage of full protected-mode control over interrupts, I/O ports, illegal opcodes, and memory.

Shulman shows how, under several versions of Windows, you can create simple batch files to run the VMM all by itself to get an "extended" version of character-mode DOS that allows direct access to many, many megabytes of memory, all through standard DOS API calls that under normal circumstances can never provide more than about 600K of memory.

Another interesting characteristic of the V86 mode is that under control of a proper multitasking operating system, multiple V86 machines can be active simultaneously, along with one system-level control program. This is, in fact, how Windows (and OS/2 for that matter) runs DOS and Windows programs. Under Windows' Enhanced Mode, you can start one or several DOS boxes simultaneously. Each is a separate V86 process. In addition, both the Windows GUI—what we normally think of as Windows—and all Windows applications run in another V86 process, the System VM (Virtual Machine). The System VM and all DOS VMs run at CPU Ring 3. The fact that all Windows programs run in the same process means that there is less protection among them; any one that crashed could take them all down. NT runs all GUI tasks as separate processes, thus providing better overall protection, but at the cost of performance.

The Ring 0 VMM controls all access to memory, I/O ports, and interrupts—both hardware and software. The VMM's control over software interrupts is what allows it to grab control from DOS and selectively perform various tasks itself, or pass them on to DOS to perform. The mechanism is based on software components called Virtual Device Drivers (VxDs), which are, in Shulman's words, "the TSRs of the 90's."

Even when the VMM passes a task on to DOS, DOS does not execute it in the microprocessor's real mode, but rather in a protected VM. There can thus be very complex sequences of events when a nominal DOS call is made by either a DOS or a Windows program. However, tracing even a single example of that kind of event chain far exceeds available space.

Nonetheless, I can provide a flavor of how it works. For example, a DOS character-mode application could issue a call that is serviced by underlying Ring 0 Win95 code running in 32-bit protected mode. Conversely, a Windows program could issue a DOS call that is serviced by plain old DOS running in a 640K VM. In fact, a given call could bounce back and forth several times between one or more VMs and the full 32-bit protected mode VMM. Further, it is even possible for that ultra-protected Ring 0 code to execute DOS VM code. In fact, all three kinds of events happen all the time while Win95 is running.

Whither DOS?

The bottom line here is that DOS is not dead. Its role has progressively diminished, but even in Windows 95, which supposedly does away with DOS, numerous

DOS calls are still executed by DOS running in a protected 386 VM. Windows 95 and Enhanced Mode Windows (all versions) are true 32-bit operating systems and have been so since Windows 3.0 was released in May of 1990.

Microsoft would like people to believe that DOS is dead. DOS rightly scares people who have no interest in learning about installing peripherals or managing memory. Corporate information departments expend all sorts of resources resolving DOS compatibility problems. Hence Microsoft has a vested interest in making it seem as if DOS were gone.

One key component of the W95 architecture is called "Plug 'n' Play." PnP is supposed to provide Macintosh-like ease in system (re)configuration. Just insert or remove a peripheral, reboot, and the system makes any required adjustments. That's the goal, anyway. Attaining that goal, however, will be difficult, because of the huge number of existing PCs and peripherals. It is a certainty that compatibility problems will not go away when W95 is finally released (latest estimate is now August of this year). The only question is whether PnP on new systems will really work as advertised. Meanwhile, don't plan on losing your knowledge of the PC/DOS system architecture.

Ramifications

Shulman makes a number of compelling points. I'll let him speak for himself on one of particular interest: "Windows supports general-purpose non-Microsoft applications in the same way that a rope can be said to support someone who will soon be hanged. Your product may be a Microsoft DLL just waiting to happen." (p. 11)

Second, and related, is the idea, discussed here many times in the past, that the operating system is gradually growing to encompass nearly every software component of value. Extending the concept, Shulman quotes an unnamed source who asserts that "Microsoft Office is the operating system, and Visual Basic the API."

Lotus who? Borland who? Novell who?

The Pentium bug

With the attention given to Intel by the nontechnical media, it's unlikely that anyone could have missed hearing about the infamous Intel division error. Just in case, I've assembled a file of information and test programs; see PENT—BUG.ZIP on the BBS (516-293-2283, v.32, v.42bis).

On a related note, you've probably seen Intel's Nine Lives advertisement in which there are three groups of nine cats. That first group is labeled "386," and all nine cats are covered by big red *X*'s. The second group is labeled "486," and seven of the cats are crossed off. The third is labeled Pentium, and prior to discovery of the bug, none were crossed off. My question is: how many lives did this cost the Pentium? To help ensure truth in advertising, contact Intel's marketing department with the correct number of *X*'s.

Comments to jkh@acm.org. Ω

WHAT'S NEWS

continued from page 4

radio stations for a "financial free-fall." The organization, which serves and represents America's radio and TV stations and all the major broadcast networks, contends that a satellite radio service would chase away national advertising dollars and dilute local audiences, threatening the profitability of the local radio stations.

The NAB is pressing the FCC to adopt an overall policy for digital radio service before considering individual applications for a narrower digital service such as satellite radio. A digital radio service that operates within the AM and FM bands is expected to be demonstrated to the public at the 1995 NAB convention in April.

Maxim and Tektronix form new company

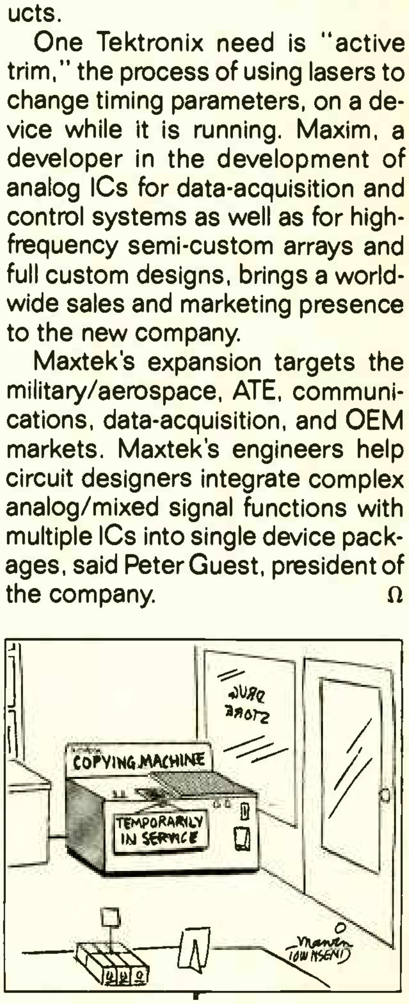
Maxim Integrated Products, Inc. and Tektronix Inc. have formed Maxtek Components Corporation, to develop and manufacture custom, high-frequency multichip modules (MCMs) and hybrids. Maxtek is ISO 9001 certified, employs more than 200 people, and has dozens of engineers working with client MCM and hybrid designs.

Multichip modules are individual electronic packages that contain multiple ICs and passive devices. Hybrid circuits usually contain discrete devices. Both contain devices in packaged or die form, bonded to a ceramic substrate or printed circuit board. The circuits function as RF power amplifiers and front ends for wireless communications, active filters, fiber-optic drivers and receivers, analog-to-digital converters, and ATE components such as pin drivers and attenuators.

Formed last summer, Maxtek is the descendent of the Tektronix MCM and hybrid facility, which produced more than eight million devices since it opened in the early 1970s. The MCM-and-hybrid facility developed unique capabilities to meet the needs of Tektronix, a manufacturer of measurement equipment, color printers, video systems, and network display products.

One Tektronix need is "active trim," the process of using lasers to change timing parameters, on a device while it is running. Maxim, a developer in the development of analog ICs for data-acquisition and control systems as well as for high-frequency semi-custom arrays and full custom designs, brings a worldwide sales and marketing presence to the new company.

Maxtek's expansion targets the military/aerospace, ATE, communications, data-acquisition, and OEM markets. Maxtek's engineers help circuit designers integrate complex analog/mixed signal functions with multiple ICs into single device packages, said Peter Guest, president of the company. Ω



BUYER'S MART

FOR SALE

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

CONTROL anything from anywhere. IR, RF. **Home Automation,** audio/video accessories, discount prices. 1 (800) 528-8556, 24 hour fax (201) 930-8720. **THE CYPRESS GROUP, INC.**

300 Experimenters Circuits — Complete in 6 practical books using diodes, relays, FET's, LED's, IC 555's, and IC CA3130's for building blocks. Only $33.00 plus $5.50 for shipping. USA and Canada only. US funds. **ETT, INC.,** PO Box 240, Massapequa Park, NY 11762-0240.

AT last: Organize and store resistors, diodes, etc. in the Sofpack. Roll up or hang on wall, holds hundreds of components. U.S. patent 5,273,158. Introductory offer, buy one get one free. Send $7.95 + $2.00 s/h. **FATHOM TECHNOLOGIES,** P.O Box 1155, Naples, FL 33939-1155.

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

CABLE test chips. Jerrold, Tocom, S.A., Zenith. Puts cable boxes into full service mode! $29.95 to $59.95. 1 (800) 452-7090, (310) 902-0841.

RESTRICTED information: surveillance, schematics, locksmithing, cable, hacking, etc. Send stamp: **MENTOR,** Box 1549-Z, Asbury, NJ 07712.

SECRET cable descramblers! Build your own descrambler for less than $12.00 **in seven easy steps! Radio Shack** parts list and free descrambling methods that **cost nothing** to try, included. Send $10.00 to: **INFORMATION FACTORY,** Dept. 4, PO Box 669, Seabrook, TX 77586. For COD's (713) 922-3512 any time.

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

CATV test chips as low as $8.95 for testing converter boxes in full service modes. Jerrold, Tocom, Scientific Atlanta, Pioneer BA5XXX — BA67XX cubes clears E2 — E5. **MICRO MASTERS, 1 (800) 360-7654.**

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 (not applicable on credit card orders). **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" × 2⅛"—$410.00; 2" × 2⅛"—$820.00; 3" × 2⅛"—$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 1st of the third month preceding the date of the issue. (i.e., March issue copy must be received by December 1st). 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.

CABLE - TV NOTCH FILTERS

- FOR ELIMINATING RF INTERFERENCE
- FOR BLOCKING UNWANTED CHANNELS

- AVAILABLE FOR VHF CHANNELS Ø THRU 36 AND 95 THRU 99
- PRICING AS LOW AS $12 EACH

Call or write for a FREE brochure today!

STAR CIRCUITS
P.O. BOX 94917
LAS VEGAS, NV 89193
1-800-535-STAR

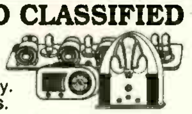
HOME automation & computer control: Two-way IR, two-way X-10, & hardware control devices from serial computer link. **COMPCO,** (615) 436-5189 BBS ext. 12 RIBINFO.ZIP.

CABLE converters, descramblers. Lowest prices available. 2 year warranty, money back guarantee. Visa/MC/C.O.D. 1 (800) 848-3049. **C&C SUPPLY.**

EXCELLENT profits, investment! Complete monitor repair equipment package. $4,995.00 write: **CMR,** 6808 Franklin Ave., Middleton, WI 53562.

CABLE descrambler! Build with 7 **Radio Shack** parts for **under $12.00.** Complete instructions $8.00. **F.A.S.T.,** Box 369-E, Pt. Salerno, FL 34992-0369.

ANTIQUE RADIO CLASSIFIED
Free Sample!
Antique Radio's Largest Circulation Monthly. Articles, Ads & Classifieds.



6-Month Trial: $17.95. 1-Yr: $34.95 ($51.95-1st Class).
A.R.C., P.O. Box 802-L15, Carlisle, MA 01741
Phone:(508) 371-0512 VISA/MC Fax:(508) 371-7129

THE Case Against the Patents. Thoroughly tested and proven alternatives that work in the real world. $28.50. **SYNERGETICS PRESS,** Box 809-C, Thatcher, AZ 85552. (602) 428-4073. Visa/MC.

CABLE descrambling, New secret manual. Build your own descramblers for cable and subscription TV. Instructions, schematics for SSAVI, gated sync, sinewave, (HBO, Cinemax, Showtime, UHF, Adult) $12.95, $2.00 postage. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

CABLE TV equipment & accessories. Wholesalers welcome! 30 day moneyback guarantee! Free catalog! **PERFORMANCE ELECTRONICS, INC., 1 (800) 815-1512.**

DESCRAMBLE cable with simple circuit added to Radio Shack RF modulator and using VCR as tuner. Instructions $10.00. **TELCOM,** Box 832-E4, Brusly, LA 70719.

Learn VCR repair!
Home study. Learn high-profit repairs without investing in high tech instruments.
Free career literature: 800-223-4542.

Name ______ Age ___
Address ______
City ______ State ___ Zip ______

The School of VCR Repair, Dept. VRE342
PCDI, 6065 Roswell Rd., Atlanta, GA 30328

CABLE TV converters. Jerrold, Zenith, Pioneer, Oak, Scientific Atlanta, and many more. 12 years experience gives us the **advantage.** Visa/MC Amex COD **ADVANTAGE ELECTRONICS, INC., 1 (800) 952-3916** 1125 Riverwood Dr., Burnsville, MN 55337.

CB Radio Modifications! Frequencies, 10M, sliders, FM, amplifiers, books, kits, repairs, high-performance accessories. The best since 1976! Catalog $3.00. **CBCI,** Box 31500EN, Phoenix, AZ 85046.

CABLE test-chips as low as $9.95, for testing cable boxes **in full service** mode. Jerrold: Starcom VI, VII & **R2 V5.** Jerrold cubes; Pioneer, clears E2 thru E5; Pioneer cubes: BA-5000 thru BA-6700; Tocom 5503/5507; Scientific Atlanta: 8500 thru 8600; Zenith: all but PZ1; **N.E. ENGINEERING,** 1 (800) 926-4030 sales, (617) 770-3830 tech, (617) 770-2305 fax.

TV Notch filters, free brochure, **MICRO THINC.,** Box 63/6025, Margate, FL 33063. (305) 752-9202.

CABLE test chips. Put your cable box in full test mode. Call (303) 731-9400.

DEALERS Only: Test chips at below wholesale prices. Scientific Atlanta quick boards and 40-pin micros. Jerrold compatible for all models starting with DP, DPV, DPBB & CFT, including R2 & V5. Pioneer 3-wire and custom 6300's. Zenith & Tocom. Direct from manufacturer, we guarantee the lowest prices. Software and master files available. We also have converters & descramblers priced to move. Visa, Mastercard, C.O.D. 1 (800) 618-7480 ext. 111.

CABLE BOX
WHOLESALERS, INC.
BEST BOXES—BEST PRICES
Immediate Shipping—COD's
Satisfaction Guaranteed
FREE Catalog—Call Now
800-841-7835

REAL STUFF! Surveillance, people tracking, entry, night vision — lowest prices. Catalog $15.00 1(800) 805-5544. **INTELLIGENCE INCORPORATED,** Dept. CQ, 2228 El Camino Real, San Mateo, CA 94403.

CABLE descramblers. Bargain headquarters. Wholesale prices. Absolutely the lowest prices! Money back guarantee. Nobody beats us! **RP ELECTRONICS,** 1 (800) 304-3604.

TEST equipment pre-owned now at affordable prices. Signal generators from $50.00, oscilloscopes from $50.00. Other equipment including manuals available. Send $2.00 U.S. for catalog refunded on first order. **J.B. ELECTRONICS,** 3446 Dempster, Skokie, IL 60076. (708) 982-1973.

CABLE TV why rent? When you can own. Low prices, quality products. Call tonite 6pm - 11pm EST. 1 (800) 865-7493. Free catalog. TRUE VALUE ELECTRONICS, PO Box 591, Lincoln, NH 03251.

CONVERTER — descramblers: Examples, Zenith Ztac $235.00, Scientific Atlanta 85XX $185.00, 8600 $325.00, Jerrold 400 $99.00, DPV 7212 $235.00, DPV-6 $215.00, Oak RTC56 $99.00, M35b $45.00. **All Pioneer test generator** $165.00. Most makes in stock, COD ok. **MOUNT HOOD ELECTRONICS,** (503) 543-7239.

CABLE TV DESCRAMBLERS
• Quantity Discounts • 24 Hour Shipping
• Save Money Don't Rent
NOBODY BEATS OUR PRICE
Call Us Last For Best Price
1-800-677-0321
Anyone implying theft of service will be denied service
VCI - NO FLORIDA SALES

SATELLITE TV

FREE catalog — Lowest prices worldwide. Satisfaction guarantee on everything sold — Systems, upgrades, parts, all major brands factory fresh and warrantied. **SKYVISION,** 1012 Frontier, Fergus Falls, MN 56537. 1 (800) 334-6455. Outside US (218) 739-5231.

VIDEOCYPHER II descrambling manual. Schematics, video and audio. Explains DES, Eprom, CloneMaster, Pay-per-view (HBO, Cinemax, Showtime, Adult, etc.) $16.95, $2.00 postage. Schematics for Videocypher II Plus, $20.00. Schematics for Videocypher II 032, $15.00. Software to copy and alter Eprom codes, $25.00. VCII Plus Eprom, binary and source code, $30.00. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

PAY TV AND SATELLITE DESCRAMBLING
all new info Volume 6 all new info

Volume 6: Our entire collection of all current cable satellite and wireless turn-onsPay TV volumes 1-5 (all different Vol. 1 basics) Satellite and DBS Handbook (includes Hacker info) Wireless Cable Hacking Hacker Video Compleat Wizzard (VCII+) Cellular Phone Hacking $15.95 each or 3/34.95 or 5/52.95. Newsletter $29.95/12 issues. Catalog $1. All our info $129.95 (includes sub)

Scrambling News
3494 Delaware Ave., Buffalo, NY 14217-1230
Voice/FAX 716-874-2088 BBS 716-871-1915

WANTED

TEST equipment wanted; top prices paid! Please send or fax your offer to: **HTB ELEKTRONIK,** Alter Apeler Weg 5, 27619 Schiffdorf, West Germany. Fax: 01149-4706-7049.

CABLE TV TURN-ON CHIPS

SUPER Cable TV "Test Chips". Provides full service activation. Excellent; instructions & illustrations. **Jerrold Starcom: DP(V)5.. DP(V)7..DPBB7..CFT-2000 series. Pioneer: BA-5000 thru BA-6700. Scientific Atlanta:** 8500 thru 8600. **Tocom:** 5503-VIP..5507. **Zenith:** ST-1000 thru ST-5000. **Call now!! MASTER COMPONENTS. 1 (800) 233-0570.**

NEW Product Announcement
Universal Cable TV Descrambler
No Converter Necessary
Works With All Systems
Call 1-800-664-6999
VISA

BUSINESS OPPORTUNITIES

EASY work! Excellent pay! Assemble products at home. Call toll free **1 (800) 467-5566** Ext. 5192.

START your own technical venture! Don Lancaster's newly updated **Incredible Secret Money Machine II** tells how. We now have autographed copies of the Guru's underground classic for $18.50. **SYNERGETICS PRESS,** Box 809-C, Thatcher, AZ 85552. (602) 428-4073. Visa/MC.

Your One Stop Component & Computer Source

Please mention VIP #4R5 to expedite your order!

Electronic Kits

velleman-kit

Universal Mono Pre-amplifier

NEW

- Requires power supply: 10-30 VDC/10 mA (P/N 20626)
- Output impedance: 1 Kohm
- Adjustable output level
- Frequency range: 20 Hz to 20 KHz +/-3dB
- Max. input signal: 40 mV
- PCB dimensions: 1.2" x 1.76"
- Weight: 0.31 lbs.

Part No.	Description	1-9	10-24
117612	Pre-amplifier	$9.95	$8.95

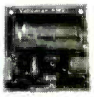
FM Oscillator

Mini FM transmitter (100-108 MHz) is ideal for family broadcasts, baby monitor, security. May be received by any portable FM radio or tuner.

- Integrated pre-amplifier (sensitivity 5 mV)
- Requires power supply: 9-12 VDC (P/N 20626 or equivalent)
- PCB dimensions: 1.8" x 2.8"
- Weight: 0.33 lbs.

Part No.	Description	1-9	10-24
117604	FM Oscillator	$12.95	$11.49

1 Amp Power Supply



Provides a regulated voltage adjustable between 1.2 and 35 Volts at 1 Amp. LM317 regulator gives you remarkably better ripple and regulation characteristics than conventional regulators.

- Output current max. 1.5A
- Requires Power transformer 36 VCT @ 1.5A (P/N 104416 or equivalent)
- Max. dissipation 15 W (cooled)
- Max. input voltage 40 V
- PCB dimensions: 2.08" x 2.08"
- Weight: 0.34 lbs.

Part No.	Description	1-9	10-24
117621	Power supply	$12.95	$11.49

Stroboscope

- Flash frequency adjustable from 2 to 20 Hz.
- Input: 110VAC
- Weight: 0.23 lbs.
- PCB dimensions: 3.48" x 2.6"

Part No.	Description	1-9	10-24
117639	Stroboscope	$19.95	$17.95

Wireless Remote Control

- Over 8000 codes
- Use several transmitters with one receiver
- Receiver/transmitter range: 100 ft.

117647:
- 2 channel transmitter
- Key ring housing
- Power supply: 12V battery type V23GA
- Wt.: 0.36 lbs.

117655: • 1 channel receiver
- Relay output 10A toggle or pulse contact
- LED indicator • Separate output to switch car alarm on or off
- Power supply: 18 VCT transformer (P/N 105531) or Power Source
- PCB dimensions: 3.04" x 3.64"
- Weight: 0.49 lbs.

Part No.	Description	1-9	10-24
117647	Transmitter	$29.95	$26.95
117655	Receiver	39.95	35.95

Portable Computer Monitor Tester

NEW

- Tests CGA, EGA, VGA and MAC-II types of monitors
- Multiple resolutions: 640 x 200, 640 x 350, 640 x 480, 720 x 400, 800 x 600 and 1024 x 768
- 1024 x 768 Interlaced and Non-Interlaced modes; 48KHz Sync on Green (MAC-II)
- Power requirements: AC adapter or battery for portability (both included)
- Color bars, Gray scale, Cross hatch and Red/Blue/Green purity test screens
- Includes adapter for MAC-II monitors
- Size: 3.5"L x 6.0"W x 1.38"H
- Weight: 1.59 lbs.

Part No.	Description	1-9	10-24
119001	Monitor Tester	$299.95	$269.95

29 Watt Linear Power Supply

- Input voltage: 120/240VAC @ 50/60Hz
- Size: 8.19"L x 6"W x 1.88"H • Weight: 3.1lbs.

Output: + 5VDC @1A, +24VDC @1A

Part No.	Product No.	Price
111982	CP516A	$12.95

Portable IC Tester

- Hand-held & easy-to-operate.
- Supports TTL, CMOS, DRAM 41, and DRAM 44 series
- Size: 7"L x 3.625"
- One-year warranty

Part No.	Description	Price
73525	Portable IC tester	$139.95

1 Socket 16K-2MB E(E)PROM Programmer

- Programs EPROM's, EEPROM's, and flash memories
- Programs 16KB to 2MB EPROM's
- Menu driven software
- Full screen buffer editor
- File formats supported: Intel Hex, Motorola S Hex, Tektronix Hex, and Binary
- 2 & 4-way Binary file splitting programs
- 2 & 4-way Binary file shuffler programs
- Includes adapter card, software and manual
- Size: 7"L x 5.5"W x 1.75"H
- One-year warranty

Part No.	Description	Price
101400	1 Socket 16K-512KB	$129.95
78457	1 Socket 16K-2MB (above)	199.95
78465	4 Socket 16K-2MB Programmer	269.95
104651	1 Socket 16K-8MB Universal	699.95

486SX 33MHz Bare-bones System

Includes motherboard, case, power supply, keyboard & IDE I/O card.

- Intel 80486SX-33 CPU
- Memory expandable to 32MB
- 256KB cache memory
- Two-year warranty
- 1 parallel, 1 game & 2 RS232 serial ports

Part No.	Description	Price
118973	486SX 33MHz	$459.95

286 12MHz Bare-bones System

Includes motherboard, computer case, power supply & keyboard

- Intel 286 12MHz CPU
- 1MB RAM
- 1.2MB (5.25") floppy disk drive
- IDE hard/floppy controller
- Five expansion slots
- Two serial & one parallel ports

Part No.	Description	Price
115705	286 12MHz	$149.95

Hyundai 2400bps Modems

- PC/XT/AT and compatible computers
- Hayes compatible
- 8-bit card
- CCIT V.22/V.22 bis & Bell 103/212A compatible
- Includes communication software

Part No.	Description	Price
106569	Internal 2400 Baud	$19.95
106577	External 2400 Baud	24.95

TTL Integrated Circuits

Part No.	Product No.	1-9	10-99
48979	7400	$.29	$.25
49040	7404	.29	.25
49120	7407	.35	.29
49146	7408	.35	.29
50420	7447	1.29	1.19
50551	7474	SALE	.25
50577	7475	.39	.35
50593	7476	.45	.39
50681	7489	2.69	2.49
50690	7490	.69	.59
50745	7493	SALE	.49
49293	74116	SALE	.99
49322	74121	.89	.79
49373	74125	.49	.45
49509	74150	1.19	1.09
49568	74154	1.29	1.09
49883	74189	1.95	1.75

CMOS Integrated Circuits

Part No.	Product No.	1-9	10-99
12677	CD4013	SALE	$.25
12749	CD4017	.49	.45
12925	CD4029	.49	.45
13055	CD4049	.29	.25
13215	CD4067	1.79	1.59
13400	CD4093	.35	.29
13590	CD4522	.89	.79
13653	CD4538	.69	.59
44564	74C922	5.95	5.49
44572	74C923	7.95	7.25
45330	74HC138	.39	.35
45401	74HC154	1.49	1.35
46199	74HC942	9.95	8.95
46201	74HC943	12.95	11.95

Jameco ABS Speedy Boxes

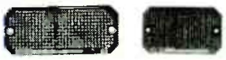
Will not crack or split when drilled or punched. PCB mounting slots on all four sides and the lid has a lip for precision fit. Complete with four screws and lid. Color: black

Part No.	Inside Dimens. (LxWxH)	Price
18921	3.125" x 2.0" x 0.875"	$1.95
18913	4.875" x 2.5" x 1.5"	2.49
18892	6.0" x 3.5" x 1.875"	2.25
18905	7.5" x 4.25" x 2.25"	3.49

Jameco Prototype Builder Boards:

The Jameco Prototype Boards are designed to fit into ABS Speedy Boxes. These pre-cut boards will allow the builder an immediate start on proto-typing circuits. Each board has 2 or 4 mounting holes. Drilled holes: .040" dia. on .080" square pad on .10" x .10" spacing. Solder mask.

VALUE



Part No.	Size (L x W)	Fits	Price
105099	2.70" x 1.60"	18921	$2.95
105128	4.40" x 2.00"	18913	4.95
105152	5.50" x 3.10"	18892	5.95
105161	7.00" x 3.60"	18905	7.95
106551	Ckt. Brd. Hdwr. (4 sets)		1.19

Call for complete line of boxes & PC Boards!

Potentiometers

3/8" Square Single-Turn Cermet

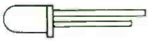
Part No.	Product No.	Ohms	1-9
42964	63P1K	1K	$.79
43078	63P5K	5K	.79
43001	63P10K	10K	.79
43051	63P20K	20K	.79
43027	63P100K	100K	.79
42981	63P1MEG	1MEG	.79

3/4" Rectangular 15-Turn Cermet

Part No.	Product No.	Ohms	1-9
41785	43P1K	1K	$.79
41890	43P5K	5K	.79
41822	43P10K	10K	.99
41873	43P20K	20K	.99
41911	43P50K	50K	.99
41849	43P100K	100K	.99
41806	43P1MEG	1MEG	.79

LEDs

SALE



Part No.	Color	Size	1-9
34606	Green	T1	$.10
34622	Red	T1	.08
94529	Bright Red	T1	.17
34657	Yellow	T1	.15
34761	Green	T1-3/4	.15
34796	Red	T1-3/4	.12
94511	Bright Red	T1-3/4	.39
34825	Yellow	T1-3/4	.15
98950	Green	Jumbo (8mm)	.18
81461	Red	Jumbo (8mm)	.25
98968	Yellow	Jumbo (8mm)	.18

Carbon Film 1/4 Watt 5% Resistor Assortments

SALE

Part No.	Description	Price
10719	5 each 70 values	$9.95
10663	100 each (27 values)	19.95

JAMECO® ELECTRONIC COMPONENTS COMPUTER PRODUCTS

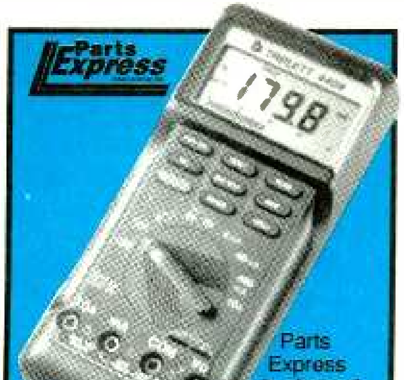
1355 Shoreway Road
Belmont, CA 94002-4100
FAX: 1•800•237•6948 (Domestic)
FAX: 415•592•2503 (International)
TEL: 415•592•8097 (International)

Call for our new 1995 Catalog today.
Mention V.I.P.# 4R5

No minimum order required! © 1995 Jameco 4/95

Call 1-800-831-4242 to order today!

CIRCLE 114 ON FREE INFORMATION CARD



Parts Express is pleased to announce that we are now stocking the complete line of fine multimeters from Tripplett Corporation. Tripplett has been producing high quality test and measurement equipment since 1904. For more information and to get a copy of our FREE 188 page catalog call our toll free number.

FREE CATALOG

1-800-338-0531
Phone: (513) 222-0173
FAX: (513) 222-4644
Parts Express Int'l Inc.
340 East First St.
Dayton, OH 45402-1257

CIRCLE 56 ON FREE INFORMATION CARD

EDUCATION & INSTRUCTION

HISTORIC and Classic hardware support magazine. ***The Computer Journal*** provides how-to information on keeping S-100, Kaypro, Z80, 6809, CP/M, and PC/XT systems running. Over **ten** years of hardware, software projects. 6 issues $24.00. Free sample. 1 (800) 424-8825. **TJC,** PO Box 535, Lincoln, CA 95648.

TEACHING BASIC TRANSISTOR THEORY IS DIFFICULT!

We have the answer! Our new 18 page text "TRANSISTORS TODAY" is simple, and easy to understand. With most other text books, the basic theory is difficult to grasp. They start with complicated explanations of electrons flowing to "holes", majority carriers, and other advanced physics theories. This is all valid, but very confusing, and not really necessary. No more than it is necessary to understand the chemical reactions in a battery before using it in an electrical circuit.

Our approach is simpler. It only concerns the practical FUNCTIONS of transistors as they perform when voltages and currents are applied to them in electrical circuits.

We guarantee that after 30 minutes with our text, anyone who had not grasped the basics of transistors will have a much clearer understanding. Elementary electrical theory, educational projects and practical info. are also included.

IN ALL, A UNIQUE AND VERY USEFUL PUBLICATION.

Send check or money order for $5.85 to:
THERMADYNE INC., Box 6167 (Dept. 5), Arlington, VA 22206

name ____________________

address ____________________

____

BECOME AN ELECTRICIAN!

Career-level home study course. Train now to make good money working on electrical systems in homes and businesses. Learn circuits, wiring, lighting, control panels, appliances, phones, cables, more. **Free career literature.**

800-223-4542

Name ____________ Age ____

Address ____________ Phone ( )

City ____________ State ____ Zip ____

THE ELECTRICIAN SCHOOL
Dept. TEE342, 6065 Roswell Rd., PCDI, Atlanta, GA 30328

ELECTRONIC engineering. 8 volumes complete. $109.95. No prior knowledge required. Free brochure. **BANNER TECHNICAL BOOKS,** 1203 Grant Avenue, Rockford, IL 61103.

ELECTRICITY/Electronics training **series** used by US military. 24 volumes, other courses available. Free catalog. **FEDERAL TECHNICAL PUBLISHERS,** Box 1218 E., Glen Lake, MN 55345.

MEMBRANE SWITCH KITS!

These highly durable water resistant flat-panel keypads can be assembled in minutes with YOUR legend! Available in 4, 12, 16, 24 & 40 Key models. Steel "clickdomes" optional. Connector and bezel included.

Call for free brochure

Sil-Walker 880 Calle Plano Unit N
Camarillo, CA 93012
(805) 389-8100 FAX (805) 484-3311

PLANS AND KITS

FIBER Optics experimenters parts, supplies and tools: Fiber, cable, connectors, splices, detectors, lasers, kits, plans, newsletter. Send $2.00 for catalog. **LIGHTLINE ENGINEERING,** PO Box 24, Mullica Hill, NJ 08062.

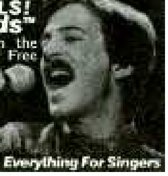
SURVEILLANCE
& COUNTERSURVEILLANCE Electronic Devices

Covert Video Cameras • Transmitter Kits • Voice Changers
Bug and Phone Tap Detectors • Shotgun Mics • Micro Recorders
• Vehicle Tracking • Locksmithing • AND MORE!

16 - Hour Telephone Recorder - silently tapes incoming/outgoing phone calls automatically. *$199.00*

SPY OUTLET FOR CATALOG SEND $5.00 TO... P.O. Box 337, Buffalo, NY 14226 (716) 691-3476 CREDIT CARDS WELCOME

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 IE-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

CALLER ID! 150 name & number storage; works stand-alone or with your PC via RS232.

Multistation Thermometer Kit: LCD, 4 stations
Telephone Dialer Kit: 240 number memory, LCD

Call for kit information! 1-800-772-3945

GENOA Group, 7304 S. Alton Way, Unit A, Englewood CO 80112

60 SOLDERLESS Breadboard Projects in two easy-to-read pocket books. Complete with circuit descriptions, schematics, parts layouts, component listings, etc. Both book (BP107 & BP113) only $11.90 plus $3.50 for shipping. USA and Canada only. US funds. **ETT, INC.,** PO Box 240, Massapequa Park, NY 11762-0240.

SURVEILLANCE Transmitter kits, 65 to 305 MHz. **Quick & Easy** Partially assembled units. Five minutes completion. 110-volt duplex receptacle, room battery types, and telephone. Countersurveillance. Catalog: $2.00. **SHEFFIELD ELECTRONICS,** PO Box 377940-C, Chicago, IL 60637-7940.

CRYSTAL set Handbook — Visit antiquity by building the radios your grandfather built. Assemble a "Quaker Oats" rig, wind coils that work and make it look like the 1920's! Only $10.95 plus $3.50 for shipping and handling. **CLAGGK INC.,** PO Box 4099, Farmingdale, NY 11735. US funds only! USA and Canada — no foreign orders.

SURVEILLANCE/Countersurveillance, bugging/phone tapping detector,telephone/fax encryption, vehicle tracking, covert video, transmitters kit, and more...**A.B. ELECTRONICS,** 1 (800) U-ANTI-BUG.

ALL-in-one catalog. AM/FM/ham/spy, transmitters, amplifiers, receivers. Voice scramblers/disguisers, audio, TV, Tesla coils, plans, "secret" books, kits, imports, exports and more. Start your own licensed or unlicensed radio station, 60 full pages for $1.00. **PAN-COM INTERNATIONAL,** PO Box 130-F4, Paradise, CA 95967.

FASCINATING kits! Lasers, voice changers, gas sensors, and more! Send $1.00 for catalog. **LNS TECHNOLOGIES,** 20993 Foothill Blvd., Suite 307R, Hayward, CA 94541-1511.

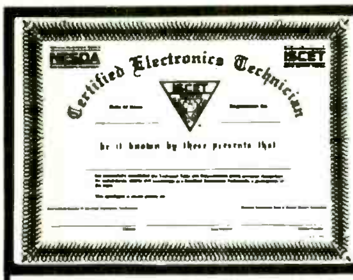
PROFESSIONAL plans for UHF TV & stereo FM broadcasting transmitters, amplifiers, antennas and UHF power transistors. Catalog — $2.00 **V & J ELECTRONICS,** PO Box 934, Cranbrook, B.C. Canada V1C 4J6.

1TUBE 80-40 breadboard transmitter kit. Not a toy! Complete kit for both 80 and 40 meter amateur bands. To order send $39.00 to **N2EDF,** PO Box 185, Ogdensburg, NJ 07439. Or write for more information.

FCC Commercial License
Radiotelephone-Radiotelegraph-GMDSS.
Fast, Easy, Inexpensive Homestudy Guides, Audio, Video, Q&As, PC Disks-Career Guide.
Guarantee Pass! 1000s of satisfied customers.
FREE DETAILS.
WPT Publications.
4701 NE 47 St. Vancouver, Wa. 98661
#800-800-7589

GIVE THE POWER TO BECOME.

Easter Seals



ADMIT ONE

Your Ticket To SUCCESS

Over 28,000 technicians have gained admittance worldwide as certified professionals. **Let your ticket start opening doors for you.**

ISCET offers Journeyman certification in Consumer Electronics, Industrial, Medical, Communications, Radar, Computer and Video. For more information, contact the **International Society of Certified Electronics Technicians, 2708 West Berry Street, Fort Worth, TX 76109; (817) 921-9101.**

Name ____________________

Address ____________________

City ____________________

State ____________ Zip ____________

____ Send material about ISCET and becoming certified.

____ Send one "Study Guide for the Associate Level CET Test." Enclosed is $10 (inc. postage).

Be a PC repair expert!

Home study. Learn PC repairs, troubleshooting, installation, upgrading, servicing. **For free career literature, call now: 800-223-4542.**

Name ____________ Age ______

Address ____________

City ____________ State ______ Zip ______

The School of PC Repair, Dept. JJE342, PCDI
6065 Roswell Road, Atlanta, Georgia 30328

INVENTIONS

FREE Invention package: DAVISON AND ASSOCIATES offers customized development, patenting, and licensing for new products and ideas. Proven results: 1 (800) 677-6382.

SECURITY PRODUCTS

ALARM industry equipment, huge discounts. Cameras, control panels, motion detectors, sirens, batteries, switches, more. 1 (800) 335-2296, fax (519) 541-1277.

NEW DESCRAMBLER TECHNOLOGY REVEALED

REVEALED Halcyon's new universal 4000 descrambler! My manual/kits perfects all universal descramblers guaranteed. **SNOW,** POB 22048, Lansdowne, St. John, Canada E2K 4T7.

MASTERCARD AND VISA are now accepted for payment of your advertising. Simply complete the form on the first page of this section and we will bill. $15.00 minimum.

Do-It-Yourself Electronic Kits

Free Catalog Available

Call 213/ 888-8988 Fax 213/ 888-6868

Mark V Electronics 8019 E. Slauson Ave., Montebello, CA 90640

▲ Beginner ▲▲ Intermediate ▲▲▲ Advanced!!

Stereo Loudspeaker Protector TY-25 ▲

Kit: $ 16.75

Super fast acting relay protects speaker against destructive DC voltage. Can connect directly to a power amp. or can use a separate power supply. Has a 3 second turn-on delay to avoid turn-on thumps.

120W MOSFET Power Mono Amp. TA-477 ▲▲

Kit: $ 70.00

120W into 8 ohms RMS. THD: < 0.007%. Frequency Response: 8 HZ-20 KHZ, + 0-0.4 dB. 2.8 HZ-65 KHZ, + 0-3 dB. Sensitivity: 1V. Power Requirement: 55V DC @ 3A. May use Mark V Model # 003 or # 012 transformer.

300W High Power Mono Amp. TA-3600 ▲▲▲

Kit: $ 89.00

300W into 8 ohms RMS. Frequency Response: 10 HZ-20 KHZ. THD :< 0.05%. Sensitivity: 1V rms at 47K. Power Requirements: 60-75V DC at 8A. May use Mark V Model # 007 or # 009 transformer.

30W+30W Pre & Main Stereo Amp. TA-323A ▲

Kit: $ 32.50

30W into 8 ohms RMS per channel. THD:< 0.1% from 100 HZ-10KHZ. Phono 3mV @ 47K. Tuner, Tape 130mV @ 47K. Power Requirement: 22-36V AC, 3A. May use Mark V Model # 002 transformer.

Metal Cabinets			Power Transformers		
LG-1273	3X12X7"	$ 26.50	#001	28/30VX2 6A	$30.00
LG-1684	4X16X8"	32.50	#002	36VX2 3A	25.00
LG-1924	4X19X11½"	38.25	#003	40VX2 6A	32.00
LG-1925	5X19X11½"	42.00	#004	24VX2 6A	25.00
LG-1983	2¼X19X8"	35.25	#005	26VX2 3A	19.00
			#006	18VX2 5A	19.00
			#007	53VX2 8A	47.00
			#009*	48/53VX2 8A	66.00
			#012*	24/42VX2 6A	48.00

Cabinet *Toroidal Transformer

Minimum order $20.00 We accept Visa, MasterCard, Money orders and Checks. Please call for shipping charges. Quantity discounts available.

ORDER 1-800-521-MARK/1-800-423-FIVE

CIRCLE 93 ON FREE INFORMATION CARD

TENMA™ TEST EQUIPMENT

Digital Sound Level Meter

High Tech DMM

Quality you can Afford

Tenma, is rapidly emerging as the top choice of test equipment among todays service professionals. Regardless of your test and measurement needs, Tenma can meet your demands. TENMA's complete line of DMMs, oscilloscopes, frequency counters, power supplies, pattern generators and more, can be found at MCM Electronics. Call today for your free MCM catalog filled with over 21,000 items including service parts, tools, semiconductors and...

TENMA test equipment.

FREE CATALOG
1-800-543-4330

Technical questions . . . 1-800-824-TECH(8324)

MCM ELECTRONICS℠
650 CONGRESS PARK DR.
CENTERVILLE, OH 45459-4072
A PREMIER Company

Get fast delivery from our distribution facilities near Dayton, OH and Reno, NV!

New hours: M–F 7 a.m.–9 p.m., Sat. 9 a.m.–6 p.m., EST.

EN-95

CIRCLE 87 ON FREE INFORMATION CARD

ADVERTISING INDEX

Electronics Now does not assume any responsibility for errors that may appear in the index below.

Gernsback Publications, Inc.
500-B Bi-County Blvd.
Farmingdale, NY 11735
1-(516) 293-3000
Larry Steckler, EHF/CET
President

Christina Estrada
assistant to the President

For Advertising ONLY
516-293-3000
Fax 1-516-293-3115

Larry Steckler
publisher

Arline Fishman
advertising director

Denise Mullen
advertising assistant

Kelly Twist
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
1 Overlook Ave.
Great Neck, NY 11021
1-516-487-9357
Fax 1-516-487-8402

MIDWEST/Texas/Arkansas/Okla.
Ralph Bergen
Midwest Advertising
One Northfield Plaza, Suite 300
Northfield, IL 60093-1214
1-708-446-1444
Fax 1-708-559-0562

PACIFIC COAST
Blake Murphy
Pacific Advertising
Hutch Looney & Associates, Inc.
6310 San Vicente Blvd.
Suite 360
Los Angeles, CA 90048
1-213-931-3444
Fax 1-213-931-7309

Electronic Shopper
Joe Shere
National Representative
P.O. Box 169
Idyllwild, CA 92549
1-909-659-9743
Fax 1-909-659-2469

NEW!! FAX US YOUR FREE INFORMATION CARDS FOR EVEN FASTER SERVICE!

Now you can send your requests for Free Information by **FAX** *or* mail. It's simple, it's easy—just follow these three steps:

1 Print your name, address and Zip Code on one of the attached cards.

2 Circle the number (or numbers) on the card that matches the number at the bottom of each ad or editorial item that you want information on. Advertisers' free information numbers also appear in the ad index.

3 **FAX** the complete card to us at 413-637-4343 or if you prefer, drop the card in the mail.

NOTE: Submit all Free Information requests by either **FAX** or mail, **NOT BOTH! DUPLICATE REQUESTS WILL BE DISCARDED.** Use the **FAX** telephone number and the postcard address for Free Information only. Address all editorial inquiries to Editor, Electronics Now®, 500-B Bi-County Blvd., Farmingdale, NY 11735

BUSINESS PROFESSIONAL FREE INFO CARD

Electronics NOW®

1-495

Name ________ Title ________

Company ________

Dept. MS ________

Daytime Business Phone ________

Company Address ________

City ________ State ________ Zip +4 ________

Unclear or incomplete mailing info will prevent our processing this request.

1 ☐ Please send me 12 issues (1 year) of ELECTRONICS NOW for $17.97 and bill me.

3 ☐ Please send me 12 issues (1 year) of POPULAR ELECTRONICS for $18.95 and bill me.

Do you own an oscilloscope? 5 ☐ Yes 6 ☐ No

Which types? (check all that apply)

7 ☐ 50 Mhz 8 ☐ 100 Mhz 9 ☐ 200 Mhz 10 ☐ Storage 11 ☐ Dual Trace

	22	43	64	85	106	127	148	169	190	211	232	253	274	295	316	337	358
	23	44	65	86	107	128	149	170	191	212	233	254	275	296	317	338	359
	24	45	66	87	108	129	150	171	192	213	234	255	276	297	318	339	360
	25	46	67	88	109	130	151	172	193	214	235	256	277	298	319	340	361
	26	47	68	89	110	131	152	173	194	215	236	257	278	299	320	341	362
	27	48	69	90	111	132	153	174	195	216	237	258	279	300	321	342	363
	28	49	70	91	112	133	154	175	196	217	238	259	280	301	322	343	364
	29	50	71	92	113	134	155	176	197	218	239	260	281	302	323	344	365
	30	51	72	93	114	135	156	177	198	219	240	261	282	303	324	345	366
	31	52	73	94	115	136	157	178	199	220	241	262	283	304	325	346	367
	32	53	74	95	116	137	158	179	200	221	242	263	284	305	326	347	368
	33	54	75	96	117	138	159	180	201	222	243	264	285	306	327	348	369
	34	55	76	97	118	139	160	181	202	223	244	265	286	307	328	349	370
14	35	56	77	98	119	140	161	182	203	224	245	266	287	308	329	350	371
15	36	57	78	99	120	141	162	183	204	225	246	267	288	309	330	351	372
16	37	58	79	100	121	142	163	184	205	226	247	268	289	310	331	352	373
17	38	59	80	101	122	143	164	185	206	227	248	269	290	311	332	353	374
18	39	60	81	102	123	144	165	186	207	228	249	270	291	312	333	354	375
19	40	61	82	103	124	145	166	187	208	229	250	271	292	313	334	355	376
20	41	62	83	104	125	146	167	188	209	230	251	272	293	314	335	356	377
21	42	63	84	105	126	147	168	189	210	231	252	273	294	315	336	357	378

FREE INFORMATION CARD

VOID after JUNE 30, 1995 **Allow 6-8 weeks for delivery of first issue**

NO POSTAGE NECESSARY IF MAILED IN THE UNITED STATES

BUSINESS REPLY MAIL

FIRST CLASS MAIL PERMIT NO. 597 BOULDER, CO

POSTAGE WILL BE PAID BY ADDRESSEE

Electronics NOW

SUBSCRIPTION SERVICE
P.O. Box 51866
BOULDER, COLORADO 80321-1866

BUSINESS PROFESSIONAL FREE INFO CARD

Electronics NOW®

2-495

Name ________ Title ________

Company ________

Dept. MS ________

Daytime Business Phone ________

Company Address ________

City ________ State ________ Zip +4 ________

Unclear or incomplete mailing info will prevent our processing this request.

1 ☐ Please send me 12 issues (1 year) of ELECTRONICS NOW for $17.97 and bill me.

3 ☐ Please send me 12 issues (1 year) of POPULAR ELECTRONICS for $18.95 and bill me.

Do you own an oscilloscope? 5 ☐ Yes 6 ☐ No

Which types? (check all that apply)

7 ☐ 50 Mhz 8 ☐ 100 Mhz 9 ☐ 200 Mhz 10 ☐ Storage 11 ☐ Dual Trace

	22	43	64	85	106	127	148	169	190	211	232	253	274	295	316	337	358
	23	44	65	86	107	128	149	170	191	212	233	254	275	296	317	338	359
	24	45	66	87	108	129	150	171	192	213	234	255	276	297	318	339	360
	25	46	67	88	109	130	151	172	193	214	235	256	277	298	319	340	361
	26	47	68	89	110	131	152	173	194	215	236	257	278	299	320	341	362
	27	48	69	90	111	132	153	174	195	216	237	258	279	300	321	342	363
	28	49	70	91	112	133	154	175	196	217	238	259	280	301	322	343	364
	29	50	71	92	113	134	155	176	197	218	239	260	281	302	323	344	365
	30	51	72	93	114	135	156	177	198	219	240	261	282	303	324	345	366
	31	52	73	94	115	136	157	178	199	220	241	262	283	304	325	346	367
	32	53	74	95	116	137	158	179	200	221	242	263	284	305	326	347	368
	33	54	75	96	117	138	159	180	201	222	243	264	285	306	327	348	369
	34	55	76	97	118	139	160	181	202	223	244	265	286	307	328	349	370
14	35	56	77	98	119	140	161	182	203	224	245	266	287	308	329	350	371
15	36	57	78	99	120	141	162	183	204	225	246	267	288	309	330	351	372
16	37	58	79	100	121	142	163	184	205	226	247	268	289	310	331	352	373
17	38	59	80	101	122	143	164	185	206	227	248	269	290	311	332	353	374
18	39	60	81	102	123	144	165	186	207	228	249	270	291	312	333	354	375
19	40	61	82	103	124	145	166	187	208	229	250	271	292	313	334	355	376
20	41	62	83	104	125	146	167	188	209	230	251	272	293	314	335	356	377
21	42	63	84	105	126	147	168	189	210	231	252	273	294	315	336	357	378

FREE INFORMATION CARD

VOID after JUNE 30, 1995 **Allow 6-8 weeks for delivery of first issue**

.19¢ POSTAGE
REQUIRED IN
U.S.A.

Electronics NOW

READER SERVICE MANAGEMENT DEPT.
P.O. BOX 5192
PITTSFIELD, MA 01203-5192

Electronics NOW

For Faster Service Call Today
1-800-999-7139

4ND50

Subscribe today to the magazine that keeps you up-to-date with the newest ideas and innovations in electronics. (If you already are a subscriber, do a friend a favor and pass this subscription card along to them.)

check offer preferred

☐ 1 year—12 issues **ONLY $17.97**
(You save $24.03 off single copy price)
Basic Subscription Rate 12 iss./$19.97

☐ 2 Years **(SAVE MORE)**—24 issues $34.97
(You save $49.03 off single copy price)
Basic Subscription Rate 24 iss./$38.97

☐ **Payment enclosed** ☐ **Bill Me**

OFFER VALID IN U.S. ONLY

Name (Please print) ______________________

Company Name (if applicable) ______________________

Address ______________________

City ____________ State ____________ Zip ____________

Allow 6-8 weeks for delivery of first issue.

.19¢ POSTAGE
REQUIRED IN
U.S.A.

Electronics NOW

READER SERVICE MANAGEMENT DEPT.
P.O. BOX 5192
PITTSFIELD, MA 01203-5192

For New Ideas In Electronics read Electronics Now® every month.

Electronics Now® will carry timely articles on:

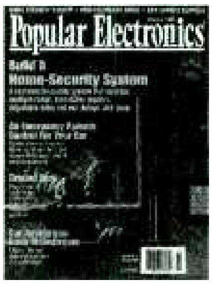
- audio
- video
- personal computers
- VCR servicing
- interactive video
- robotics
- experimenter circuits
- TV scrambling and descrambling
- solid-state technology
- exceptional construction projects

Electronics Now offers a unique combination of articles on electronics technology, service, audio, video, computers. Keep up-to-date! Subscribe Today!

USE THE ORDER CARD ON YOUR LEFT

Popular Electronics

Delivers projects for the beginning and advanced builder, articles that help you get the most from your hobby, news and reviews on the hottest new consumer and hobby gear, monthly columns on computers, ham radio, shortwave listening, antique radio, and more!



SUBSCRIBE TODAY!

Another bright idea from

OPTOELECTRONICS

But don't just take our word for it...

-I purchased the Scout... WHAT A
-NIT! VERY IMPRESSED!!!"
Allen Wilde - Littleton, MA

-I take my Scout with me every-
where - it's very effective in mobile
-se, either in the car or on foot. I
-ecommend a Scout over another
scanner when adding to your collec-
ion... the most effective device so
-ar from Opto for the Scannist."
Steve Dawkins - Pensacola, FL

-This is a breakthrough product in
veryway... KUDOS!"
Robert Caron - DesMoines, IA

-The Scout is AWESOME-the folks
t OPTO keep coming up with
-inners, and this is their best yet!"
Gordon West
Gordon West Radio School

Scantastic"
Brad Schroeder - Omaha, NE

- 400 Frequency Memory with 250 Hit Counter
- Sleep Mode to prevent data loss when battery dies
- Reaction Tune - will tune a reciever with CI-V port in .01 seconds
- Beeper and Vibrator Signal indicator
- Digital Filter and Auto Capture
- CI-V Serial Data Port
- Software for uploading Frequencies to a PC included
- 16 Segment Signal Level Bargraph
- 10MHz to 2.8GHz Frequency Range
- 7 Hour Battery Operation
- Maximized Sensitivity for maxmum antenna pick-up

SCOUT..............$449.00

OPTIONS: **Option 1:** Mini DB32 Ant....$29.00 **Option 2:** AC100 Rapid Charger....$39.00 **Option 3:** Spectrum-CD ROM....$39.00

Scout SPECTRUM-CD ROM

The SCOUT

Scout Reaction-Tune

ORDER LINE: 800-327-5912

TEL: (305) 771-2050 FAX: (305) 771-2052
5821 NE 14TH AVE, FORT LAUDERDALE, FL, 33334
VISA,MC,C.O.D.,CASH OR MONEY ORDER-SHIPPING ADDT'L
ALL SPECIFICATIONS & PRICES ARE SUBJECT TO CHANGE
WITHOUT NOTICE OR OBLIGATION.

CIRCLE 99 ON FREE INFORMATION CARD

DC-2000 MHz

AMPLIFIERS

25th Anniversary Celebration
25%* DISCOUNT
*Prices Shown Only
Expires 12/1/96

from **99¢** ea. (qty.50)

In plastic and ceramic packages, for low-cost solutions to dozens of application requirements, select Mini-Circuits surface mount or flatpack wide-band monolithic amplifiers. For example, cascade three MAR-2 monolithic amplifiers and end up with a 25dB gain, 0.3 to 2000MHz amplifier for less than $4.50. Design values and circuit board layout available on request.

It's just as easy to create an amplifier that meets other specific needs, whether it be low noise, high gain, or medium power. Select from our wide assortment of models (see chart), sketch a simple interconnect layout, and the design is done. Each model is characterized with S parameter data included in our 740 page RF/IF Designer's Handbook or available from our applications department.

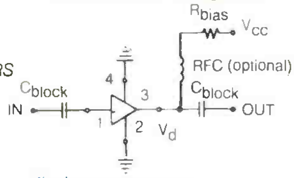
All Mini-Circuits amplifiers feature tight unit-to-unit repeatability, high reliability, a one year guarantee, tape and reel packaging for SMD, off-the-shelf availability, with prices starting at only 99¢.

Mini-Circuits monolithic amplifiers...for innovative do-it-yourself problem solvers.

Mini-Circuits...we're redefining what VALUE is all about!

DESIGNER'S KIT, KH-1 available only $59.95 includes:
40 AMPLIFIERS*10 MAR-1, 10 MAR-3, 10 MAR-4, 10 MAR-8
150 CAPACITORS* 50 100pf, 50 1,000pf, 50 10,000pf
740 page RF/IF DESIGNER'S HANDBOOK
MIXERS • POWER SPLITTER/COMBINERS • AMPLIFIERS
ELECTRONIC ATTENUATORS • I&Q/QPSK MODULATORS
ATTENUATORS/TERMINATIONS • DIRECTIONAL COUPLERS
RF TRANSFORMERS • DIGITAL ATTENUATORS
LIMITERS • PHASE DETECTORS • FILTERS
SWITCHES/DRIVERS • FREQUENCY DOUBLERS
** Values or models may be substituted without notice, depending on supplies.*

Typical Circuit Arrangement



finding new ways ...
setting higher standards

	MODEL	Freq. (MHz) DC TO	GAIN (Typ. dB) At 100MHz	MAX. Power (@ 1dB Compr.) dBm	NF dB (Typ.)	Price $ea. (Qty. 50)
MAR	MAR-1	1000	18.5	1.5	5.5	.99
	MAR-2	2000	12.5	4.5	6.5	1.35
	MAR-3	2000	12.5	10.0	6.0	1.45
	MAR-4	1000	8.3	12.5	6.5	1.55
MAR SM	MAR-6	2000	20.0	2.0	3.0	1.29
	MAR-7	2000	13.5	5.5	5.0	1.75
	MAR-8	1000	32.5	12.5	3.3	1.70
RAM	RAM-1	1000	19.0	1.5	5.5	*6.40
	RAM-2	2000	12.5	4.5	6.5	*6.40
	RAM-3	2000	12.5	10.0	6.0	*6.40
	RAM-4	1000	8.5	12.5	6.5	*6.40
	RAM-6	2000	20.0	2.0	2.8	*6.40
	RAM-7	2000	13.5	5.5	4.5	*6.40
	RAM-8	1000	32.5	12.5	3.0	*6.40
MAV	MAV-1	1000	18.5	1.5	5.5	1.10
	MAV-2	1500	12.5	4.5	6.5	1.40
	MAV-3	1500	12.5	10.0	6.0	1.50
	MAV-4	1000	8.3	11.5	7.0	1.60
MAV SM	MAV-5SM	50-1500	8.0	18.0	6.5	2.07
	MAV-11	10-1000	12.7	17.5	3.6	2.10
VAM	VAM-3	2000	11.5	9.0	6.0	1.45
	VAM-6	2000	19.5	2.0	3.0	1.29
	VAM-7	2000	13.0	5.5	5.0	1.75

*Qty. 10
MAR & MAV MODELS: Plastic flat pack...for surface mount, add SM suffix to model number and 5¢ to price. Example: MAR-2SM...$1.40.
MAV-5SM available plastic surface mount only.
RAM MODELS: Ceramic surface mount.
VAM MODELS: Plastic surface mount.

Mini-Circuits™

WE ACCEPT AMERICAN EXPRESS AND VISA

P.O. Box 350166, Brooklyn, New York 11235-0003 (718) 934-4500 Fax (718) 332-4661
Distribution Centers / NORTH AMERICA 800-654-7949 • 417-335-5935 Fax 417-335-5945 EUROPE 44-252-835094 Fax 44-252-837010

CIRCLE 183 ON FREE INFORMATION CARD

F 155 Re