

**Radio** - **BUILD A ROBOT LAWN MOWER**

JULY 1990

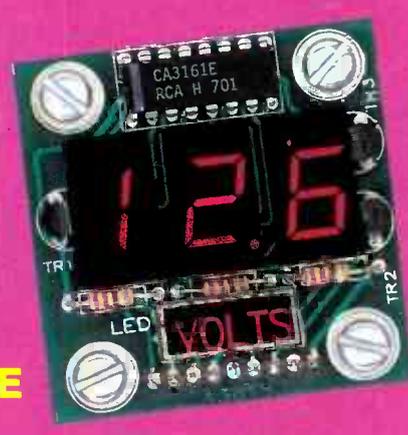
# Electronics

TECHNOLOGY - VIDEO - STEREO - COMPUTERS - SERVICE



**BUILD R-E's DIGITAL DASHBOARD**

Add hi-tech monitoring to any car



**BUILD A SUPER DIRECTIONAL MICROPHONE**

Our novel design gives you long-distance ears



**ADD A DISPLAY TO YOUR PROJECT**

How to use multi-line LCD displays

**ROCK, RELIGION, & RHETORIC**

A look at U.S.-based shortwave stations



**CIRCUIT COOKBOOK**

Alarm generator circuits and fault indicators for your security system

**BUILD A SOLID STATE DISK DRIVE**

Use static RAM to speed up your computer and save wear and tear on your mechanical drives

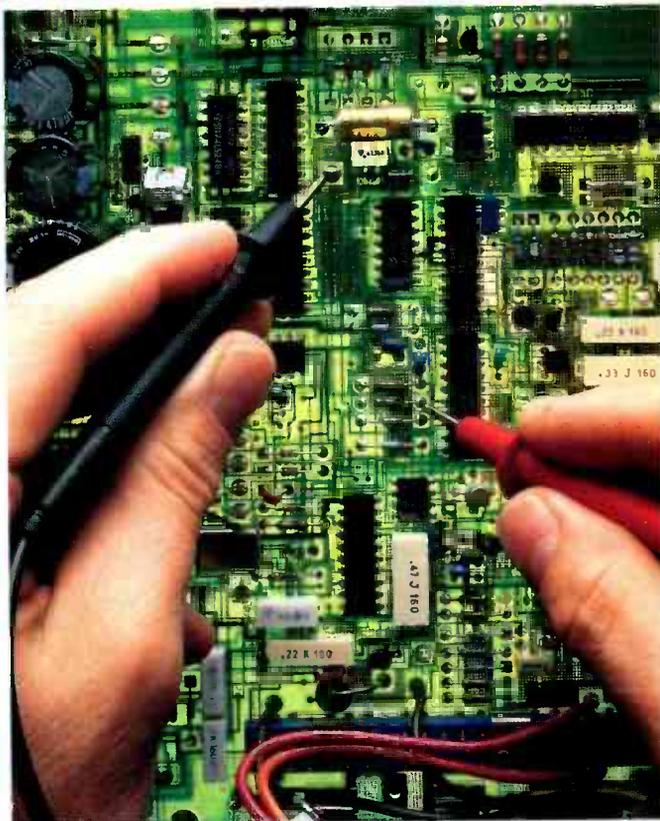
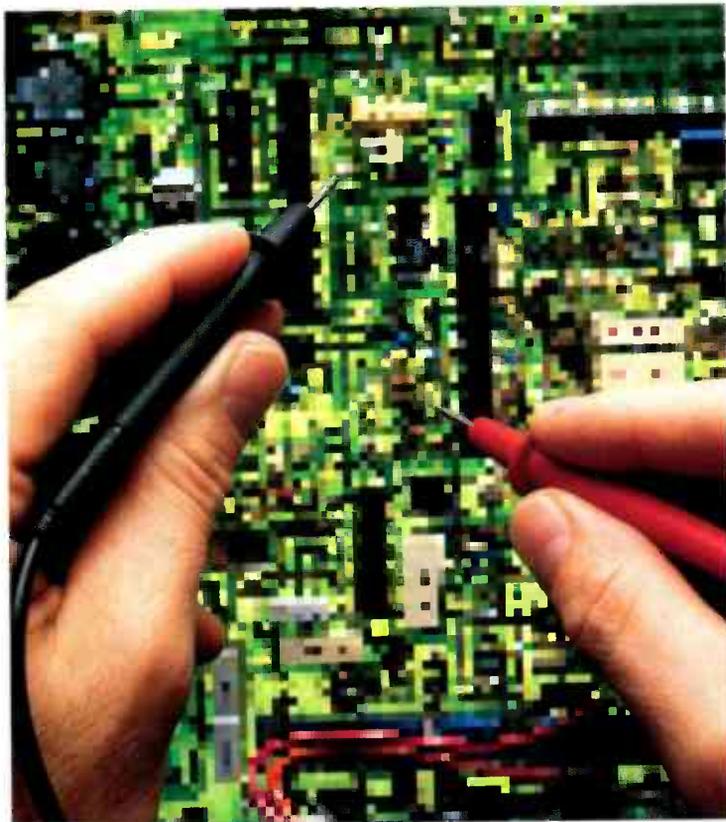


\$2.50 U.S.  
\$2.95 CAN



XXXXXXXXXXXX 5-DIGIT 60506  
39073604MD9970093 17 88  
JAN 91  
RD  
MR ROBERT DAHM  
997 GRAND AV  
AURORA, IL 60506

# Better resolution and accuracy can change the whole picture.



## Clear up the uncertainty in your test measurements with these three versatile Fluke multimeters.

When you need performance that leaves no room for doubt, focus on the Fluke 25, 27 and 37 Analog/Digital Multimeters. With their patented A/D converters, they deliver DC volts accuracy within 0.1%. An easy-to-view display also provides a full 4 digits of resolution for readings up to 3200 counts.

Fully sealed, drop proof cases protect the handheld Fluke 25 and 27 from abuse on the job site. The unique design of the Fluke 37 is well suited for benchtop and portable use, and includes a convenient storage compartment for test leads and small accessories.

The circuitry in each model is shielded to eliminate interference — even near

motors, radar, or other transmitters. And thirty-six components are dedicated to high-energy overload protection, for you and the meter.

All three instruments offer simplicity of operation. Select functions with one rotary dial. Don't worry about range selection — it's automatic. Plus, the auto-polarity digital readout and analog bar graph give you two ways to look at the signal. The 27 and 37 also add extra features like MIN/MAX Recording and Relative mode.

Next time you make a measurement, think about what you're missing. Then call us toll-free **1-800-44-FLUKE, ext. 33** and ask about the Fluke 25, 27 and 37 meters. You'll get the picture.

FROM THE WORLD LEADER  
IN DIGITAL MULTIMETERS



### FLUKE 25, 27, & 37

0.1% basic dc accuracy
Analog/Digital Display
Volts, ohms, amps, diode test
0.1 $\mu$ A to 10A, all fused
30 kHz ac bandwidth
100 $\mu$ V to 1000V ac and dc
Touch Hold™ function
Relative (difference) mode and MIN/MAX recording mode (27 & 37)
Integral handle, storage compartment (37)
Three-year warranty (25, 27). Two year warranty (37)

**FLUKE**®

John Fluke Mfg. Co., Inc., P.O. Box C9090, M/S 250C, Everett, WA 98206, Sales (206) 356-5400, Other (206) 347-6100.  
© Copyright 1988 John Fluke Mfg. Co., Inc. All rights reserved. Ad No. 0200-F20

CIRCLE 121 ON FREE INFORMATION CARD

## BUILD THIS

- 31 R-E's DIGITAL DASHBOARD**  
Give your dashboard a facelift with six attractive, and accurate new gauges.  
**Ross Ortman**
- 41 SUPER-DIRECTIONAL MICROPHONE**  
Our build-it-yourself model outperforms many store-bought models!  
**Dale B. Blackwell**
- 45 THE LAWN RANGER: PART 2**  
A look at the robotic lawn mower's motor control board.  
**Raymond Rafaels**

## CIRCUITS

- 50 ADD A DISPLAY TO YOUR PROJECT**  
Installing the alpha-numeric display in your project.  
**Steven Avritch**
- 56 SECURITY SYSTEM COOKBOOK**  
An assortment of security circuits to build for your home and car.  
**Ray Marston**

## TECHNOLOGY

- 53 ROCK, RELIGION, AND RHETORIC**  
Tune in to privately owned, U.S.-based shortwave stations.  
**Gerry L. Dexter**

## COMPUTERS

- 75 BUILD A SOLID-STATE DISK DRIVE**  
Retain important PC data with our inexpensive battery-backed RAM disk.  
**Mark Hatten**

## DEPARTMENTS

- 6 VIDEO NEWS**  
What's new in this fast-changing field.  
**David Lachenbruch**
- 18 EQUIPMENT REPORTS**  
Tektronix analog/digital-storage oscilloscope.
- 62 HARDWARE HACKER**  
Power-control fundamentals.  
**Don Lancaster**
- 69 AUDIO UPDATE**  
Taking care of your tapes.  
**Larry Klein**
- 72 DRAWING BOARD**  
Scrambling and Macrovision.  
**Robert Grossblatt**
- 75 EDITOR'S WORKBENCH**  
Reader mail.  
**Jeff Holtzman**



**PAGE 31**

## COMPUTERDIGEST



**PAGE 75**

## AND MORE

- 94 Advertising and Sales Offices**
- 94 Advertising Index**
- 8 Ask R-E**
- 95 Free Information Card**
- 14 Letters**
- 82 Market Center**
- 25 New Lit**
- 21 New Products**
- 4 What's News**

## ON THE COVER



If your car's "instrument cluster" (commonly known as a dashboard), consists primarily of idiot lights that don't provide all the information you want, take a look at our digital dashboard. We show you how to put together six digital gauges: voltage, oil pressure, water temperature, fuel level, vacuum, and an auxiliary display whose function you can choose. Not only do these gauges give accurate, detailed level readings, they also look good. To give your dashboard an updated, high-tech look worthy of the name "instrument cluster," turn to page 31.

## COMING NEXT MONTH

### THE AUGUST ISSUE GOES ON SALE JULY 3.

#### **BUILD A VIDEO GRABBER**

Capture a frame of video and manipulate it on your computer.

#### **BUILD A 100-MHz FREQUENCY COUNTER**

An easy-to-build, accurate instrument based on the Intersil 7216.

#### **AC POWER MEASUREMENT**

A refresher course.

#### **MICROWAVES**

A look at the many uses of microwaves in the past, present, and future.

#### **BUILD A TELEPHONE-LINE CONTROLLER**

A programmable card that lets your computer control incoming and outgoing calls.

As a service to readers, RADIO-ELECTRONICS publishes available plans or information relating to newsworthy products, techniques and scientific and technological developments. Because of possible variances in the quality and condition of materials and workmanship used by readers, RADIO-ELECTRONICS disclaims any responsibility for the safe and proper functioning of reader-built projects based upon or from plans or information published in this magazine.

Since some of the equipment and circuitry described in RADIO-ELECTRONICS may relate to or be covered by U.S. patents, RADIO-ELECTRONICS disclaims any liability for the infringement of such patents by the making, using, or selling of any such equipment or circuitry, and suggests that anyone interested in such projects consult a patent attorney.

RADIO-ELECTRONICS, (ISSN 0033-7862) June 1990. Published monthly by Gernsback Publications, Inc., 500-B Bi-County Boulevard, Farmingdale, NY 11735 Second-Class Postage paid at Farmingdale, NY and additional mailing offices. Second-Class mail registration No. 9242 authorized at Toronto, Canada. One-year subscription rate U.S.A. and possessions \$17.97. Canada \$23.97, all other countries \$26.97. All subscription orders payable in U.S.A. funds only, via international postal money order or check drawn on a U.S.A. bank. Single copies \$2.50. © 1990 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

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

A stamped self-addressed envelope must accompany all submitted manuscripts and/or artwork or photographs if their return is desired should they be rejected. We disclaim any responsibility for the loss or damage of manuscripts and/or artwork or photographs while in our possession or otherwise.

## Radio Electronics

Hugo Gernsback (1884-1967) founder  
M. Harvey Gernsback,  
editor-in-chief, emeritus

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

#### EDITORIAL DEPARTMENT

Brian C. Fenton, editor  
Marc Spiwak, associate editor  
Daniel Goodman, technical 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  
Richard D. Fitch  
contributing editor  
Kathy Campbell, editorial assistant

#### ART DEPARTMENT

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

#### PRODUCTION DEPARTMENT

Ruby M. Yee, production director  
Janice Box,  
editorial production  
Karen S. Tucker  
advertising production  
Marcella Amoroso  
production assistant

#### CIRCULATION DEPARTMENT

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

Typography by Mates Graphics  
Cover photo by Diversified Photo  
Services

Radio-Electronics is indexed in  
*Applied Science & Technology Index*  
and *Readers Guide to Periodical Literature*.

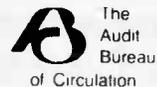
Microfilm & microfiche editions are  
available. Contact circulation department  
for details.

#### Advertising Sales Offices listed on page 94.

Radio-Electronics Executive and  
Administrative Offices:

1-516-293-3000.  
Subscriber Customer Service:

1-800-288-0652.  
Order Entry for New Subscribers:  
1-800-999-7139.



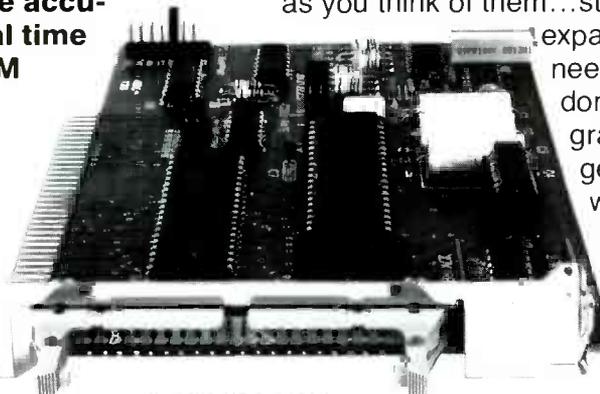
# PLUG IN. TURN ON. GET DATA. FAST. FREE SOFTWARE. NO PROGRAMMING.

**NEW!**

**Turnkey ProtoKey™ 8-channel data acquisition system...the accurate, low cost solution to real time data collection from your IBM compatible PC...with user-friendly software included.**

Sophisticated, without being frightening. Truly functional. Amazing accuracy. More than mere hardware. Requires no programming skills. And, truly affordable at only \$395.

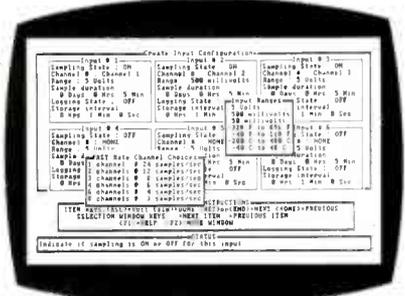
All describe the hot, new Global Specialties American-made ProtoKey™ 8-channel data acquisition system, which includes ■ 8 A/D input channels with 12 Bit resolution ■ selectable conversion times of 7 Hz or 30 Hz ■ 3 input ranges from 5 Volts to 50mV ■ 100 uv resolution ■ thermocouple linearization ■ interfaces to a variety of transducers ■ plus, operating software and a complete users manual.



Now you can create daring experiments as fast as you think of them...store them indefinitely...expand or modify them as needed. Best of all, you don't have to be a programmer, because you get an unlimited data window with Global's menu-driven software package...the power of a programmable package, without the hassle...simplified operation with every-

thing you ever need to know right there on the screen in pop-up menu formats. Plus, on-line help, with interfaces to popular spreadsheet or analysis programs...with just a single keystroke.

Get the facts today. Just say, "Data...fast!" We'll understand. That's ProtoKey!



*Easy does it!*



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

**GLOBAL SPECIALTIES**

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

CIRCLE 189 ON FREE INFORMATION CARD

A0012

JULY 1990

3

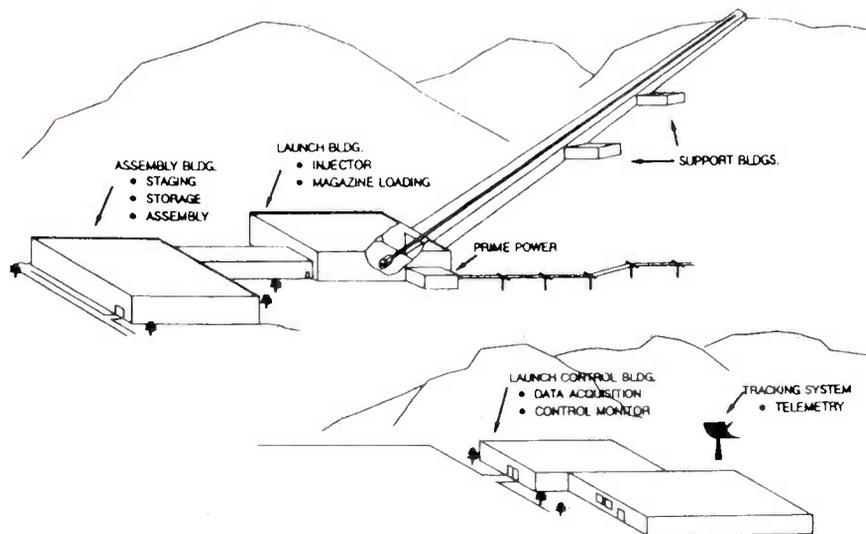
# WHAT'S NEWS

## New earth-to-orbit launcher will use electromagnetism

A new technology that might be used to launch small satellites from earth to orbit, currently being developed by Sandia National Laboratories (Albuquerque, NM), uses electromagnetic induction and involves no sliding electrical contact between the projectile and the barrel. Providing an alternative method to rockets for the launching of satellites up to 1,000 pounds, it could have potential military and commercial applications.

In the new launcher, the projectile passes through a series of cylindrical coils that form a contactless barrel. Just before firing, a pneumatic device sets the projectile spinning, for aerodynamic stability. The firing is under electronic control: One after another, coils are energized by a heavy capacitor discharge, accelerating the armature forward down the length of the flyway. Between each coil, a high-speed optical-fiber sensor measures the precise position and velocity of the projectile and instructs the computer to fire the next coil at the right instant to provide maximum effect. The launch mass for a full-scale earth-to-orbit projectile would include an iron or other magnetizable armature, a removable aeroshell, small rocket motor, and the payload. An existing mockup resembles a small rocket or a very large artillery shell, with the tapered aeroshell streamlined to reduce atmospheric friction.

A sophisticated code called "WARP 10" has been used to support the experiments. The code has successfully predicted the results of all of the experiments made so far. Its predictions for scaled-up versions of the electromagnetic launch system are making scientists extremely optimistic that the larger systems will also be successful.



**A FUTURE FULL-SCALE EARTH-TO-ORBIT** electromagnetic launch system might look like this. The flyway, consisting of hundreds of stages, is built up the side of a hill to present a 30-degree launch angle.



**SANDIA EXPERIMENTER** Ronald Kaye inserts a projectile into the breech of a six-stage electromagnetic launcher, which is being developed as a possible alternative to rockets for frequent launches of small payloads.

The electromagnetic launcher would provide enough velocity—about 4.5 kilometers per second at the end of the flyway—to send the main part above the earth's atmosphere (the armature would drop away shortly after launch). Once the projectile was above the atmosphere, the aeroshell would drop away and the rocket motor would step up the velocity about another

4.5 km/sec, to achieve orbit velocity. The combination of electromagnetic and rocket techniques reduces costs and risks for the electromagnetic launch.

Still in the exploratory development phase, the work has achieved a record velocity for contactless electromagnetic launchers of 1 kilometer per second with a 160-gram projectile. Experiments are now underway with a larger, six-stage launcher that fires a 4-kilogram (10-pound) projectile that is 5½ inches in diameter. Subsequent development stages will focus first on still larger launchers. After that, the concept would be scaled up further by adding more stages to the launcher, increasing the length of the flyway along which the launch mass is accelerated. For earth-to-orbit launch, the flyway would consist of multiple stages, each powered by its own capacitor bank, and elevated at a 30-degree angle. The technology seems especially promising for the economical launching of large numbers of relatively small objects into earth orbit.

R-E

# Radio Shack Parts Place<sup>SM</sup>

**YOUR NEARBY SOURCE FOR HOBBY AND REPAIR ELECTRONICS**  
Over 7000 Locations in the USA—NOBODY COMPARES!

## Try Our Special-Order "Hotline"



ICs, Crystals, Tubes, Lots More

Your Radio Shack store manager can special-order a wide variety of parts and accessories from our warehouse—vacuum tubes, ICs, microprocessors, phono cartridges and styli, crystals, even SAMS Photofacts® manuals. There are no handling charges or minimum order requirements—just fast delivery to our store near you.

## Battery Special-Order Service

Hundreds of Types Available Now

In addition to our large in-store stock, Radio Shack can now supply almost any currently manufactured battery—even special communications batteries for walkie-talkies and pagers. Batteries are sent from our main warehouse to the Radio Shack near you. Never a postage charge!

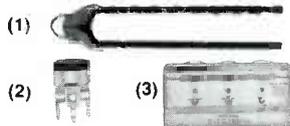


### Plug-In Board



- (1) 72-Position Board. Great for a variety of projects. Popular 100" contact centers. 4 1/2 x 5 1/16". #276-192 ..... 4.99  
(2) Socket for Above. #276-1452 ..... 4.59

### Resistor Buys



- (1) Thermistor. #271-110 ..... 1.99  
(2) 0.1W Trimmers. 1k. #271-280, 4.7k, #271-281, 10k, #271-282, 47k, #271-283, 100k, #271-284 ..... Each 49¢  
(3) Color-Code Decoder. #271-1210, 69¢

### Hookup Tools



- (1) D-Sub Pin Crimper. Crimps #20, #24 and #28 pins. #276-1595 ..... 9.95  
(2) IDC Tool. Attaches IDC-type plugs to flat cables. #276-1596 ..... 12.95

### Cooling Fan

18<sup>95</sup>

Quiet and Efficient



Protect your equipment! This 4" fan operates on 120VAC and provides about 65 cubic feet per minute airflow. It's easy to mount and rated 11 watts. #273-241

### Car Connectors



- (1) Solderless Motorola-Type Plug. Fits car radios and many scanners. #274-709 ..... 1<sup>39</sup>  
(2) Solderless Jack. #274-710 ..... 1<sup>39</sup>  
(3) Lighter Outlet DC Plug. #274-335 ..... 1<sup>99</sup>

### Tran and Choke



- (1) Power Transformer. 120VAC primary. Secondary is 18VAC, 2.0 amps, center-tapped 2 3/4 x 2 1/4 x 2". #273-1515 ..... 8<sup>99</sup>  
(2) 0.1 mH RF Choke. #273-102 ..... 99¢

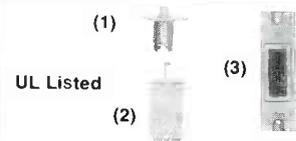
### Project Box

Only 3<sup>99</sup>



Transmitter Case. Ideal for an RF or infrared control, beeper or portable device. Durable molded case has a removable end panel and compartment for 9V battery. 3 3/4 x 2 9/16 x 1". #270-293

### Security Switches



- (1) Normally Closed. #49-513 ..... 1.29  
(2) Tamper Switch. For alarm panel or siren. Normally open. #49-528 ..... 1.59  
(3) Panic Switch. N.O. #49-517 ..... 1.49

### Prewired Temperature Module



19<sup>95</sup> Just Add Battery

You can use it "as-is" for a thermometer. Or, add switches to select F or C display and simple circuits to control a buzzer, LED, fan or heater at preset temperatures. Automatic attic exhaust fan controller is just one possible application. 1/2" digits. Range: -40 to +120° F. 2 1/16 x 1 3/8 x 1 1/8". Requires "AA" battery. Low current drain. With complete data. #277-123

### Connectors for Test Equipment



- (1) Solderless Male BNC. For RG-58 cable. #278-185 ..... 3.59  
(2) 90° BNC Adapter. #278-116 ..... 3.99  
(3) Stackable Banana Plugs. Built-in jack for "chain" hookups. Solder type. One red, one black. #274-734 ..... Set of 2/1.59  
(4) Flex Banana Plugs. #274-730. Set of 2/1.69  
(5) Gator Adapters. #270-354 ..... Pair/1.89  
(6) Mini-Hook Adapters. Fit test probe tips. #270-334 ..... Pair/2.59  
(7) Micro Flat Test Clips. 1 red, 1 black. #270-336 ..... Set of 2/1.19

### Crimp D-Sub Connectors



Gold-Plated Contacts

Pos.	Type	Cat. No.	Each	Pos.	Type	Cat. No.	Each
9	Male	276-1427	.99	25	Male	276-1429	2.49
9	Female	276-1428	1.19	25	Female	276-1430	2.99

### Autorangeing Probe DVM

39<sup>95</sup>



Great for Tight Spaces

Data-hold button freezes display and lets you remove tester for easy reading. Has continuity sounder, low-battery indicator and overload protection. Measures to 400 volts AC/DC and resistance. Includes batteries, manual, case. #22-165

### 4-in-1 Soldering Tool



Provides up to 60 minutes of operation and refills with butane lighter fuel. #64-2161 ..... 29.95  
2.4 mm Replacement Tip. #64-2162 ..... 9.95  
1.0 mm Replacement Tip. #64-2163 ..... 9.95  
Blow Torch Tip. #64-2168, Heat Blower Tip. #64-2169, and Hot Knife Tip. #64-2170 are available on special CMC order ..... Each 9.95

Over 1000 items in stock! Binding Posts, Books, Breadboards, Buzzers, Capacitors, Chokes, Clips, Coax, Connectors, Fuses, Hardware, ICs, Jacks, Knobs, Lamps, Multitesters, PC Boards, Plugs, Rectifiers, Resistors, Switches, Tools, Transformers, Transistors, Wire, Zeners, More!

Prices apply at participating Radio Shack stores and dealers. Radio Shack is a division of Tandy Corporation.

**Radio Shack**  
**AMERICA'S**  
**TECHNOLOGY**  
**STORE<sup>SM</sup>**

CIRCLE 78 ON FREE INFORMATION CARD

# VIDEO NEWS



**DAVID LACHENBRUCH,**  
CONTRIBUTING EDITOR

• **Ghostbuster tests.** The first major American test of automatic ghost cancelling was pronounced a rousing success, and there were predictions that anti-ghost technology could be put into the FCC's broadcast standards before the year is out. The exorcism occurred in Atlanta, the site of the 1990 convention of the National Association of Broadcasters, where six television stations used the ghostbusting system developed—and now in use—in Japan. As reported here (**Radio-Electronics**, November 1989), the system employs a "training pulse," broadcast in the vertical interval (in Atlanta it was line 18), which instructs specially equipped TV sets to remove ghosts and accept the true image. Observers of the demonstrations at the convention were impressed with its performance. Set-top tuners equipped with ghostbusters are currently selling in Japan for \$700–\$1,000, but more-integrated, chip-based systems built into television sets are expected to be much cheaper. Although other ghost-canceling systems have been proposed—notably by AT&T, Zenith, and the David Sarnoff Research Center—the Japanese system now has the inside track because of the successful Atlanta tests and its proven quality in everyday use in Japan.

• **Laserdisc shortage.** When laser optical videodiscs' popularity slumped almost to nothing a few years ago, who would have thought they would become so popular in 1990 that there would be a severe shortage of programs? Thanks to the influence of the compact disc, the laserdisc now has become the preferred playback medium of videophiles. With about 10 brands of players either on the U.S. market or about to enter it, and player sales expected to double this year to 250,000, disc manufacturers are hurrying to try to relieve the shortage. The latest to go into videodisc pressing in the United States is Sony, whose Digital Audio Disc Co. plant in Terre Haute, IN, is adding videodiscs to its compact-disc manufacturing ability.

The videodisc's comeback started, ironically, with the ballyhoo for an unsuccessful product—Compact Disc-Video—a name coined by Philips

and its affiliate Polygram in hopes that the magic of the CD boom would rub off on videodiscs. The two companies retreated in early 1990, and the name reverted to laserdisc. But today's players take advantage of most recent laserdisc's compatibility with audio CD's, and almost all of the new players can play CD's as well as LD's. The new laserdisc players also have copied from Super VHS, by using Y/C (luminance and chrominance) outputs to plug directly into "S-connectors" on high-resolution TV sets.

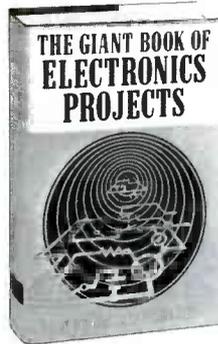
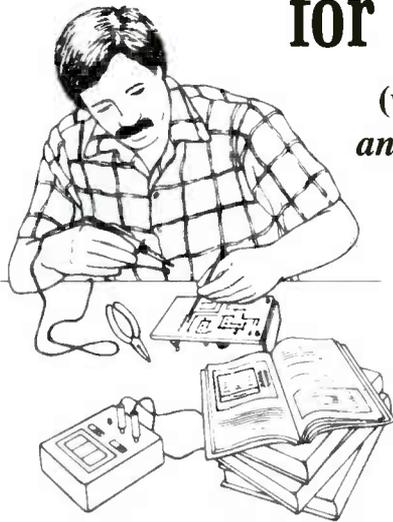
• **Full-Motion CD-I.** The Compact Disc-Interactive (*CD-I*) system has added something new that makes it far more significant as a consumer product: full motion. The system espoused by Philips and Sony has suffered in the past in comparison with Intel's Digital Video Interactive (*DVI*) system. The addition of full motion to the digital CD-I system makes it a very potent potential product of the 1990's. A standard 5-inch compact disc recorded in the CD-I mode now can provide up to 72 minutes of full-motion digital video plus digital audio. As demonstrated recently by Philips, the picture quality of the CD-I disc was virtually indistinguishable from videotape. The system is scheduled for marketing next year in the U.S. and Europe. It also has the potential to become an important movie-carrying medium. As a digital-video system, the same disc can be played on the American and Japanese NTSC system, the European PAL system, or any other color TV system.

While the Intel DVI system is designed for playback using a computer (and isn't intended to be a consumer product), CD-I uses a player that resembles an audio CD player. Philips says that DVI takes several hours to record an hour of video, but CD-I can record in real time—requiring only an hour to record an hour of video. Philips' enthusiasm about CD-I is best summarized by a quotation from a company official: "CD-I is what publishers have been waiting for since the 1450's, when Johann Gutenberg produced the first printed version of the Bible. We have pushed CD-I full-motion video far beyond DVI. There is no discussion any more."

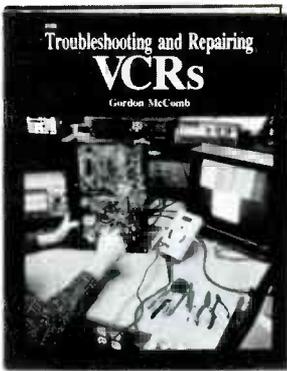
R-E

# SELECT 5 BOOKS for only \$4.95

(values to \$124.70)  
and get a **FREE Gift!**



1367P \$24.95



2960 \$27.95  
Counts as 2



2867P \$18.95



3260 \$22.95



3258 \$27.95  
Counts as 2



3275 \$22.95



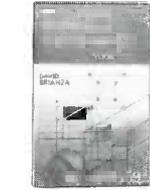
2613P \$17.95



3285 \$25.95  
Counts as 2



2707 \$26.95  
Counts as 2



3383 \$14.95



3155 \$19.95



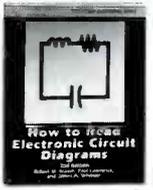
1599P \$17.95



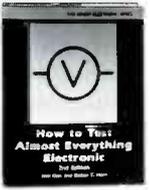
2809 \$29.95  
Counts as 2



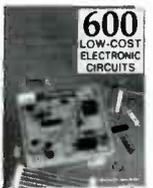
3131 \$26.95  
Counts as 2



2880P \$14.95



2925P \$9.95



3219 \$27.95  
Counts as 2



2724P \$16.95

For 25 years, your most complete source for electronics books.

**Membership Benefits • Big Savings.** In addition to this introductory offer, you keep saving substantially with members' prices of up to 50% off the publishers' prices. • **Bonus Books.** Starting immediately, you will be eligible for our Bonus Book Plan, with savings of up to 80% off publishers' prices. • **Club News Bulletins.** 15 times per year you will receive the Book Club News, describing all the current selections—mains, alternates, extras—plus bonus offers and special sales, with scores of titles to choose from. • **Automatic Order.** If you want the Main Selection, do nothing and it will be sent to you automatically. If you prefer another selection, or no book at all, simply indicate your choice on the reply form provided. You will always have at least 10 days to decide. As a member, you agree to purchase at least 3 books within the next 12 months and may resign at any time thereafter. • **Ironclad No-Risk Guarantee.** If not satisfied with your books, return them within 10 days without obligation! • **Exceptional Quality.** All books are quality publishers' editions especially selected by our Editorial Board.

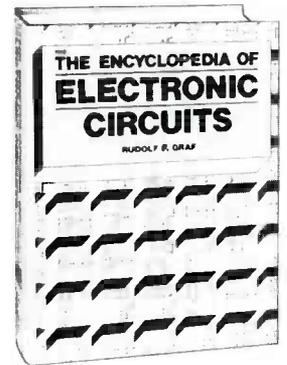
**FREE when you join!**

**15 Easy Electronic Projects From Delton T. Horn**

Projects you can build—some unique, some old favorites—from the author's vast treasury of electronics know-how.



1938P \$29.95  
Counts as 2



**ELECTRONICS BOOK CLUB<sup>SM</sup>**  
Blue Ridge Summit, PA 17294-0810

Please accept my membership in the Electronics Book Club and send the 5 volumes listed below, plus my FREE copy of *Delton T. Horn's All-Time Favorite Electronic Projects* (3105P), billing me \$4.95. If not satisfied, I may return the books within ten days without obligation and have my membership cancelled. I agree to purchase at least 3 books at regular Club prices during the next 12 months and may resign any time thereafter. A shipping/handling charge and sales tax will be added to all orders.

--	--	--	--	--	--

**50% MONEY-SAVING OPTION:** I also wish to order my first Club Selection at 50% off the Publishers' price (plus shipping/handling). I then need to purchase only 2 or more books within the next 12 months.

Name \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_  
State \_\_\_\_\_ Zip \_\_\_\_\_ Phone \_\_\_\_\_  
Signature \_\_\_\_\_

Valid for new members only. Foreign applicants will receive special ordering instructions. Canada must remit in U.S. currency. This order subject to acceptance by the Electronics Book Club. RE790

**Call Toll-Free 1-800-233-1128 to join Now!**

CIRCLE 181 ON FREE INFORMATION CARD



804P \$21.95  
Counts as 2



3226 \$22.95



3145 \$19.95



1625P \$22.95



2800P \$16.95



2790P \$13.95

All books are hardcover unless number is followed by a "P" for paperback. (Publishers' Prices Shown)

# ASK R-E

WRITE TO:

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

## RING MY PHONE

There is not enough line current to ring the telephone bells in our house. Either we're too far out or there are too many phones on the line. Is there any other way I can get the phones to ring?—G. Myers, Meridian MS

Before we start on this, and by the way the answer is yes, let me tell you that I haven't heard of a problem like this in a long time. In these post-divestiture days, most phones have gone a long way from the original Western Electric 2500 series. CMOS has replaced most of the circuitry in the old phones and I haven't seen a real carbon granule in years.

The popular lore and certain legends have it that the telephone line voltage is fixed at a value written in stone. Nothing could be further from the truth. It has never been promised by the telephone company that you'll find 50-volts DC on-hook, 5-volts DC off-hook, and a 90-volt AC ringing voltage.

All the phone company guarantees is that the phone circuit is a 20-milliamp line. As a historical note, that's interesting because 20-milliamp current loops have been around for a long time. But this isn't helping you solve your problems.

The development of CMOS-based telephone parts has resulted in a sort of revolution in telephone design. Given a 20-milliamp limit, most phone manufacturers have been able to design multi-featured telephones that draw their power directly off the phone line. Just about the only use for batteries is to preserve memory in phones that let you store numbers.

Several semiconductor manufacturers make chips that are designed with your specific application in mind. An example of those is made by AMI (3800 Homestead Road, San-

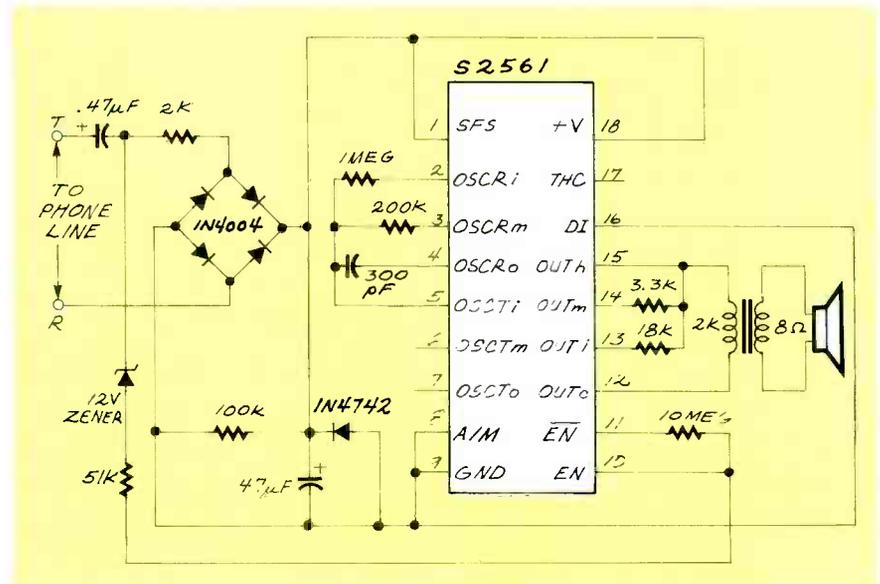


FIG. 1

ta Clara, CA 95051 (408) 246-0330). The chip you need is their S2561—a dedicated telephone-ringer IC that can be powered directly off the phone line. You can use a battery if you're afraid of loading the line.

The chip doesn't need much support to make it work, and everything you could want to know about it is described in the data sheet. The circuit in Fig. 1 shows you what has to be done to put the IC to work. You can use it to drive a small speaker, since the chip puts out up to 50 milliwatts when you power it off 10 volts. As an alternative, you can feed the output to an amplifier and get even more gain.

## TOUCH TONE DECODER

I've been trying to design a circuit that would decode Touch Tone frequencies and display them on LED's. So far, the best I've been able to do is less than what I want. Can you point me in the right direction?—W. Brown, Golden CO

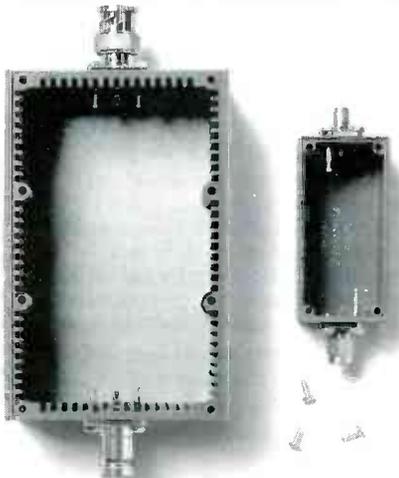
Once upon a time, doing something like that was a real pain in the neck, since you had to do analog decoding of the frequencies in the high and low groups used for DTMF (Dual Tone Multi Frequency) tones. Fortunately, this is America, and capitalism usually fills any consumer needs that show up in the marketplace—and that is even true in the world of semiconductors.

Several manufacturers make DTMF decoders, including such well-known names as National, AMI, and Mostek. I'm not listing any of the chip numbers because each of those companies have several of them and which one you use depends entirely on what you want to do. Call or write them and get yourself a handful of data sheets.

What all of the decoders have in common, though, is that they decode only the incoming frequency and put out a binary equivalent. If you want to build something that can display a dialed number, you're



# Pomona's Boxes Are Everything But Wired.



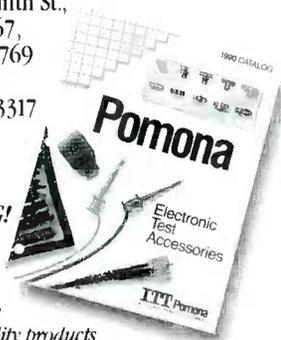
When you're looking for just the right box for your connections, we've probably got it. Good chance it's even in stock. Thermoplastic, Phenolic, Extruded Aluminum or Die-Cast Aluminum. Plain or with connectors; BNC, UHF, Type N, Binding Posts, Banana Plugs, or any combination of the same.

**Dependable Choices.** All you need to worry about is your circuit. There are dozens of standard choices including rugged connectorized boxes that won't let you down. Lids and screws are included. See your nearest Authorized

Distributor or contact  
**POMONA ELECTRONICS,**  
1500 E. Ninth St.,

P.O. Box 2767,  
Pomona, CA 91769  
(714) 623-3463  
FAX (714) 629-3317

**FREE**  
**1990 CATALOG!**  
Thousands of test solutions and accessories in this new, 138-page handbook of quality products. It's Free! Call or write today.



**ITT Pomona**  
AN ITT EMC WORLDWIDE COMPANY  
*Discover our strengths.*

RADIO-ELECTRONICS

12 CIRCLE 101 ON FREE INFORMATION CARD

going to have to work out a circuit that can store the number being decoded and then be able to display at least ten digits—more if you use access codes.

Several of these circuits have appeared on the pages of **Radio-Electronics** over the years and, of course, there are some chips, such as National's MM74C9XX series, that make the job really simple. It's possible to design a circuit to do the job with two or three IC's, a handful of passive parts, and the displays themselves.

## 50-Hz TAPE SPEED

**I have a European cassette recorder that was designed to run at the correct speed with 50-Hz AC. Is there any way, without changing the pulleys and belts, to have the machine run correctly in the USA?—F. Peterson, Brampton ONT**

There's a way to do anything, but that doesn't make everything worth doing. You could have the machine run at the correct speed by building a 50-Hz AC generator capable of putting out as much power as is required by the recorder. But that is not a trivial task.

Some machines have a dual-pulley system, so that the speed can be adjusted by moving the belt from one groove to another. If that isn't true in your case, the next step would be to contact the manufacturer and see if they can sell you a replacement pulley for 60-Hz operation. The voltage can be taken care of with a small transformer, as I'm sure the machine doesn't use a great deal of power.

I know you're really looking for a different kind of answer but, believe me, this is the best way to do it. You may think of having to change pulleys as a pain in the neck, but it's a piece of cake compared to the brain damage involved in designing circuits from the ground up. And, in any event, opening up the machine and changing a pulley isn't really that big a job. It's easy, sometimes, to get so involved in something you're trying to do that you forget what you were trying to accomplish when you first started.

## CGA TO VGA

**I have an IBM-compatible computer and have just upgraded my display from CGA to VGA. Since I already**

**own a good CGA monitor, it seems a shame to have to junk it and spend the money necessary to get a VGA monitor. Isn't there something simple I could do to my CGA monitor to make it compatible with my VGA card?—F. Ischer, New York, NY**

Believe it or not, there's a simple way you can do that. It takes some work but it can be done. Remove the power cord from your CGA monitor and attach it to a VGA monitor. When you're finished, the new monitor will work perfectly.

But seriously folks, there's no other way.

I suppose it's possible to modify all of the circuitry in the CGA monitor to handle VGA, but I'm sure it's not an easy thing to do. And even if you were able to do it, I'm not sure the phosphor in the picture tube has a long enough persistence to be usable for VGA. A safe bet would be no.

VGA scan frequencies are about double those of CGA, and you would have replace so many parts in the CGA monitor that you'd more than likely have nothing of the old one in use except the case. Nobody likes saving a buck more than I do, but this is definitely one of those times when it's better to rob the piggy bank than warm up the soldering iron.

## TELLING SCR'S FROM TRIACS

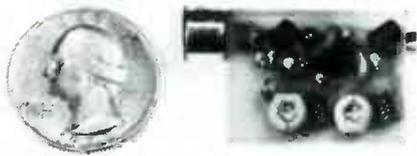
**I recently bought a bag of mixed SCR's and Triacs. Since the parts aren't easily marked, I'm having a hard time telling the SCR's from the Triacs. Do you have some simple circuit I can use?—D. Koetting, St. Louis, MO.**

The following method is an easy way to solve your problem: An SCR is a DC device, and a Triac is an AC device. The former conducts one way only, while the latter conducts both ways. A battery and bulb let you find out which are which. Put the bulb in series with the battery and connect the two leads to the large legs of the device.

Use a piece of wire to momentarily connect the third leg to each large leg, one at a time. If the bulb doesn't light, reverse the battery polarity and do it again. If you can't get the bulb to light at all, the part is either dead or another kind of device. If it lights one way only, it's an SCR, whereas if it lights both ways, it's a Triac.

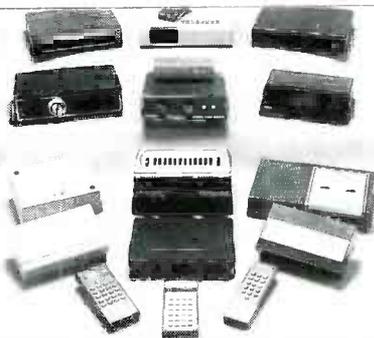
R-E

# Radio-Electronics mini-ADS



**SIMPLY SNAP THE WAT-50 MINIATURE FM TRANSMITTER** on top of a 9v battery and hear every sound in an entire house up to 1 mile away! Adjustable from 70-130 MHz. Use with any FM radio. Complete kit **\$29.95 + \$1.50 S + H**. Free shipping on 2 or more! COD add \$4. Call or send VISA, MC, MO. **DECO INDUSTRIES, Box 607, Bedford Hills, NY 10507. (914) 232-3878.**

CIRCLE 127 ON FREE INFORMATION CARD



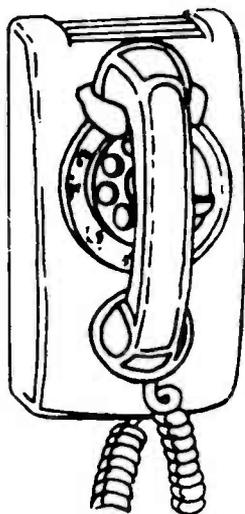
**CABLE TV CONVERTERS AND DE-SCRAMBLERS SB-3 \$79.00 TRI-BI \$95.00 MLD-\$79.00 M35B \$69.00 DRZ-DIC \$149.00.** Special combos available. We ship COD. Quantity discounts. Call for pricing on other products. Dealers wanted. **FREE CATALOG.** We stand behind our products where others fail. One year warranty. **ACE PRODUCTS, P.O. Box 582, Saco, ME 04072 1 (800) 234-0726.**

CIRCLE 75 ON FREE INFORMATION CARD



**FREE CATALOG OF HARD-TO-FIND TOOLS** is packed with more than 2000 quality items. Your single source for precision tools used by electronic technicians, engineers, instrument mechanics, schools, laboratories and government agencies. Also contains Jensen's line of more than 40 tool kits. Send for your free copy today! **JENSEN TOOLS INC., 7815 46th St., Phoenix, AZ 85044. (602) 968-6231.**

CIRCLE 115 ON FREE INFORMATION CARD



## CALL NOW AND RESERVE YOUR SPACE

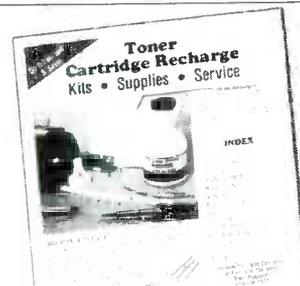
- 6 x rate \$940.00 per each insertion.
- Fast reader service cycle.
- Short lead time for the placement of ads.
- We typeset and layout the ad at no additional charge.

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



**APPLIANCE REPAIR HANDBOOKS—13** volumes by service experts: easy-to-understand diagrams, illustrations. For major appliances (air conditioners, refrigerators, washers, dryers, microwaves, etc.), elec. housewares, personal-care appliances. Basics of solid state, setting up shop, test instruments. **\$2.65 to \$7.90 each.** Free brochure. **APPLIANCE SERVICE, P.O. Box 789, Lombard, IL 60148. (312) 932-9550.**

CIRCLE 84 ON FREE INFORMATION CARD



**GET YOUR RECHARGE CATALOG FREE...EARN BIG \$\$ IN YOUR SPARE TIME—**All supplies and Do-It-Yourself kits with complete instructions available. Supplies cost from **\$9.95** in qty and you can sell recharged toner cartridges for **\$40.00** to **\$55.00** each. Printers include HP LaserJet and Series II, Apple LaserWriter, QMS, etc. Canon PC-25 Copier also. **CHENESKO PRODUCTS, 62 N Coleman Rd., Centereach, NY 11720, 516-736-7977, 800-221-3516, Fax: 516-732-4650**

CIRCLE 183 ON FREE INFORMATION CARD



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



**THE MODEL WTT-20 IS ONLY THE SIZE OF A DIME,** yet transmits both sides of a telephone conversation to any FM radio with crystal clarity. Telephone line powered - never needs a battery! Up to 1/4 mile range. Adjustable from 70-130 MHz. Complete kit **\$29.95 + \$1.50 S + H**. Free Shipping on 2 or more! COD add \$4. Call or send VISA, MC, MO. **DECO INDUSTRIES, Box 607, Bedford Hills, NY 10507. (914) 232-3878.**

CIRCLE 127 ON FREE INFORMATION CARD

# LETTERS

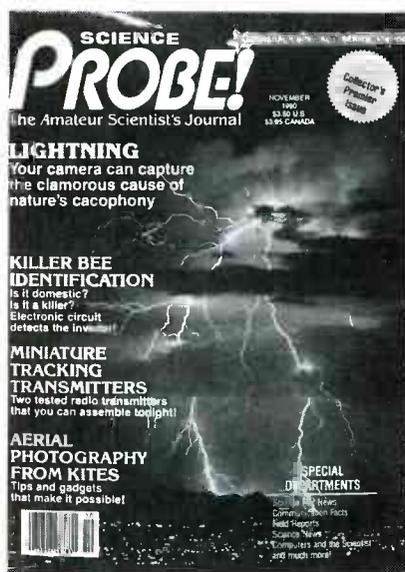


## AMATEUR SCIENTIST'S WISH

This is just a quick note to let you know how much I enjoy Don Lancaster's "Hardware Hacker" column. The topics presented are extremely interesting and diverse. I only wish more such information, articles, and publications were available to the amateur scientist, inventor, and general tinkerer. Many years ago—well before my time—a number of publications existed for the amateur experimenter. But today, unfortunately, only two really useful regular columns (that cover fields other than computers and electronics) exist that I know of: **Radio-Electronics'** "Hardware Hacker" and *Scientific American's* "The Amateur Scientist."

On another note, the gremlins attacked your April column by substituting iridium (sic) for indium in the 117 alloy. I volunteer to purchase all the 20% iridium alloy anyone will sell me at \$78.00 per pound, and I'll retire rather quickly!  
ROBERT N. WILLIS  
Stone Mountain, GA

Your wish has come true. This September, the magazine you have been asking for will be available. It's called **Science Probe, The Amateur Scientists Journal**, and it does exactly what you're looking for. Just scan the titles on the first issue (its cover is shown above)—"Lightning—How to Capture it With Your Camera;" "Killer Bee Identification—An Electronic Device that Makes Identification a Snap;" "Miniature Tracking Transmitters—Two Tested Radio Transmitters that Anyone Can Build;" and "Aerial Photography from Kites—Tips and Gadgets that Make it Possible." And then there's a wide range of special departments to grab your interest. They include "Science Fair News," "Communications Facts," "Field Reports," "Com-



puters," "The Scientist," and much, much more.

They will be sending out subscription materials as soon as they're available. But if you want to start today, you can become a Charter Subscriber right now. It will be starting with four issues a year. The cover price in the U.S. will be \$3.50 per issue, and you can order your 4-issue subscription for only \$9.95. Write to Science Probe!, Subscription Dept., P.O. Box 54098, Boulder, CO 80321-4098. Be one of the first to enjoy this unique publication!—Editor

## PROPER STORAGE PROCEDURES

Each month when I receive my copy of **Radio-Electronics**, I look forward to seeing what new toys and sweets Don Lancaster has in his "Hardware Hacker" column. I'm always looking for new information or a different view on how to do things, and he always has some great input!

I was disturbed by something in the April "Hardware Hacker." On page 59, we are told to use

*Tupperware* to store ammonium-persulfate. Nothing was mentioned about labeling the container! Chemicals should *never* be stored in unmarked containers, and in the case of *Tupperware*, both the lid and the container should be labeled. Remember, someone else coming upon the container doesn't have the knowledge of what's inside.

PHILL LEYVA  
Hollister, CA

## POLARITY POINTERS

Like many people, I tend to get behind in my reading, and just recently had the opportunity to catch up on the January 1990 issue of **Radio-Electronics**. I enjoyed the article entitled "Telephone Mute Switch," the device that's used to turn off the stereo or TV when the phone rings. However, there was one point that I feel should have been emphasized to the readers constructing the project.

Tip and ring are very important, but the article failed to mention that the project is *polarity* sensitive. If tip and ring are wired backwards in the user's house, which is very common in older homes, the phone will remain off-hook forever. To avoid that, check the line for polarity. If no dial tone is heard when the project is connected, simply reverse tip and ring, the red and green wires mentioned in the article.

ERNEST SCHMELTZER  
PCU, Inc.  
Midland, TX

## IN PRAISE OF THE MAC

The article concerning Microsoft Windows in December's *Editor's Workbench* was interesting in its discussion of the graphic interface. Although I've never used Windows, I'm an old window-hacker on my Mac. It surprises me that after four years of development the DOS

world has yet to implement a consistent, high-quality graphic interface for its machines.

The command line interface is clearly obsolete, a holdover from the days when personal computers had 64K (or less) of memory. Even the original 128K Mac successfully demonstrated the graphic interface. Practically all new software is menu-driven, but the blank screen of DOS is always waiting.

As stated in the article, the Mac is a finely crafted piece of equipment. When I launch a new program, I feel confident that it will run on my machine with no need for tinkering, and that the basic menu commands will look as I expect them to look and be where I expect them to be. That standardization means that a total novice can do useful work with an afternoon's training. I consult documentation only when using the more esoteric features of an application. Usually, the on-line help is more than sufficient. A great deal of the pleasure that I derive from working with the Mac is in appreciation of the elegance of the "overall architecture" of the entire integrated software/hardware system.

I really don't understand the mixture of patronizing amusement and grudging respect that the Mac commands from DOS users. The article opens with a reference to "toys like the early Macintosh"; later, it offers considerable praise for that "toy." I think that since the Mac is simple and fun to use, and DOS is demanding of the user, that the Macintosh is not taken seriously: "No pain, no gain."

I can attest to the Mac's power. I recently attended a seminar that demonstrated a new instrumentation software package called Lab-View. An application that fully implemented the standard Mac interface communicated with an oscilloscope, a microphone, a thermal sensor, QuickBASIC, and the Excel spreadsheet—no surprises there. The bonus was in the interface: An on-screen image of a custom control panel was drawn by the user, with toggle switches, slide controls, rotary knobs, etc. Those controls actually operated the program. Data was displayed in a user-designed graphic format. What's more, *not one line of code was typed!* All programming was done by selecting

# Cable TV Descrambler Article Parts

We stock the exact parts, PC Board and AC Adaptor for two articles published in Radio-Electronics magazine on building your own CABLE TV DESCRAMBLER

## February 1984 issue

#701 Parts..... 19.00  
Includes all original parts.

#702 PC Board..... 7.95  
Original 3x4 etched, drilled and silk-screened pc board.

#704 AC Adaptor..... 7.95  
Original 18 Volt DC @ 200ma.

#701, 702 & 704..... 29.00

## February 1987 issue

#301 Parts..... 29.00  
Includes all original parts.

#302 PC Board..... 7.95  
Original 5x8 etched, drilled and silk-screened pc board.

#304 AC Adaptor..... 7.95  
Original 18 Volt DC @ 200ma.

#301, 302 & 304..... 39.00

Free article reprint with purchase.

Snooper Stopper..... 39.00  
Cable TV descramblers can be detected, protect your privacy with the Snooper Stopper  
Free article on Cable Snooping.

Macrovision Kit..... 29.00  
Macrovision now you see it, now you don't with our macroscrubber kit. Article was published in Radio Electronics 1987 issue.

CALL TOLL FREE 1-800-332-3557

Out side USA 1-508-699-6935

Visa, Master Card and C.O.D.

Add \$3.50 S & H, \$6.00 outside USA.

Visa

MC

D & D Electronics, Inc., PO Box 3310, N Attleboro, Ma 02761

CIRCLE 196 ON FREE INFORMATION CARD

## LEARN VCR CLEANING/MAINTENANCE/REPAIR

EARN UP TO \$1000 A WEEK, WORKING PART TIME FROM YOUR OWN HOME!



Secrets Revealed!

NO Special Tools or Equipment Needed.

### THE MONEY MAKING OPPORTUNITY OF THE 1990'S

IF you are able to work with common small hand tools, and are familiar with basic electronics (i.e. able to use voltmeter, understand DC electronics)...

IF you possess average mechanical ability, and have a VCR on which to practice and learn... then we can teach YOU VCR maintenance and repair!

**FACT:** up to 90% of ALL VCR malfunctions are due to simple MECHANICAL or ELECTRO-MECHANICAL breakdowns!

**FACT:** over 77 million VCRs in use today nationwide! Average VCR needs service or repair every 12 to 18 months!

Viejo's 400 PAGE TRAINING MANUAL (over 500 photos and illustrations) and AWARD-WINNING VIDEO TRAINING TAPE reveals the SECRETS of VCR maintenance and repair—"real world" information that is NOT available elsewhere!

Also includes all the info you'll need regarding the BUSINESS-SIDE of running a successful service operation!

FREE INFORMATION

CALL TOLL-FREE 1-800-537-0589

Or write to: Viejo Publications Inc.  
3540 Wilshire BL, STE. 310  
Los Angeles, CA 90010 Dept. RE

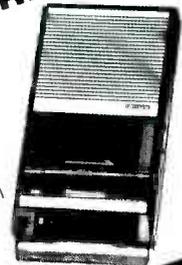
CIRCLE 179 ON FREE INFORMATION CARD

www.americanradiohistory.com

## SUPER LONG PLAY TAPE RECORDERS

12 Hour Model — USES D-120 TAPE \$119.00\*

Modified Panasonic Slimline, high quality AC-DC provide 6 continuous hours of quality recording & playback on each side of cassette for 12 hours total. Includes • Voice level control • Digital counter, etc. TDK D-120 Cassette Furnished.



### PHONE RECORDING ADAPTER

Records calls automatically. All Solid state connects to your telephone jack and tape recorder. Starts recording when phone is lifted. Stops when you hang up. \$28.50\* FCC APPROVED

VOX VOICE ACTIVATED CONTROL SWITCH Solid state. Self contained. Adjustable sensitivity. Voices or other sounds automatically activate and control recorder. Uses either recorder or remote mike. \$28.50\*

\*Add for ship & hdlg. Phone Adapter & Vox \$1.50 ea. Recorders \$4.00 ea. Cal. Res. add tax. Mail order. VISA, M/C, COD's OK. Money Back Guarantee. Qty. disc. avail. Dealer Inquiries invited. Free data. AMC SALES INC. Dept. A 9335 Lubec St. Box 928. Downey, CA. 90241. Phone (213) 869-6519 FAX (213) 923-1478

CIRCLE 108 ON FREE INFORMATION CARD

## FRIENDLY VIDEOS

'The Pioneer In AT Clone Videos'

# COMPUTER HOW-TO VIDEOS

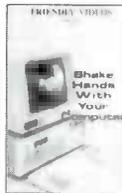


"Video Tape Is A Great Teacher"



"HOW TO BUILD YOUR OWN IBM 286/386 AT CLONE COMPUTER" Easy to do in a couple of evenings of work with just a screwdriver. A real money-saver! 60 MINUTES VHS \$39.95

"SHAKE HANDS WITH YOUR PC/XT/AT COMPUTER". A complete new-user's hardware and software learning guide. Everything from powering up, to the directory structure. 60 MINUTES VHS \$29.95



"HOW TO UPGRADE YOUR PC OR XT COMPUTER TO AN AT FOR UNDER \$200". All in one evening with only a screwdriver. Complete step-by-step guide, anyone can do it! 30 MINUTES VHS \$24.95

"HP LASERJET SERIES II PRIMER". The most complete video available on laser printing, featuring the LaserJet II printer, desktop publishing, fonts, hardware and software accessories. 60 MINUTES VHS \$49.95



### FREE OFFER!

SAVE \$40 NOW by ordering the complete set of all four titles at the ridiculously LOW PRICE of \$100, and receive, absolutely FREE, "After Hours" - a software program to turn your PC into an unattended Message Center!



ORDER NOW!

VISA

TOLL FREE: 1-800-PC-BUYER

Customer Service or CA, Call (714) 898-4055

### Friendly Videos

RE07

PO Box 5684  
Garden Grove, CA 92645 (714) 898-4055  
Please rush me the following VHS format titles:  
 "Clone Assy" @ \$39.95  "Shake" @ \$29.95  
 "PC Upgrade" @ \$24.95  "LaserJet" @ \$49.95  
 Complete Set including FREE software @ \$100  
(Add \$1 S&H per video, and sales tax if CA address)

Name \_\_\_\_\_  
Street Address \_\_\_\_\_  
City, State, Zip \_\_\_\_\_  
Telephone \_\_\_\_\_

icons that represented functions, devices, and subroutines, and drawing lines between them. Labels and function parameters were typed. In the space of ten minutes, we had run data acquisition and spectrum analysis on a sound sample, crunched a selection of the analysis in Excel, and displayed a color bar chart. And the compatibility was excellent. The seminar was conducted on Macintosh II's with large, high-resolution color monitors. The demo disk ran equally well without any tinkering on a low-end MacPlus.

Apple is thick-headed in its pricing and marketing practices. The Mac is not cheap, but it does avoid the hidden costs associated with open architecture—buying boards,

hardware compatibility, etc. I feel safe buying a second-hand Mac because the probability that anyone has opened the case and touched the hardware is very small.

As far as tinkering goes, if I want to modify hardware, I'll use an inexpensive "classic computer." If I want to sit right down and get to work, I'll use the Mac.

I'd like to build some stuff to attach to my SCSI port, but hobbyists and hackers are seriously neglected. It would be a great service to a sizable (and growing) population of users if Radio-Electronics would address that issue occasionally. Connectivity is a hot issue. Expand our horizons!

MICHAEL J. SCHENK  
Baltimore, MD

## Do You Know the ABC's of Home Theater?

If you're looking to recreate the movie theater experience at home, home theater is just what you're looking for. The integration of large screen televisions, videodisc players, VCRs and surround sound processors is one of the most exciting trends in today's consumer electronics world. The following quiz will tell you how much you know about home theater. Score 10 points for each question you answer correctly.

- True or false: Only large screen televisions can be used in home theater systems.
- Which of the following are types of televisions used in home theater systems?
  - Rear projection
  - Direct view
  - Front projection
  - Combination television/monitors
  - Virtually any type of television can be used in a home theater system
- True or false: Television programs have never been broadcast in Dolby surround sound.
- Which of the following are necessary to experience surround sound?
  - A universal remote control
  - A surround sound processor
  - Two extra speakers
  - None of the above
- Videodisc players that play all sizes of videodiscs and compact discs are called
  - All-in-one players
  - Multi-players
  - Continuation players
  - Combination players
- What is a television set without a tuner that accepts input from such sources as a VCR, videodisc player, home computer, and a video game?
  - Monitor
  - Large screen television
  - Viewer
  - All the above
- Videodisc players offer consumers two different formats: one with few special effects, and another that allows such added features as frame search, freeze-frame, and multi-speed play. Those formats are:
  - CLV and CAV
  - DBA and DBD
  - CNV and CVA
  - SLO and FAS
- How many projection televisions were sold in 1989?
  - 50,000
  - 110,000
  - 265,000
  - 1,000,000
- True or false: Surround sound decoders must be incorporated in a home theater system for the system to work properly.
- How many speakers are required for surround sound?
  - 2
  - 5
  - 4
  - 1



Electronic Industries Association  
Consumer Electronics Group

Answers: 1-False. Screen sizes from 31 inches and up can be used effectively in home theater set-ups. 2-E. 3-False. Many movies are broadcast in Dolby surround sound. 4-B, C, 5-D, 6-A, 7-A, 8-C, 9-False. Although the full effect of the home theater environment is not felt unless surround sound is incorporated. 10-C.

# No other training—in school, on the job, anywhere—shows you how to troubleshoot and service computers like NRI

## DIGITAL MULTIMETER

Professional test instrument for quick and easy measurements.

## LESSONS

Clearcut, illustrated texts build your understanding of computers step by step.

## SOFTWARE

Including MS-DOS, GW BASIC, word processing, database and spreadsheet programs.

## HARD DISK

20 megabyte hard disk drive you install internally for greater data storage capacity and data access speed.

## NEW! AT-COMPATIBLE COMPUTER

High-speed 80286 CPU (12 MHz clock, 0 wait states), 1 meg RAM, 1.2 meg, 5 1/4" high-density floppy disk drive.

## MONITOR

High-resolution, non-glare, 12" TTL monochrome monitor with tilt and swivel base.

## TECHNICAL MANUALS

With professional programs and complete specs on your computer.

## DIGITAL LOGIC PROBE

Simplifies analyzing digital circuit operation.

## DISCOVERY LAB

Complete breadboarding system to let you design and modify circuits, diagnose and repair faults.

Only NRI walks you through the step-by-step assembly of a powerful AT-compatible computer system you keep—giving you the hands-on experience you need to work with, troubleshoot, and service all of today's most widely used computer systems. You get all it takes to start a money-making career, even a business of your own in computer service.

No doubt about it: The best way to learn to service computers is to actually *build* a state-of-the-art computer from the keyboard on up. As you put the machine together, performing key tests and demonstrations at each stage of assembly, you see for yourself how each part of it works, what can go wrong, and how you can fix it.

Only NRI—the leader in career-building, at-home electronics training for more than 75 years—gives you such practical, real-world computer servicing experience. Indeed, no other training—in school, on the job, *anywhere*—shows you how to troubleshoot and service computers like NRI.

**You get in-demand computer servicing skills as you train with your own AT-compatible system—now with 20 meg hard drive**

With NRI's exclusive hands-on training, you actually build and keep the powerful new AT-compatible West Coast 1010 ES computer, complete with 1 meg RAM and 20 meg hard disk drive.

You start by assembling and testing the 101-key "intelligent" keyboard, move on to test the circuitry on the main logic board, install the power supply and 1.2 meg 5 1/4" floppy disk drive, then interface your high-resolution monitor. But that's not all.

**Only NRI gives you a top-rated micro with complete training built into the assembly process**

Your NRI hands-on training continues as you install the powerful 20 megabyte hard disk drive—today's most wanted computer peripheral—included in your course to dramatically increase your computer's storage capacity while giving you lightning-quick data access.

Having fully assembled your West Coast 1010 ES, you take it through a complete series of diagnostic tests, mastering professional computer servicing techniques as you take command of the full power of your computer's high-speed 80286 microprocessor.

In no time at all, you have the confidence and the know-how to work with, troubleshoot, and service every computer on the market today. Indeed you have what it takes to step into a full-time, money-making career as an industry technician, even start a computer service business of your own.

**No experience needed, NRI builds it in**

You need no previous experience in computers or electronics to succeed with NRI. You start with the basics, following easy-to-read instructions and diagrams, quickly

moving from the fundamentals to sophisticated computer servicing techniques. Step by easy step, you get the kind of practical hands-on experience that makes you uniquely prepared to take advantage of every opportunity in today's top-growth field of computer service.

What's more—you learn at your own pace in your own home. No classroom pressures, no night school, no need to quit your present job until you're ready to make your move. And all throughout your training, you have the full support of your personal NRI instructor and the NRI technical staff always ready to answer your questions and give you help whenever you need it.

**Your FREE NRI catalog tells more**

Send today for your free full-color catalog describing every aspect of NRI's innovative computer training, as well as hands-on training in robotics, video/audio servicing, electronic music technology, security electronics, telecommunications, and other growing high-tech career fields.

If the coupon is missing, write to NRI School of Electronics, McGraw-Hill Continuing Education Center, 4401 Connecticut Avenue, Washington, DC 20008.

AT is a registered trademark of International Business Machines Corporation

NRI

School of  
Electronics

McGraw-Hill

McGraw-Hill Continuing Education Center  
4401 Connecticut Avenue, Washington, DC 20008

For career courses approved under GI bill  
 check for details

Check one FREE catalog only

<input type="checkbox"/> Computers and Microprocessors	<input type="checkbox"/> Security Electronics
<input type="checkbox"/> Robotics	<input type="checkbox"/> Electronic Music Technology
<input type="checkbox"/> TV/Video/Audio Servicing	<input type="checkbox"/> Basic Electronics
<input type="checkbox"/> Computer Programming	<input type="checkbox"/> Telecommunications

Name \_\_\_\_\_ (please print) Age \_\_\_\_\_

Address \_\_\_\_\_

City/State/Zip \_\_\_\_\_

Accredited Member, National Home Study Council

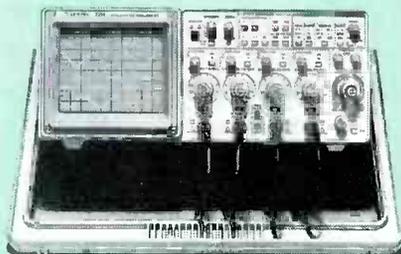
4219-070

# EQUIPMENT REPORTS

## Tektronix 2214 Digital/Analog Oscilloscope

*A unique combination of features makes this scope ideal for physical-system measurements.*

CIRCLE 28 ON FREE INFORMATION CARD



WHAT DO YOU GET WHEN YOU CROSS A 20-MHz, 4-channel oscilloscope with four digitizers and an RS-232 interface? You get the 2214 Digital/Analog oscilloscope from Tektronix (P.O. Box 500, Beaverton, OR 97077).

At first glance, the 2214 doesn't appear any different from a standard analog scope. The front-panel controls are laid out in an intuitively easy-to-use format. Above each BNC input connector is its corresponding input-coupling switch, attenuation selector or VOLTS/DIV switch, position control, and  $\times 10$  selector. To the right of the four vertical-amplifier controls are the time-base controls. The trigger controls are grouped together at the top right of the front panel, next to another group of controls for storage functions.

The front-panel layout is kept uncluttered in part by using a single push-button where you might expect more. For example, to select one of six possible trigger sources, a single push-button is used. Each time the button is pressed, a call-out above the button is back-lighted to indicate the choice.

Connectors that are used less frequently are relegated to the side panel. They include external-trigger and Z-axis inputs, and a trigger-level output. The Z-axis input doubles as an external-clock input when the scope is in its digital-storage mode. The hardcopy serial interface con-

nectors and its related parameter-selection switches are also located on the side panel.

### Special features

The basic specifications of the 2214 may not seem too impressive at first: an analog bandwidth of 20 MHz, a bandwidth in digital-storage mode of 8 MHz. Such specifications, however, tell only part of the story. The 2214 offers a number of features that make it stand out as an

excellent tool in electromechanical and process-control applications, for which it was designed.

One of the interesting features worth noting is that the scope can operate at a wide variety of speeds. Its roll mode can be used to slowly display up to 500 seconds of on-screen data. Such a display can often make the data easier to comprehend. Alternately, the digitizer can be clocked from an external source at any rate from DC to 8 MHz.

The 2214's horizontal timebase is variable even in the storage mode. Waveforms—even frozen captured signals, which consist of 16K data samples—can be expanded by up to a factor of 50 to let you zoom in for close examination. All 16K sample points are visible on the screen in the expanded mode. All four channels, and all 64K samples, can be displayed simultaneously.

You can freeze and store the signals from any or all channels and

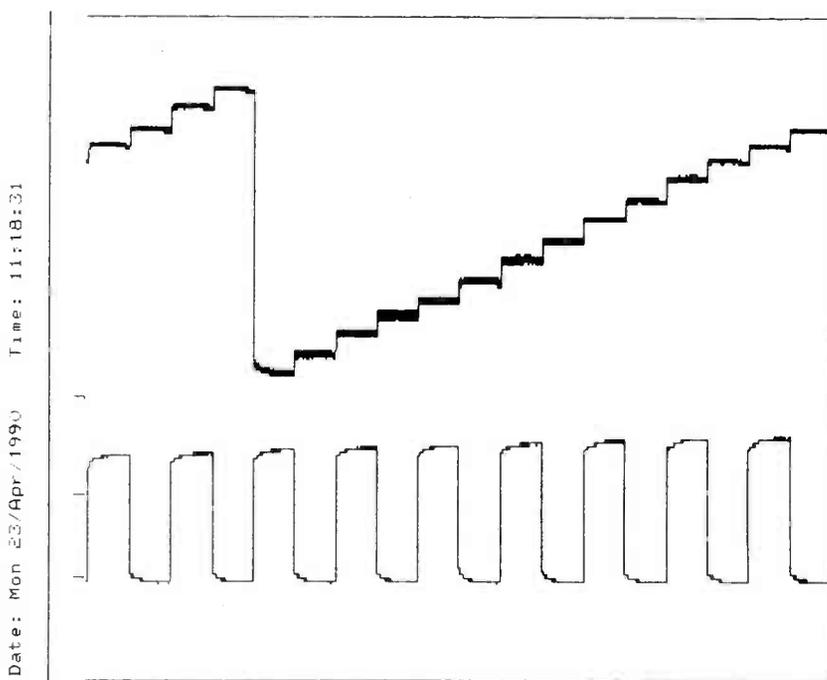


Fig. 1

# ELENCO & HITACHI PRODUCTS AT DISCOUNT PRICES

**NEW!** RSOs (Real-Time & Storage Oscilloscopes) From HITACHI **NEW!**  
The RSO - its the new solution  
View, Acquire, Test, Transfer and Document Your Waveform Data

**4-Channel, 100MS/s Model** **Introductory Price**  
100MS/s (25MS/s on 4 channels simultaneously), 100MHz, 4kw x 1ch., 2kw x 2ch., 1kw x 4ch. VC-6145 \$ 4,695.00

**Compact, Full Feature Models**  
40MS/s, 100MHz, 4kw x 1ch., 2kw x 2ch. VC-6045 \$ 3,049.00  
20MS/s, 50MHz, 2kw x 2ch. VC-6025 \$ 2,295.00

**Low Cost/High Value Models**  
20MS/s, 50MHz, 2kw x 2ch. VC-6024 \$ 2,049.00  
20MS/s, 20MHz, 2kw x 2ch. VC-6023 \$ 1,749.00

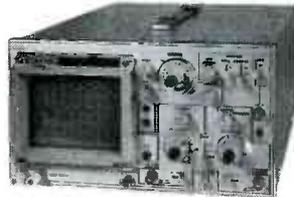
RSOs from Hitachi feature such functions as roll mode, averaging, save memory, smoothing, interpolation, pretriggering, cursor measurements, plotter interface, and RS-232C interface. With the comfort of analog and the power of digital.



V-212  
**\$435**  
DC to 20MHz  
Dual Channel  
V-422 40MHz Dual Trace \$795

**Hitachi Portable Scopes**  
DC to 50MHz, 2-Channel, DC offset  
function, Alternate magnifier function  
V-525 CRT Readout, Cursor Meas. \$1,025  
V-523 Delayed Sweep \$995  
V-522 Basic Model \$895

## 20MHz Elenco Oscilloscope



**\$375**  
MO-1251  
• Dual Trace  
• Component Tester  
• 6" CRT  
• X-Y Operation  
• TV Sync  
• 2 p-1 Probes

**FREE DMM**  
with purchase of  
**ANY SCOPE**  
**SCOPE PROBES**  
P-1 65MHz, 1x, 10x \$19.95  
P-2 100MHz, 1x, 10x \$23.95

## Compact Series Scopes



Delayed Sweep  
Lightweight (13lbs)  
2mV Sens  
3 Yr Warranty

Model V-1065  
Shown

This series provides many new functions such as CRT Readout, Cursor measurements (V-1085/1065/665), Frequency Ctr (V-1085), Sweetime Autoranging and Trigger Lock using a 6-inch CRT. You don't feel the compactness in terms of performance and operation.

V-660 60MHz Dual Trace \$1,195  
V-665 60MHz Dual Trace w/Cursor \$1,345  
V-1060 100MHz Dual Trace \$1,425  
V-1065 100MHz Dual Trace w/Cursor \$1,695  
V-1085 100MHz Quad Trace w/Cursor \$2,045  
V-1100A 100MHz Quad Trace w/Cursor \$2,295  
V-1150 150MHz Quad Trace w/Cursor \$2,775

## Elenco 35MHz Dual Trace Good to 50MHz \$495



MO-1252  
• High luminance 6" CRT  
• 1mV Sensitivity  
• 6KV Acceleration Voltage  
• 10ns Rise Time  
• X-Y Operation • Z Axis  
• Delayed Triggering Sweep  
• Includes 2 P-1 Probes

All scopes include probes, schematics, operators manual, and 3 year (2 yrs for Elenco scopes) world wide warranty on parts & labor. Many accessories available for all Hitachi scopes. Call or write for complete specifications on these and many other fine oscilloscopes.

**WE NOW  
CARRY  
COMPLETE LINE  
OF  
FLUKE  
MULTIMETERS  
Models**

- 21F 83
- 23F 85
- 25F 87
- 27F 8050A
- 73 8060A
- 75 8062A
- 77F + More

**CALL FOR  
SPECIAL PRICING**

**True RMS 4 1/2  
Digit Multimeter  
M-7000  
\$135**  
.05% DC Accuracy  
.1% Resistance  
with Freq. Counter  
and deluxe case

**Function Generator  
Blox  
\$28.95**  
Provides sine, triangle, square  
wave from 1Hz to 1MHz  
AM or FM capability

**10 Function  
Multimeter  
CM-365  
\$65**  
AC + DC Voltage & Amps  
Resistance to 2000Ω  
Diode, Logic, & Trans test  
Capacitance to 200uF

**Triple Power Supply XP-620  
Assembled \$65  
Kit \$45**  
2 to 15V at 1A,  
-2 to -15V at 1A  
(or 4 to 30V at 1A)  
and 5V at 3A  
Contains all the desired features for doing experiments.  
Features short circuit protection, all supplies.

**Digital Capacitance Meter  
CM-1550  
\$58.95**  
9 Ranges  
.1pf-20,000ufd  
.5% basic acy  
Zero control  
with case

**Digital LCR Meter  
LC-1801  
\$125**  
Measures:  
Coils 1uH-200H  
Caps .1pf-200uf  
Res .01-20M

**Wide Band Signal Generators  
SG-9000  
\$129**  
RF Freq 100K-450MHz  
AM Modulation of 1KHz  
Variable RF output  
SG-9500 w Digital Display and 150MHz built-in Counter \$249

**AC Current Meter  
ST-1010  
\$69.95**  
1000 Amps  
Data & Peak hold  
8 Functions  
Deluxe Case

**Decade Blox  
\$9610 or  
\$9620  
\$18.95**  
#9610 Resistor Blox  
47 ohm to 1M & 100K pot  
#9620 Capacitor Blox  
47pf to 10MFD

**Quad Power Supply XP-580  
\$59.95**  
2-20V at 2A  
12V at 1A  
5V at 3A  
-5V at .5A  
Fully regulated and short circuit protected  
XP-575 without meters \$39.95

**LEARN TO BUILD AND PROGRAM  
COMPUTERS WITH THIS KIT!**  
INCLUDES: All Parts, Assembly and Lesson Manual  
Model  
MM-8000  
\$129.00

**Digital Triple Power Supply XP-765  
\$249**  
0-20V at 1A  
0-20V at 1A  
5V at 5A  
Fully regulated, Short circuit protected with  
2 limit control, 3 separate supplies  
XP-660 with Analog Meters \$175

**GF-8016 Function Generator  
with Freq. Counter  
\$249**  
Sine, Square, Triangle  
Pulse, Ramp, .2 to 2MHz  
Freq Counter .1 - 10MHz  
GF-8015 without Freq. Meter \$179

Starting from scratch you build a complete system. Our Micro-Master trainer teaches you to write into RAMs, ROMs and run a 8085 microprocessor, which uses similar machine language as IBM PC. You will write the initial instructions to tell the 8085 processor to get started and store these instructions in permanent memory in a 2816 EPROM. Teaches you all about input and output ports, computer timers. Build your own keyboard and learn how to scan keyboard and display. No previous computer knowledge required. Simple easy to understand instruction teaches you to write in machine language.  
**ROBOTICS KIT FOR ABOVE (MM-8010) \$71.95**

**WE WILL NOT BE UNDERSOLD!**  
UPS Shipping: 48 States 5%  
(\$10 Max) IL Res., 7% Tax

**C & S SALES INC.**  
1245 Rosewood, Deerfield, IL 60015  
(800) 292-7711 (708) 541-0710

**15 Day Money Back Guarantee**  
**2 Year Warranty** Prices subject to change  
**WRITE FOR FREE CATALOG**

CIRCLE 109 ON FREE INFORMATION CARD

# ATTENTION! ELECTRONICS TECHNICIANS

EARN YOUR  
**B.S.E.E.  
DEGREE**

THROUGH HOME STUDY

Our New and Highly Effective Advanced-Placement Program for experienced Electronic Technicians grants credit for previous Schooling and Professional Experience, and can greatly reduce the time required to complete Program and reach graduation. No residence schooling required for qualified Electronic Technicians. Through this Special Program you can pull all of the loose ends of your electronics background together and earn your B.S.E.E. Degree. Upgrade your status and pay to the Engineering Level. Advance Rapidly! Many finish in 12 months or less. Students and graduates in all 50 States and throughout the World. Established Over 40 Years! Write for free Descriptive Literature.

**COOK'S INSTITUTE  
OF ELECTRONICS ENGINEERING**



4251 CYPRESS DRIVE  
JACKSON, MISSISSIPPI 39212

CIRCLE 58 ON FREE INFORMATION CARD

## New AOR Scanner

**1000 Channels.  
8-600MHz,  
805-1300  
MHz**



### AR1000

Total Price: Freight Prepaid  
(Express Shipping Optional)

**\$499**

- Continuous coverage (except UHF TV 600-805)
- AM, FM and wide band FM tuning modes
- 10 Scan Banks, 10 Search Banks
- Selectable Priority Channel
- Selectable Search Increments: 5 955KHz
- Permanent memory backup.
- 25 Day Satisfaction Guarantee Full refund if not Satisfied
- No Frequencies cut out
- All normal accessories included.
- Size: 6 7/8" H x 1 3/4" D x 2 1/2" W
- Wt. 12 oz



10701 E. 106th St. Indpls., IN 46256  
Toll Free 800-445-7717



Visa and Mastercard  
(COD slightly higher)



FAX (317) 849-8794

CIRCLE 195 ON FREE INFORMATION CARD

can view both "live" and stored signals at the same time. For example, a reference signal can be stored on screen while live inputs are monitored.

Any of the four input channels can serve as a trigger source, as can a signal at the external trigger input. Positive- and negative-slope triggering is available, as is a "BiSlope" mode that can obtain stable triggers for both positive and negative signals. That's useful if you cannot predict the polarity of signals you wish to acquire. The trigger level you select is available at an output jack for display on either a DMM or on one of the scope channels itself.

### Hardcopy output

An RS-232 interface is built into the 2214. You can output stored waveforms directly to plotters that support the HPGL (Hewlett-Packard Graphics Language) or, alternatively, an Epson-compatible dot-matrix printer. A sample printout is shown in Fig. 1. The printer can easily be used to emulate a chart recorder. In that mode, acquired signals are continuously output to the printer, resulting in a four-channel chart-recorder-like output. Speeds from 10 s/cm to 2500 s/cm are available, making this mode ideal for recording transient events.

Since the interface is RS-232-compatible, you can, as you might expect, transfer data and waveforms to your PC. Waveform-transfer software, *Grabber II*, is included with the scope.

A flexible assortment of differential measurement capabilities add to the value of the scope. Signals can be inverted and added together to cancel unwanted common-mode noise and offsets.

The 2214 isn't a mass-market oscilloscope. If you're looking for a digital oscilloscope that offers the analog operation with which you're familiar, you'd be better served by one of the other, less expensive, scopes in Tektronix's 2200 series. However, if you have special applications that require dual differential measurement capability, or if full four-channel capability is important to you, then the 2214 becomes the obvious choice. The scope is priced at \$3995, including the RS-232 interface, waveform-grabbing software, and two 10x probes.

R-E

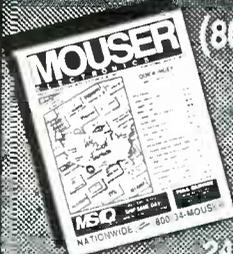
# 23477

## ELECTRONIC COMPONENTS

Whether you order 1 part or all 23,477... **MOUSER** stocks and... can ship today!!  
**MOUSER** also makes it easy to do business.

Call ...  
**(800) 992-9943**

for your  
**FREE**  
catalog



2401 Hwy 287 N  
Mansfield, TX 76063

**MOUSER**  
ELECTRONICS  
Sales & Stocking Locations Nationwide

CIRCLE 117 ON FREE INFORMATION CARD

Get A Complete Course In

## ELECTRONIC ENGINEERING

8 volumes, over 2000 pages, including all necessary math and physics. 29 examinations to help you gauge your personal progress. A truly great learning experience.

Prepare now to take advantage of the growing demand for people able to work at the engineering level.

Ask for our brochure giving complete details of content. Use your free information card number, or write us directly. **\$99.95**, Postage Included. Satisfaction guaranteed or money refunded.



**Banner  
Technical  
Books, Inc.**

1203 Grant Ave.  
Rockford, IL 61103

CIRCLE 67 ON FREE INFORMATION CARD

# NEW PRODUCTS

**INDUSTRIAL SECURITY CAMERA.** Small enough to be hidden in a standard electrical receptacle box, *Chinon's CX-101* camera is also versatile enough to meet a wide variety of security needs. Combining ultra-compactness, wide-angle viewing, and the ability to view even under near-dark conditions, the CCTV camera can be positioned in many locations, including doors. Suitable for industrial or home security systems, it features a 4.5mm lens with a fixed iris and electronic shutter that allows viewing in such diverse locations as loading docks, stores, and hotel or apartment lobbies. Measuring just  $1\frac{13}{16} \times 2\frac{3}{4} \times 1$  inches, and weighing only 6.3 ounces, the camera is easy to place for robotic vision and inspection applications in quality control, manufacturing, and production. Its  $f/1.8$  lens and  $\frac{1}{3}$ -inch MOS-type imaging chip pro-



CIRCLE 11 ON FREE INFORMATION CARD

vide light sensitivity as low as 2 lux—candle-light conditions—and sharp resolution of  $230 \times 240$  TV lines, or 80,000 pixels. In addition, the *CX-101* runs composite video leads, allowing direct cable connection to a television monitor. The camera requires only 0.8 watts from a standard 12-volt DC power

supply, and has an operating temperature range of  $0-40^\circ\text{C}$ . A metal housing with  $\frac{1}{4}$ -inch-20 mounting is also available.

The *CX-101* costs \$550.—**Chinon America, Inc.**, Industrial Products Division, 1065 Bristol Road, P.O. Box 1248, Mountainside, NJ 07092-1248; Tel. 201-654-0404.

**FREQUENCY COUNTER.** Designed to provide an unusual number of convenience features and to operate over a broad frequency range, *Beckman Industrial's FC130A* microprocessor-controlled frequency counter measures frequency, period, and RPM from 0.01 Hz to 1.3 GHz. Its standard features include very high resolution (as low as 10 nHz for a 1-Hz input); a bright, 8-digit LED frequency readout with floating point and overflow; 10-mV input sensitivity (typical); continuously variable gate time selection; switchable AC or DC coupling; a built-in self-diagnosis routine; and a switchable  $\times 20$  input attenuator and low-pass filter. Two separate channels are used to achieve high measurement ranges: Channel A covers frequency measurements from 0.01 Hz



CIRCLE 12 ON FREE INFORMATION CARD

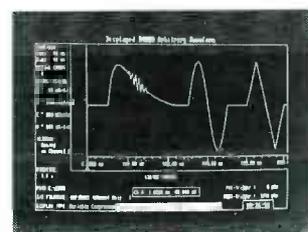
to 120 MHz, and Channel B covers 50 MHz to 1.3 GHz. Its wide range, combined with its heavy-duty design, makes the *FC130A* suitable for both bench and field use in a variety of applications ranging from amateur and business radio, cordless-phone repairs, and computer service. The instrument can be used in R&D, for troubleshooting and repair, and to check

equipment calibration.

The *FC130A* frequency counter—complete with power cord, operator's manual, two BNC-to-alligator-clip test cables, and a spare fuse—has a suggested list price of \$595.00.—**Beckman Industrial Corporation**, 3883 Ruffin Road, San Diego, CA 92123-1898; Tel. 619-495-3200.

**WAVEFORM GENERATOR.** *Rapid Systems' R4010* waveform-creation and -generation instrument lets you use a mouse to visually create any waveform and then output the electrical waveform with a 10-MHz, 12-bit, arbitrary waveform generator. The advanced PC-based product easily accomplishes waveform creation and realization functions where stand-alone function gener-

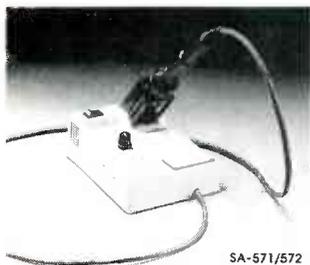
ators, synthesizers, and signal sources cannot graphically create electrical waveforms. The *R4010* also makes it easy to edit any digitized real-world signal on a PC screen and output the same signal. Special features include color waveform-creation software (with free demo disk); 16,000-point waveform memory; continuous, sweep, and burst output modes; programmable output voltage to 10 volts p-p; and a built-in library of waveforms that includes sine, square, triangle, ramp, pulse, noise, and telephone waves.



CIRCLE 13 ON FREE INFORMATION CARD

The *R4010* waveform creator/generator costs \$2995.00.—**Rapid Systems, Inc.**, 433 North 34th Street, Seattle, WA 98103; Tel. 206-547-8311.

**SOLDERING STATION.** Designed to meet hand-soldering needs of the 1990's, The *SA-570 Series* soldering station from *OK Industries* provides cost-effective flexibility and consistent performance. Offering both durability and quick recovery, it features a powerful 70-watt heating element with precise RTD temperature control that allows excellent stability and repeatability, as well as quick recovery on "heavy joints." The *SA-570 Series'* operating range of  $600-800^\circ\text{F}$  offers high power for a variety of applications, including on



SA-571/572

CIRCLE 14 ON FREE INFORMATION CARD

boards with exceptional thermal demands. Its directly grounded tip meets MIL-STD-2000 resistance and voltage requirements. The soldering station's low-profile, small-footprint housing takes up little bench space, and the iron's light-weight handpiece provides maximum operator comfort and safety. The station uses high-mass soldering tips that are available in a wide range of profiles.

The SA-570 Series soldering station has a list price of \$86.90.—OK Industries, Inc., 4 Executive Plaza, Yonkers, NY 10701; Tel. 1-800-523-0667.

**RAM-RESIDENT ELECTRONIC MAIL.** Offering the distinct advantage of not requiring the user to leave his application program, *Notework* is a RAM-resident electronic-mail program that uses only 5K of RAM on each PC. It allows users to pop up a note, file-transfer, or phone-message form without interrupting his work on a word-processing or spreadsheet program. Even non-technical users can learn to send, receive, and forward notes and phone messages right away, learning as they go from the *Notework's* menu. *Notework* also allows screen samples to be attached to a message, and files to be



CIRCLE 15 ON FREE INFORMATION CARD

transferred between directories and from disk to disk without leaving the original application program. Other capabilities include printing hard copies of any message, importing messages to text files in word-processing and desktop-publishing programs to keep a mail log, and sending "Urgent" messages. The original installation disk authorizes eight users; more users can be easily installed with additional user-authorization disks.

The *Notework* eight-user installation disk costs \$495.00; additional 2-, 10-, and 50-user authorization disks cost \$99.00, \$399.00, and \$1499.00, respectively. Additional discounts are offered on larger networks.—**Professional Productivity Corporation**, 72 Kent Street, Brookline, MA 02146; Tel. 1-800-767-6683.

**RADIO-FREQUENCY FINDER.** A handheld frequency counter from *Optoelectronics* detects and displays two overlapping frequency



CIRCLE 16 ON FREE INFORMATION CARD

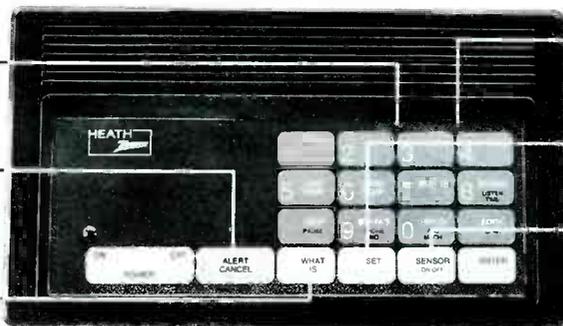
ranges, from 10 Hz to 12 MHz and from 10 MHz to 2.4 GHz, with 1-Hz and 100-Hz resolution, respectively. The model 2210-A personal frequency finder/counter's exceptional range is accomplished by using a unique input-prescaling technique similar to television-receiver design. Rather than dividing the incoming signal by a decade number, the instrument divides it by 256, which extends the upper range—and, in the process, uses low-cost TV parts. Because of the bin-

# THE HOUSE SITTER THAT DOESN'T NEED A KEY

Use the keyboard to set emergency phone numbers, high and low temperatures, listen-in time and more

ALERT/CANCEL key cancels automatic dial-out, allows you to answer phone

WHAT IS key lets you listen to function settings and dial-out numbers



Use the keyboard to ask for information

SET key allows you to change previous settings

SENSOR ON/OFF key chooses the functions to report

**ONLY \$129.95**

"This is 555-3210. Alert condition is OK. Temperature is 65°. Electricity is on. Sound level is OK." Monitoring your home from work or a vacation spot is made easy with the Heath/Zenith House Sitter Security Monitor/Dialer.

## Monitors Your Home

When you call, the House Sitter will report on the AC electric power, the room temperature – comparing it with high and low limits you've already set, loud noises such as burglar alarms and fire alarms, the unit's own battery backup condition, and an additional alert condition. You can even listen to the sounds in the room using the built-in microphone.

## Dials Out In Alert Conditions

Set the unit to call out to your office, neighbors' and relatives' to announce any alert conditions that are outside preset limits. Up to four numbers can be programmed.

## Order Toll Free 1-800-253-0570

The SD-6230 House Sitter is yours for only \$129.95\*. To order, call toll-free 1-800-253-0570. VISA, MasterCard, American Express or your Heath Revolving Charge card accepted. Use order code 620-012

See our full line of electronic products for your home in the **Heathkit** catalog – call **1-800-44-HEATH** for your **FREE** copy.

**Heath**<sup>®</sup>  
Benton Harbor, MI

\*Price does not include shipping and handling, or applicable sales tax.

CIRCLE 86 ON FREE INFORMATION CARD

ary scheme, the internal time base is referenced to a popular 3.90625-MHz crystal, which is the correct frequency to divide by 256. That approach reduces the prescaler time base to just four parts, and affords it a 10-mV input sensitivity. At the low-frequency range, the 2210-A uses a 10-MHz crystal and a divide-by-decade technique to get down to as low as sub-audio 10 Hz.

Front-panel features include an eight-place LED display, range-select switch, power-select switch (external 9–12 VDC or four rechargeable Ni-Cd batteries), and a gate-control switch and LED indicator for long or short sampling times. Available options include five different antennas, a probe for PC-board work, and a high-accuracy time base for better than  $\pm 1$ -PPM accuracy. Housed in a high-impact aluminum housing for years of durability and maximum EMI/RFI shielding, the frequency finder measures an easily portable  $4 \times 3\frac{1}{2} \times 1$

inches and weighs only 9 ounces.

The model 22i0-A handheld frequency finder/counter costs \$219.00.—**Optoelectronics Inc.**, 5821 NE 14th Avenue, Fort Lauderdale, FL 33334; Tel. 800-327-5912 (in FL, 305-771-2050).



CIRCLE 17 ON FREE INFORMATION CARD

**REMOTE AC-POWER CONTROL SYSTEM.** A compact remote-control switch that can be used to turn on and off any AC-powered device, *Midland International's* model 72-300, consists of a compact transmitter and a small module that plugs an

AC outlet. Electrical items that are plugged into the module can be controlled by the transmitter from as far as 50 feet away. The 72-300 can handle up to 1000-watt loads and can be used to control such things as televisions, lamps, stereos, appliances, fans, and most other electrical appliances. It operates on the UHF radio band and is powered by an ordinary 9-volt battery.

The 72-300 remote AC power switch system has a suggested list price of \$39.95.—**Midland International Corporation**, Consumer Communications Division, 1690 North Topping, Kansas City, MO 64120; Tel. 816-241-8500.

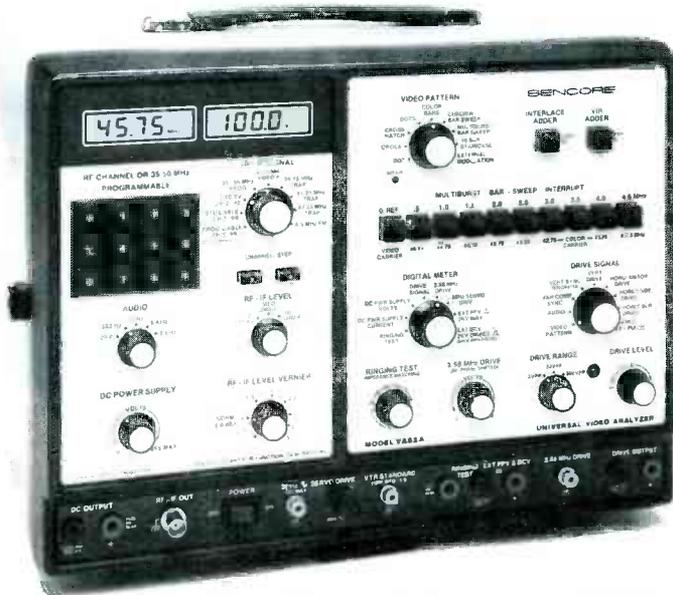
**PORTABLE WAVEFORM MONITOR.** An upgraded EFP/ENG waveform monitor from *Leader Instruments*, model 5864A, offers studio-quality monitoring for on-location shooting, and the convenience of dual-input capability for signal comparison and timing adjust-



CIRCLE 18 ON FREE INFORMATION CARD

ments. The battery-powered unit, which weighs less than three pounds, provides 2H/2V MAG and 2H/2V sweep rates. It offers flat and IRE filters as well as a  $4 \times$  vertical magnifier that simplifies set-up level and black-balance checks. Designed for use with Leader's compact vectorscope (model 5854) and SID signal generator (model LCG-413), the 5864-A is portable, rugged, and easy to use.

The 5864-A portable waveform monitor costs \$1,395.00.—**Leader Instruments Corporation**, 380 Oser Avenue, Hauppauge, NY 11788; Tel. 1-800-645-5104.



## With The Market Proven VA62A Universal Video Analyzer™

Are you finding it tough to service today's hi-tech VCR and TV circuits? Successful video servicers have told us that, to them, the new technology meant lost profit and troubleshooting grief until they tried the VA62A's time tested, functional analyzing methods. "The VA62A cuts servicing time and increases profits . . ."

\*Based on a nationwide survey of users who reported an average time savings of 54% compared to their previous test equipment.

# Cut Your Video Servicing Time by 54%\*

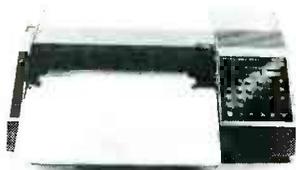


**\$3,495 Patented**

You can prove it to yourself, in your shop, absolutely risk free—and share in the profits successful video servicing can bring. Call **1-800-SENCORE (736-2673)** and ask about our exclusive VA62A instrument evaluation program. Tech-Tape Video Preview and FREE full line color catalog are also available.

**SENCORE®**  
3200 Sencore Drive, Sioux Falls, SD 57107  
100% American Made

CIRCLE 176 ON FREE INFORMATION CARD



CIRCLE 19 ON FREE INFORMATION CARD

**ANALOG CHART RECORDER.** Combining both XY and strip-chart modes, *Fluke's PM 8278* dual-pen analog chart recorder also adds digital enhancements, such as built-in facilities for automatic chart annotation and pen-offset compensation. Optional IEEE-488 or RS-232 interfaces are available for complete remote control and data transfer in instrument systems or for use as a hard-copy output device for a digital storage scope.

The *PM 8278* is easy to use. At the push of one button, time, date, and instrument settings—including channel

number, span, zero-suppression, and chart speed—are printed on the chart output. User-defined text can also be added through the optional interfaces. The chart recorder accepts 8-1/2 x 11 and 11 x 17-inch paper, as well as Z-fold paper for continuous charts. It features automatic paper-edge detection and sheet positioning and an optical pen-positioning system for reliable operation.

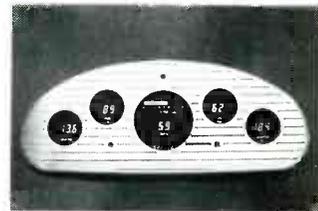
As an XY recorder, the *PM 8278* has 25 calibrated input ranges on both X and Y channels, with a sensitivity range of 40  $\mu$ V/cm to 2 V/cm. Fast dynamic response of 100 cm/s and 10-G acceleration ensure that even fast-changing signals are accurately traced. In strip-chart mode, the recorder has 24 timebase settings, including 10 user-programmable lines, varying from 10 mm/h to 120 mm/min. Step response is 0.25 seconds full scale.

The *PM 2878* dual-pen analog chart recorder has a U.S. list price of \$3360.00. (A single-pen chart recorder,

model *PM 2877*, has a list price of \$2340.00)—**John Fluke Mfg. Co., Inc.**, P.O. Box 9090, Everett, WA 98026; Tel. 800-443-5853, ext. 77.

**VACUUM FLUORESCENT DIGITAL DASHBOARD.**

Breaking away from traditional LED displays, *Dakota Digital's vacuum-fluorescent digital dashboard* provides a bright-blue fluorescent readouts with superior performance and visual appeal. The displays are readable in direct sunlight, and the system automatically dims for night-time driving. The dashboard uses a micro-processor system to measure, calculate, and display speed, RPM, mileage, voltage, oil pressure, water temperature, and fuel level. If a reading should vary from normal limits, an "idiot light" system causes the gauge display to flash. A resettable "trip meter" is included. Vehicle mileage is stored in a nonvolatile memory that does not lose its informa-



CIRCLE 20 ON FREE INFORMATION CARD

tion even when the battery is disconnected. Intended to hobbyists, car buffs, and street-rod enthusiasts, the dashboard systems can be custom-built to virtually any user-specified arrangement, and can be easily installed in any truck, car, or boat.

The *vacuum-fluorescent digital dashboard* is available as a complete set with aluminum insert (as pictured) for \$499.95. Alternately, if you send in your dashboard, the display can be mounted in it (without the aluminum insert) for approximately \$420.00.—**Dakota Digital**, 11301 Kuhle Drive, Sioux Falls, SD 57107; Tel. 1-800-852-3228. R-E

**BK PRECISION**  
MAXTEC INTERNATIONAL CORP.

**SUMMER**  
*Sale-abration*

**MODEL 2120**  
Oscilloscope, 20 MHz,  
Dual Trace.  
REG. \$549.00 SALE \$374.95

**MODEL 1541A**  
Oscilloscope, 40 MHz,  
Dual Trace.  
REG. \$845.00 SALE \$597.95

**MODEL 2160**  
Oscilloscope, 60 MHz, Dual-  
Trace, w/Delayed Sweep.  
REG. \$1099.00 SALE \$874.95

**MODEL 2501**  
Digital Storage Adaptor.  
Converts Your Analog Scope  
To Digital Storage!  
REG. \$795.00 SALE \$299.95

**MODEL 2832**  
3-1/2 Digit Multimeter/  
Capacitance Meter.  
REG. \$175.00 SALE \$124.95



**\$99.95**

**MODEL 388-HD**  
Test Bench.  
REG. \$129.00

**PRINT**  
Products International

8931 Brookville Rd.  
Silver Spring, MD 20910  
(800)638-2020 (301)587-7824  
FAX (301)585-5402  
Easy Order Fax Line 1-800-545-0058

"We Make Ordering Easy"

COMPLETE B&K LINE AVAILABLE  
"CALL FOR YOUR PRICE QUOTES"



800-638-2020

CIRCLE 188 ON FREE INFORMATION CARD

**CABLE - TV**

**SIGNAL REMOVERS**

- FOR ELIMINATION OF SEVERE INTERFERENCE
- FOR "CENSORING" OF ADULT BROADCASTS



FOR FULL DESCRIPTION OF USES ask for our free brochure

- ATTENUATION - 45 dB TYPICAL
- BANDWIDTH - 4 MHz AT 5 dB POINTS
- INSERTION LOSS - 2 dB

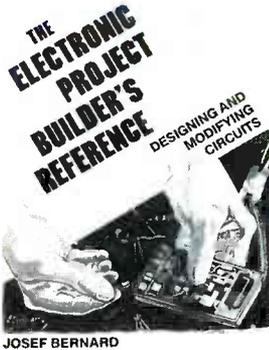
MODEL	TUNING RANGE	FOR CHANNELS	PASSBAND	PRICE	SHIPPING
23H	50-66 MHz	2,3 (or 6 meter ham)	50-300 MHz	\$30	NO SHIPPING or C.O.D. CHARGES
46FM	66-108 MHz	4,5,6 (or any FM)	50-300 MHz	\$30	
1417	120-144 MHz	14(A) 15(B) 16 (C) 17(D)	50-400 MHz	\$30	
1822	144-174 MHz	18(E) 19(F) 20(G) 21(H) 22 (I)	50-400 MHz	\$30	
713	174-216 MHz	7,8,9,10,11,12,13	50-400 MHz	\$30	

3 for \$75 - 10 for \$200 - mix or match

CALL TOLL FREE FOR C.O.D. OR SEND CHECK TO ORDER  
FAST DELIVERY  
30 DAY MONEY BACK GUARANTEE (3 FILTER LIMIT)

**Star Circuits**  
P. O. Box 94917  
Las Vegas, NV 89193-4917  
1-800-433-6319

# NEW LIT



JOSEF BERNARD

CIRCLE 25 ON FREE INFORMATION CARD

**THE ELECTRONIC PROJECT BUILDER'S BOOK: DESIGNING AND MODIFYING CIRCUITS;** by Josef Bernard. TAB Books, Inc., Blue Ridge Summit, PA 17294-0850; 1-800-822-8158 (in PA and AK, 717-794-2191); softcover; \$14.95.

If, like many electronics hobbyists, you've ever found yourself stumped—stuck at a dead-end while building a project, or unable to answer a deceptively simple question—and had no place to turn for help, you'll appreciate this book. In it, former **Radio-Electronics** technical editor Joe Bernard has compiled a treasury of practical advice and information that will go a long way toward eliminating that kind of frustration. Along the way, he gives you tips and pointers and shows you how to design, build, and troubleshoot your own, customized electronics projects.

What sets this book apart from the crowd is that it focuses not only on what to do, but on *why* and *how* to do it. A practical understanding of basic concepts is emphasized throughout the book. When combined with the answers to dozens of commonly asked electronics questions—Why are there so many different kinds of transistors? How do I choose the

value of a current-limiting resistor?—that knowledge becomes a powerful skill that can be applied to designing and building your own circuits. In his usual easy-going, easy-to-understand style, the author takes the mystery out of electronics by clearly explaining how all those laws and formulas relate to the real world, and how you can put them to work for you.

**1990 FLUKE DISTRIBUTOR PRODUCTS CATALOG.** John Fluke Mfg. Co., Inc., P.O. Box 9090, Everett, WA 98206; 1-800-443-5853; free.

Featuring analog and digital multimeters, digital thermometers, and multifunction counters, this 20-page catalog also includes an expanded section of new leads, probes, and clips for a variety of applications. The versatile *Fluke 80 Series* of handheld multimeters, which offer a combination of measurement functions and special features for automotive, electrical, and electronic test applications, is highlighted. Also highlighted is the *Fluke 45* dual-display multimeter, which allows the user to make two different measurements of signal parameters simultaneously.



CIRCLE 26 ON FREE INFORMATION CARD

**SOLDERING IRONS CATALOG.** M.M. Newman Corporation, 24 Tioga Way, P.O. Box 615, Marblehead, MA 01945; 617-631-7100; free.

## Soldering Irons



CIRCLE 27 ON FREE INFORMATION CARD

The complete line of Antex miniature and standard-size

soldering irons and a wide selection of tips are featured in this 8-page catalog. Accessories for electronics assembly, field service, and general use are also included. In addition, the brochure describes a heavy-duty, 60-watt soldering iron; temperature-control stations; a universal power-supply unit; a portable, 12-volt soldering iron; and a selection of soldering-iron stands. Specifications for each type of iron are provided, along with a corresponding tip-selection chart and illustrations of the various tip shapes, including spade, chisel, needle, pyramid, and hot-knife tips. All kinds of soldering equipment is included, so choosing the right iron for your next project is easy. R-E

## CRAMOLIN® DeOxidizer

DEOXIDIZES • CLEANS • PRESERVES • LUBRICATES • IMPROVES CONDUCTIVITY  
For All Metals, Including Gold!

CRAMOLIN® DeOxidizer... is a fast-acting deoxidizing solution that cleans, preserves, and lubricates all metal surfaces including gold.

When applied to metal contacts, connectors and other metal surfaces, CRAMOLIN® DeOxidizer removes resistive oxides and forms a protective molecular layer that adheres to metal surfaces, preventing future oxidation. CRAMOLIN® DeOxidizer maintains maximum electrical conductivity, reduces wear, and has excellent migration properties.

### IDEAL FOR:

- Switches & Relays • Connecting Cables & Adaptors
- Edge Connectors • Terminal Strips • Plugs & Sockets
- Gold Plated Connectors • Potentiometers • Battery Contacts

### USED BY THOSE WHO DEMAND THE BEST;

- Bell & Howell • Capital Records • Dolby Laboratories
- Hewlett Packard • John Fluke Mfg. • McIntosh Labs
- MCI (Sony) • Motorola • NASA • Nakamichi
- RCA • Switchcraft

Since 1956



P.O. Box J • Escondido, CA 92025-0051  
(619) 743-7143 • FAX: (619) 743-2460



- Economical / Long Lasting
- Ozone Safe Propellents
- Operates in Any Position
- Contents Completely Dispensed
- Uniform Spray Pattern

CIRCLE 50 ON FREE INFORMATION CARD

# Join the Electronics and Control Engineers' Book Club®

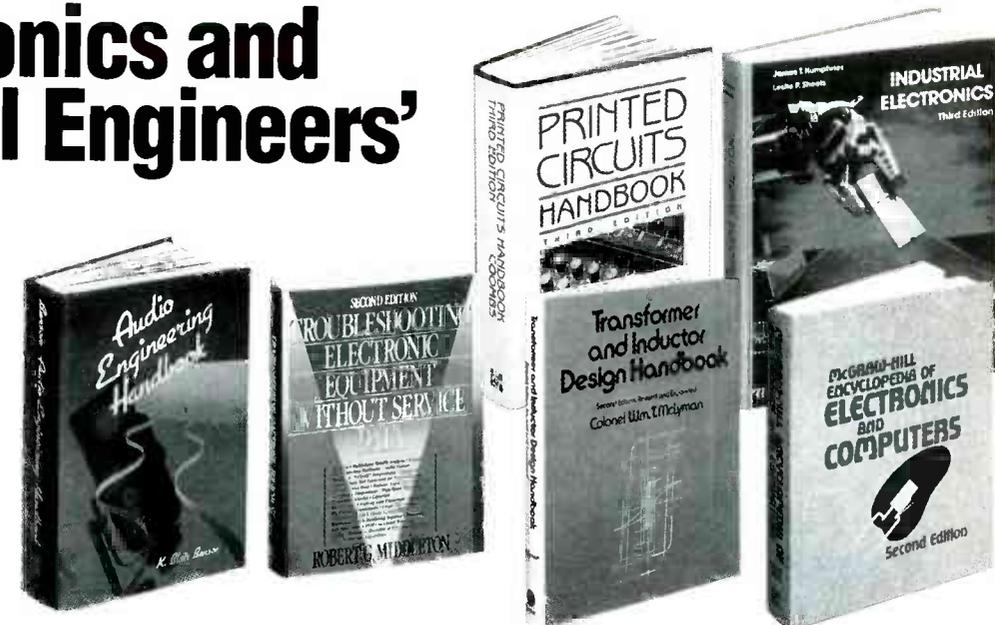
**TROUBLESHOOTING ELECTRONIC EQUIPMENT WITHOUT SERVICE DATA, Second Edition.** By R.G. Middleton. 320 pp., illus. This indispensable new edition features all the information that made the first edition so successful, plus the latest developments in digital testing, phase checks, IC troubleshooting, and repair of VCRs, stereos, TVs, tape recorders, and much, much more.  
585092-3 Pub. Pr., \$30.00 Club Pr., \$22.50

**PRINTED CIRCUITS HANDBOOK, Third Edition.** By C.F. Coombs, Jr. 960 pp., 556 illus. Here in one handy volume is all the information you need to design, manufacture, test, and repair printed wiring boards and assemblies. This new edition features ten all-new chapters, including three on SMT.  
126/097 Pub. Pr., \$64.95 Club Pr., \$45.50

**SOUND SYSTEM ENGINEERING, Second Edition.** By D. Davis and C. Davis. 665 pp., illus. The definitive source for all professionals responsible for audio system design, covering everything from concert halls to virtually every oscillator in use today. Packed with proven strategies for solving design and engineering problems and cutting your clients' costs.  
584657-8 Pub. Pr., \$39.95 Club Pr., \$31.50

**MCGRAW-HILL ENCYCLOPEDIA OF ELECTRONICS AND COMPUTERS, Second Edition.** S. Parker, Editor-in-Chief. 1,047 pp., 1,250 illus. Featuring 160 new and revised articles, this new edition treats the entire spectrum of applications, devices, systems, and theory in areas ranging from the flow of electricity to hardware, software, robotics, and IC fabrication.  
454/99X Pub. Pr., \$79.50 Club Pr., \$54.95

**COMMUNICATIONS RECEIVERS: Principles and Design.** By Ulrich L. Rohde and T.T.N. Bucher. 608 pp., 402 illus. Everything you need to know if you design or work with communications receivers, from theory to practical design approaches. Coverage includes all types of receivers: shortwave, broadcast, radar, military, marine, aeronautical, and more.  
535/701 Pub. Pr., \$64.95 Club Pr., \$44.50



- your one source for engineering books from over 100 different publishers
- the latest and best information in your field
- discounts of up to 40% off publishers' list prices

New Members!  
Take any one of these great professional books **\$289** for only as a premium with your first selection!

Spectacular values up to **\$204.95**

**HANDBOOK OF TRANSDUCERS.** By H.N. Norton. 554 pp., illus. Get fast answers to all of your questions about commercially available transducers. This up-to-date reference explains how they operate, how to select the right transducer for a given measurement, and the characteristics and relative merits of each category of transducer.  
585142-3 Pub. Pr., \$44.00 Club Pr., \$34.50

**DESIGNING WITH FIELD-EFFECT TRANSISTORS, Second Ed.** By Siliconix Inc., Revised by E. Oxner. 320 pp., illus. This on-the-job guide provides page after page of practical data, tables, examples, and design and specification strategies to help you capitalize on recent breakthroughs in MOSFET design. Coverage includes FET operating principles and procedures . . . step-by-step fabrication methods . . . how to bias FETs for desired performance . . . and much more.  
575/371 Pub. Pr., \$39.95 Club Pr., \$29.95

**CIARCIA'S CIRCUIT CELLAR, Volume VII.** By S. Ciarcia. 256 pp., 100 illus., softcover. More do-it-yourself circuits from the master—Steve Ciarcia. Step-by-step guidance on projects ranging from a gray-scale video digitizer and the Circuit Cellar AT Computer to parallel interfacing and the Neighborhood Strategic Defense Initiative.  
109/699 Pub. Pr., \$19.95 Club Pr., \$15.95

**THE COMPACT DISC: A Handbook of Theory and Use.** By K. C. Pohlmann. 288 pp., illus., softcover. The most readable and comprehensive guide to CD technology offers clear descriptions of disc design and manufacturing . . . player circuitry . . . and comparisons of different types of players—all without complicated theoretical or mathematical discussions.  
585096-6 Pub. Pr., \$29.95 Club Pr. \$22.50

**MOBILE CELLULAR TELECOMMUNICATIONS SYSTEMS.** By W.C.Y. Lee. 442 pp., 215 illus. A to Z coverage of state-of-the-art cellular systems, from design to implementation and troubleshooting. Clearly explains spectrum efficiency, propagation models and prediction, interference treatment, and more.  
370/303 Pub. Pr., \$62.95 Club Pr., \$44.50

**TRANSFORMER AND INDUCTOR DESIGN HANDBOOK, Second Edition.** By Col. W.T. McLyman. 440 pp., illus. All the information you need to design today's lighter, smaller transformers and inductors, without relying on outmoded approximation methods. In ready-reference tabular format, this new edition covers the latest equations in transformer and gapped design applications.  
584646-2 Pub. Pr., \$55.00 Club Pr., \$38.50

**ENCYCLOPEDIA OF TELECOMMUNICATIONS.** Edited by R. Meyers. 575 pp., illus. The expertise of 40 recognized leaders in the field is captured in this A to Z reference. Areas covered range from fiber optics, intelligent systems, and networking, to signal processing, mathematical relationships, and theory.  
584897-X Pub. Pr. \$49.95 Club Pr., \$37.50

**PROGRAMMABLE LOGIC DESIGNER'S GUIDE.** By R.C. Afford. 304 pp., illus., softcover. This practical guidebook shows you how to design devices that provide all the logic functions a circuit requires and avoid the compromises inherent in conventional methods. Covers design philosophy, PLD families, hardware, software, and programming languages.  
585141-5 Pub. Pr., \$29.95 Club Pr., \$22.95

**SURFACE-MOUNT TECHNOLOGY FOR PC BOARD DESIGN.** By J.K. Hol-lomon, Jr. 504 pp., illus., softcover. Get a real working understanding of SMT. This up-to-date guide provides a proven, step-by-step approach to SMT design as it thoroughly covers components, methods, and techniques for maximizing quality, reliability, and profitability.  
585235-7 Pub. Pr., \$49.95 Club Pr., \$36.50

**PORTABLE ELECTRONICS DATA BOOK**

360 pp., 6 x 9, illus., softcover 585390-6

A-to-Z coverage of all the essential facts, figures, and formulas you need, in a format that's easy to use and easy to carry. John Douglas-Young has filled this handy on-the-job companion with equations, algorithms, calculus formulas, and BASIC programs in areas ranging from alternating current and amplifiers to transducers and waveguides . . . and they're all yours ABSOLUTELY FREE!

**A \$33.00 Value—Yours ABSOLUTELY FREE when you join!**

**INDUSTRIAL ELECTRONICS, Third Ed.** By J.T. Humphries and L.P. Sheets. 651 pp., illus. A clear, convenient guide to the components and systems used in modern industry. Included is an extensive collection of manufacturers' data sheets, along with many quick-access tables and charts. 585226-8 Pub. Pr., \$41.95 Club Pr., \$31.95

**BUILD YOUR OWN UNIVERSAL COMPUTER INTERFACE.** By B. Chubb. 309 pp., illus., softcover. Guiding you from theory to step-by-step assembly instructions, this lively manual shows you how to construct a computer interface and hook it up to virtually any IBM or IBM compatible personal computer, including the XT, XT-286, AT, and System/2 Model 30. 585080-X Pub. Pr., \$19.95 Club Pr., \$15.95

**DIGITAL FILTERS AND SIGNAL PROCESSING, Second Ed.** By L.B. Jackson. 410 pp., illus. An acclaimed guide to signal processing theory, design methods, and implementation strategies. Using an intuitive approach, the author covers state-space representation, A/D and D/A conversion, the DFT, FFT, and much more. 585269-1 Pub. Pr., \$52.50 Club Pr. \$39.50

**SWITCHGEAR AND CONTROL HANDBOOK, Second Ed.** Edited by R. W. Smeaton. 1,056 pp., 789 illus. The only handbook that treats all aspects of switchgear control, including design, applications, safety, and maintenance. Updated to reflect the changes brought about by the use of computers, solid-state devices, and programmable controls. 584/494 Pub. Pr., \$85.00 Club Pr., \$59.95

**ANTENNA APPLICATIONS REFERENCE GUIDE.** Edited by R. C. Johnson and H. Jasik. 496 pp., 368 illus. and tables. Covers the major applications of antenna technology in all areas of communications and their design methods. Emphasizes important new applications such as earth station, satellite, seeker, aircraft, and microwave-relay antennas. 322/848 Pub. Pr., \$59.95 Club Pr., \$42.50

**RADIO HANDBOOK, Twenty-Third Ed.** Edited by W. I. Orr. 667 pp., 1,073 illus. and tables. The latest edition of the most complete, current resource on radio technology and its applications. Expert contributors show you how to select, design, build, test and operate all kinds of equipment. 584638-1 Pub. Pr., \$29.95 Club Pr., \$23.95

**AUDIO ENGINEERING HANDBOOK.** Edited by K. B. Benson. 1056 pp., 722 illus. The ideal on-the-job reference for professionals who design, operate, and service audio equipment. It's a one-volume source of fundamental audio acoustics engineering information and practical how-to source book covering generation, transmission, storage, and reproduction of the audio signal. 047/774 Pub. Pr., \$86.95 Club Pr., \$59.95

**Be sure to consider these important titles as well!**

**BUCHSBAUM'S COMPLETE HANDBOOK OF PRACTICAL ELECTRONIC REFERENCE DATA, Third Ed.** By W.H. Buchsbaum. 583880-X Pub. Pr., \$34.95 Club Pr., \$26.50

**ON-LINE ELECTRICAL TROUBLESHOOTING.** By L. Lundquist. 391/106 Pub. Pr., \$34.50 Club Pr., \$26.50

**ESSENTIAL CIRCUITS REFERENCE GUIDE.** By J. Markus & C. Weston. 404/623 Pub. Pr., \$59.95 Club Pr., \$47.50

**INTRODUCING PC-DOS AND MS-DOS, Second Ed.** By T. Sheldon. 565/651 Pub. Pr., \$29.95 Club Pr., \$19.95

**ENGINEERING FUNDAMENTALS FOR THE PROFESSIONAL ENGINEERS' EXAM, Third Ed.** By L.M. Polentz. 503/931 Pub. Pr., \$39.50 Club Pr., \$27.95

**INTRODUCTION TO DIGITAL SIGNAL PROCESSING.** By J. G. Proakis and D. G. Manolakis. 584954-2 Pub. Pr., \$50.00 Club Pr., \$37.50

**AUTOMATIC CONTROL SYSTEMS, Fifth Ed.** By B.C. Kuo. 583706-4 Pub. Pr., \$57.40 Club Pr., \$43.50

**MICROCOMPUTER TROUBLESHOOTING AND REPAIR.** By J.G. Stephenson and B. Cahill. 585106-7 Pub. Pr., \$24.95 Club Pr., \$18.95

**DIGITAL AND MICROPROCESSOR TECHNOLOGY, Second Ed.** By P. J. O'Connor. 585184-9 Pub. Pr., \$42.00 Club Pr., \$33.50

**MICROELECTRONICS, Second Ed.** By J. Millman and A. Grabel. 423/30X Pub. Pr., \$56.95 Club Pr., \$41.50



**FOR FASTER SERVICE IN ENROLLING CALL TOLL-FREE 1-800-2-MCGRAW**

**MAIL THIS COUPON TODAY**

**McGraw-Hill Book Clubs  
Electronics and Control Engineers'  
Book Club®**

P.O. Box 582, Hightstown, NJ 08520-9959

Please enroll me as a member and send me the two books indicated, plus the PORTABLE ELECTRONICS DATA BOOK. I am to receive one book for just \$2.89, the other at the discounted member's price, plus local tax, shipping and handling charges. I agree to purchase a minimum of one additional book during my first year of membership as outlined under the Club plan described in this ad. I understand that a shipping and handling charge is added to all shipments.

Your FREE Data Book	
585390-6	
Write Code No. of the \$2.89 selection here	Write Code No. for the First selection here
<input type="text"/>	<input type="text"/>

Signature \_\_\_\_\_

Name \_\_\_\_\_

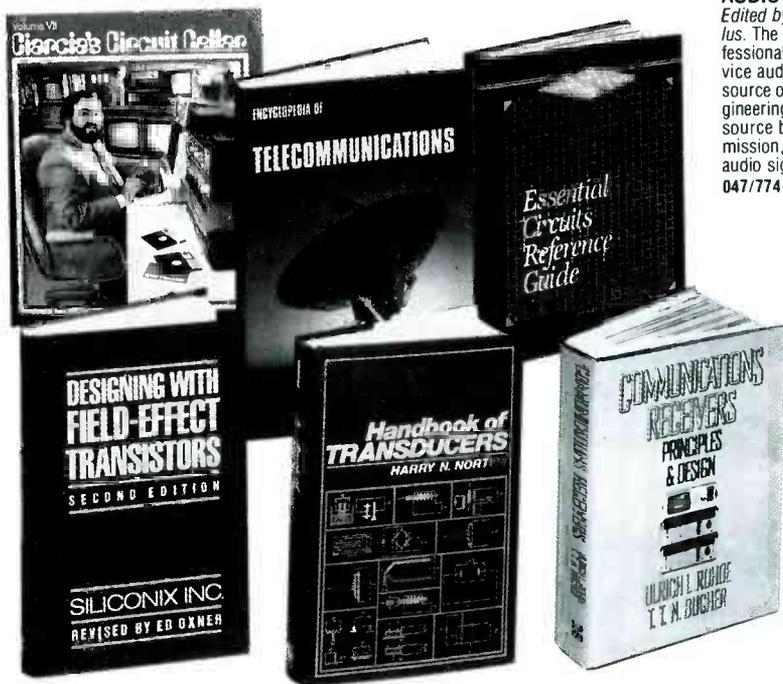
Address/Apt. # \_\_\_\_\_

City \_\_\_\_\_

State \_\_\_\_\_ Zip \_\_\_\_\_

This order subject to acceptance by McGraw-Hill. All prices subject to change without notice. Offer good only to new members. Foreign member acceptance subject to special conditions.

ECGA-040



## Here's how the Club works to serve YOU:

### ■ IMPORTANT INFORMATION... WE MAKE IT EASY TO GET!

In our rapidly changing world, those who perform best are those who are best informed. Designed exclusively for the practicing engineer, the Electronics and Control Engineers' Book Club provides you with information that is relevant, reliable, and specific enough to meet your needs. Each Club bulletin comes your way 14-16 times a year and offers you more than 30 books to choose from — the best and newest books from all publishers!

### ■ DEPENDABLE SERVICE... WE'RE HERE TO HELP!

Whether you want information about a book or have a question about your membership, our qualified staff is here to help. Just call us toll-free or write to our Customer Service. We also make sure you get only the books you want. All you do is simply tell us your choice on the Reply Card and return it to us by the specified date. If you want the Main Selection, do nothing — it will be sent to you automatically. (A small shipping and handling charge is added to each shipment.)

### ■ CLUB CONVENIENCE... WE DO THE WORK!

Beyond the benefit of timely information, Club membership offers many other benefits. For example, you get a wide choice of books that cannot be matched by any bookstore — anywhere. And all your books are conveniently delivered right to your door. You also get the luxury of 10 full days to decide whether you want the Main Selection. If you should ever receive a Main Selection you don't want because the Club bulletin came late, just return it for credit at our expense.

### ■ SUBSTANTIAL SAVINGS... AND A BONUS PROGRAM TOO!

In keeping with our goal to provide you with the best information at the greatest possible savings, you will enjoy substantial discounts — up to 40%! — on every book you buy. Plus, you're automatically eligible for our Bonus Book Plan which allows you savings up to 70% on a wide selection of books.

### ■ EASY MEMBERSHIP TERMS... IT'S WORTHWHILE TO BELONG!

Your only obligation is to purchase one more book — at a handsome discount — during the next 12 months, after which you enjoy the benefits of membership with no further obligation. Either you or the Club may cancel membership anytime thereafter.



# OPTOELECTRONICS

## The only name in HANDI-COUNTERS

Check These Incredible Features On The All New UTC3000

- 10Hz to 2.4GHz Range.

Simply amazing!

- 10 Digit LCD Display.

1Hz resolution to over 150 MHz direct.

Readable in bright sunlight.

- RF Signal Strength Bargraph.

16 Segment, Zero, & Full Scale adjustment.

SEE the input signal!

- Super Sensitivity. <1mV 10-200MHz, <5mV to 2GHz for efficient antenna pickup.

- 6 Functions. Frequency, Period, Ratio Time Interval, Average, & Prescale.

- Hold Button.

"Locks in" your exact Measurement FAST!

- Extruded Aluminum Enclosure.

Designed to fit every hand.

- Priced Right! Only \$375.

Includes Nicads, AC Charger/Adapter.

Or Select Our Most Popular

**HANDI-COUNTER**, the model 2210

that set the standard in handheld frequency counter technology!

**Value Priced at only \$239.**

Professionals and Hobbyists all over the world have chosen OEI for 16 years! **Shouldn't YOU?**

**HANDI-COUNTERS!** ...Only from OEI!

Choose the model that fits your needs... and your budget! **CALL NOW!**



### UTC3000



Period Average Mode



Display Showing All Annunciators

Model	UTC3000	2600H	2210	1300H/A	2400H	CCA	CCB
Function	Freq, Period Ratio, Interval, Avg. Prescale	Frequency	Frequency	Frequency	Frequency	Frequency	RF Indicator
Range	10Hz-2.4GHz	10MHz-2.4GHz	10Hz-2.2GHz	1MHz-1.3GHz	10MHz-2.4GHz	10MHz-550MHz	10MHz-1.8GHz
Display	10 Digit LCD A/F Function Annunciators	10 Digit LCD	8 Digit LED	8Digit LED	8 Digit LED	8 Digit LED	.
RF Signal Strength Indicator	16 Segment Adjustable Bargraph	16 Segment Adjustable Bargraph	.	.	.	LED with Adjustable Threshold	10 Segment Adjustable Bargraph
Price	\$375.	\$325.	\$239.	\$179.	\$189.	\$299.	\$119.

Sensitivity: <1 to <10mV typical. Time Base: ± 1 ppm.; ± .5ppm. add \$75 - LED Models; ± 2ppm add \$80 - LCD Models. Nicads & AC charger/adapter included. (9v Alkaline - CCB.) Carry Case, Antennas and Probes extra. One year parts & labor warranty on all products.



## OPTOELECTRONICS

5821 NE 14th Avenue • Ft. Lauderdale, FL 33334

Toll Free Order Line:  
**1-800-327-5912**

FL(305)771-2050 • FAX(305)771-2052



Visa, MC, COD, Cash, M.O. accepted. Personal Check allow 3 weeks. 5% Shipping, Handling, (Maximum \$10) U.S. & Canada. 15% outside continental U.S.A. In FL add 6% sales tax.

CIRCLE 185 ON FREE INFORMATION CARD



# BUILD R-E's DIGITAL DASHBOARD

Update your dashboard  
with six accurate,  
good-looking  
gauges.

ROSS ORTMAN

THE ELECTRONICS CONTENT OF TODAY'S automobiles is higher than ever before. Electronics can be found in everything from the ignition system to the instrument cluster, commonly called your dashboard. That's what tells you of your vehicle's performance, and warns you of possible problems. However, some gauges are simply not found on some dashboards, or there may be just an idiot light, which, if your lucky, will warn you of a problem—but usually *after* a problem has occurred. If you want to monitor certain functions, then reliable and accurate gauges are a must.

We'll look at six digital gauges: voltage, oil pressure, water temperature, fuel level, vacuum, and an auxiliary gauge for displaying any temperature, be it outside air, inside air, transmission, oil, or whatever else you wish to monitor.

The digital voltmeter measures and displays the voltage level of the automobile's electrical system. The correct voltage level is a good indication of a healthy charging system which, in turn, will extend the life of the battery. A failure in the automobile's charging system can, of course, leave you stranded.

Proper oil pressure is very important to the operation of your automobile's engine. Without it, the oil would not be pumped into bearings, journals, and over moving metal parts. The end result would be a seized or badly damaged engine. The digital oil-pressure gauge keeps you informed as to how well your engine is being lubricated.

The digital water-temperature gauge is used to monitor the engine's cooling system, which is designed to

maintain constant engine temperature. Without a temperature gauge, the first indication of an overheating engine is usually the steam that comes from under the hood, which is often too belated to prevent engine damage.

Next to the speedometer, the fuel gauge is probably the most watched instrument in the dashboard. The digital fuel gauge presented here displays the level of fuel left in the tank on a scale of 0 to 99%.

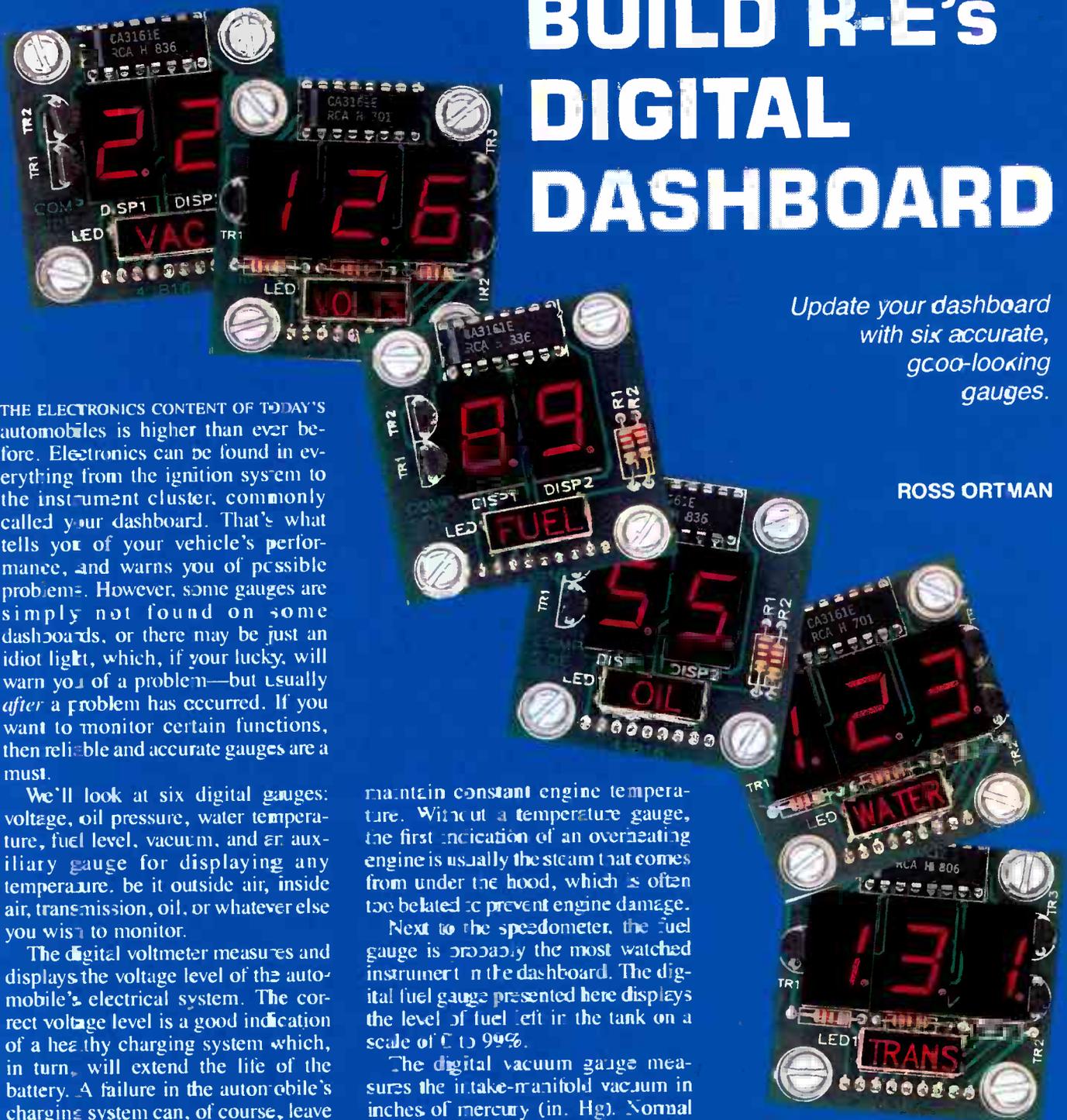
The digital vacuum gauge measures the intake-manifold vacuum in inches of mercury (in. Hg). Normal driving usually produces a vacuum reading between 16 and 22 in. Hg. The general rule of thumb is, the higher the vacuum level, the lower the gauge reading, and the better the gas mileage.

As you probably already know, an automobile uses many other fluids besides the water and antifreeze in the radiator. And, just like the coolant in the radiator, many of those fluids get hot under use. Since excessive heating indicates a potentially serious problem, it is advantageous to

monitor such things as the oil, transmission fluid, differential fluid, etc. In addition to automotive operating parameters, convenience items such as outside air temperature and inside air temperature can also be monitored.

## Circuitry

A block diagram, which describes the circuitry that's common to all of the gauges, is shown in Fig. 1. The central component of each digital



gauge is the A/D converter. Because it is common to all of the gauges, it deserves a thorough explanation. The CA3162E A/D converter and the CA3161E display driver form an accurate, low-cost, three-digit analog to digital converter system that can operate from a single 5-volt supply.

The basic operation of the A/D converter is based on the dual slope system. Here, an integrating capacitor is charged to a level determined by the input voltage. That is accomplished by converting the input voltage to a relative current and using that current to charge the integrating capacitor for a predetermined time. After that charge time, the voltage-to-current converter is removed and a current source of opposite polarity is connected to the capacitor. The time required to discharge the capacitor to its original value is measured to deter-

mine the original input voltage level.

The CA3161E has a differential input which greatly simplifies circuit design. The full-scale input is 0.999 volts which results in a reading of "999" on a three-digit display. The resolution, or smallest change the A/D converter can show, is 1 mV.

The CA3162E also controls the display multiplexing and updating. Using multiplexing, the parts count is greatly reduced, and, although only one digit is lighted at a time, it appears that all the digits are on all the time.

The Binary Coded Decimal (BCD) output of the CA3162E is sent to the CA3161E display decoder/driver, which supplies segment current to each of the displays. Because the display driver contains internal current limiting, external current-limiting resistors are not needed.

Let's take a closer look at each individual gauge. The gauges are very similar to each other, so we will not repeat descriptions for similar sections. The same goes for the display boards.

### Voltage gauge

The voltage gauge displays the voltage of the automobile's electrical system on a three-digit readout with 0.1-volt resolution. The gauge will display voltages from 8 to 19.9 volts. Because the input of the A/D converter has a maximum input of 0.999 volts, the input voltage to the meter must be divided by 100. That way, the A/D's actual input voltage ranges from 0.080 to 0.199. That results in a reading of "080" to "199," and by fixing the decimal point to the second digit, a resulting display of "08.0" to "19.9" is obtained.

The voltage gauge schematic is shown in Fig. 2. Power is supplied to the voltmeter through P1. The unit is protected from excessive current by fuse F1. Diode D2 assists in protecting from reverse battery connection, and also clamps any momentary negative spikes on the automobile's electrical system. Diode D2 allows only positive voltage to reach the 5-volt regulator, IC1, that reduces the vehicle's 12 to 13.8 volts to the 5-volt level needed by the gauge's circuitry.

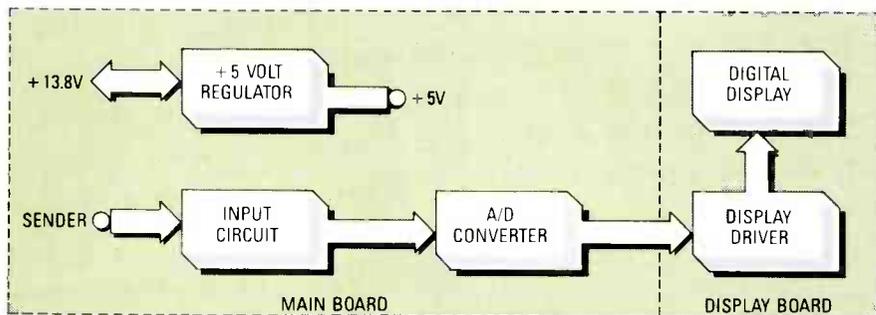


FIG. 1—BLOCK DIAGRAM COMMON to all of the gauges. The central component of each digital gauge is the A/D converter.

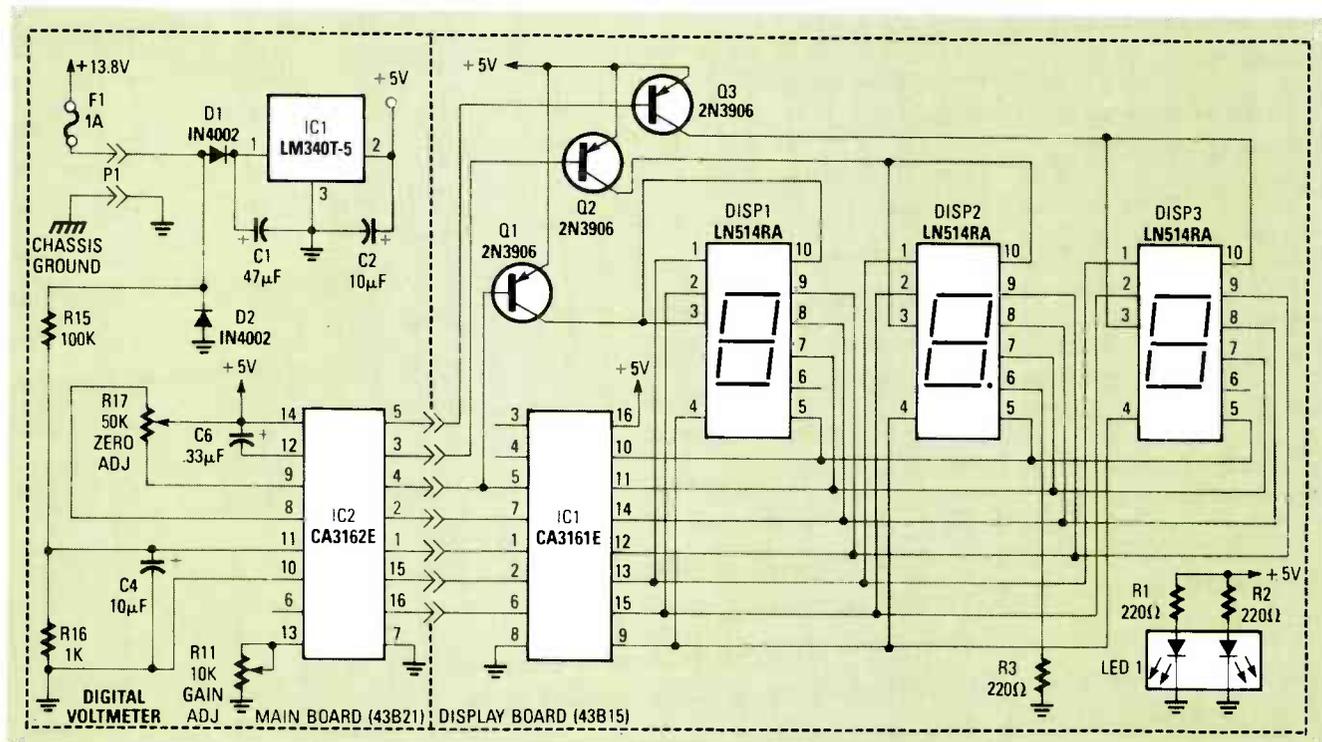


FIG. 2—THE DIGITAL VOLTAGE GAUGE displays the voltage level of your automobile's electrical system.

### VOLTAGE GAUGE

All resistors are 1/4-watt, 5%, unless otherwise indicated.

- R1-R10, R12-R14—not used
- R11—10,000 ohms, PC-mounted trimmer potentiometer
- R15—100,000 ohms
- R16—1000 ohms
- R17—50,000 ohms, PC-mounted trimmer potentiometer

#### Capacitors

- C1—47  $\mu$ F, 25 volts, electrolytic
- C2, C5—10  $\mu$ F, 35 volts, electrolytic
- C3, C4—not used
- C6—0.33  $\mu$ F, 50 volts, stacked film

#### Semiconductors

- IC1—LM340T-5, 5-volt regulator
- IC2—CA3132E, A/D converter
- D1, D2—1N4002 diode

**Miscellaneous:** 43B21 main PC board, 3-digit display board, in-line fuse holder, 1-amp fuse, four 6-32  $\times$  0.625" standoffs, eight 5/16-inch #6 screws, bronze or red plexiglass, mounting hardware, hookup wire

Capacitors C1 and C2 help reduce voltage transients and fluctuations.

The A/D converter (IC2) converts the input voltage to a relative digital value, and C6 is the integrating capacitor that was discussed earlier. A divide-by-100 network, that provides the proper input voltage for the A/D converter, is formed by R15 and R16. Capacitor C4 filters the A/D input

voltage to ensure stable readings. A zero-adjust is provided by R17 and a gain-adjust by R11.

Once the input voltage has been converted, its digital value is sent to the display section. There, IC1 of the display board receives multiplexed BCD information and outputs that information to the three seven-segment displays, one at a time. The multiplexing is controlled by IC2. Current to each display is switched by Q1, Q2, and Q3. For example, when Q1 is on, current is delivered to DISP1, the most significant digit of the display. To display a "138," the CA3162E would send a binary 0001 to the CA3161E, which would then turn on the necessary segments to display a "1" on the first digit. After a predetermined time, the system moves on to the second and third digits and finally repeats itself. Because the voltmeter is designed to display 0.1-volt increments, the decimal point on DISP2 is kept on all of the time by R3. A "VOLTS" annunciator is formed by LED1, which is a pre-formed module containing two LED's, and limiting resistors R1 and R2. The module has a plastic "lens" over it that is all black except for the clear letters V-O-L-T-S.

### Oil pressure

The oil-pressure gauge, shown in Fig. 3, displays engine oil pressure

### OIL-PRESSURE GAUGE

All resistors are 1/4-watt, 5%, unless otherwise indicated.

- R1—470 ohms
- R2-R8, R10, R12-R16—not used
- R9—100,000 ohms
- R11—10,000 ohms, PC-mounted trimmer potentiometer
- R17—50,000 ohms, PC-mounted trimmer potentiometer

#### Capacitors

- C1—47  $\mu$ F, 25 volts, electrolytic
- C2, C3, C4—10  $\mu$ F, 35 volts, electrolytic
- C5—not used
- C6—0.33  $\mu$ F, 50 volts, stacked film

#### Semiconductors

- IC1—LM340T-5, 5-volt regulator
- IC2—CA3132E, A/D converter
- D1, D2—1N4002 diode

**Miscellaneous:** 43B21 main PC board, 15G5 oil-pressure sender, 2-digit display board, in-line fuse holder, 1-amp fuse, four 6-32  $\times$  0.625" standoffs, eight 5/16-inch #6 screws, bronze or red plexiglass, mounting hardware, hookup wire

from 0 to 80 psi (pounds per square inch) with 1-psi resolution. The input voltage to the A/D converter must therefore range from 0 to 0.80 volts. The oil pressure is sensed by the oil pressure sending unit which convert pressure to electrical resistance. In the case of the sending unit used here pressure is converted to resistance

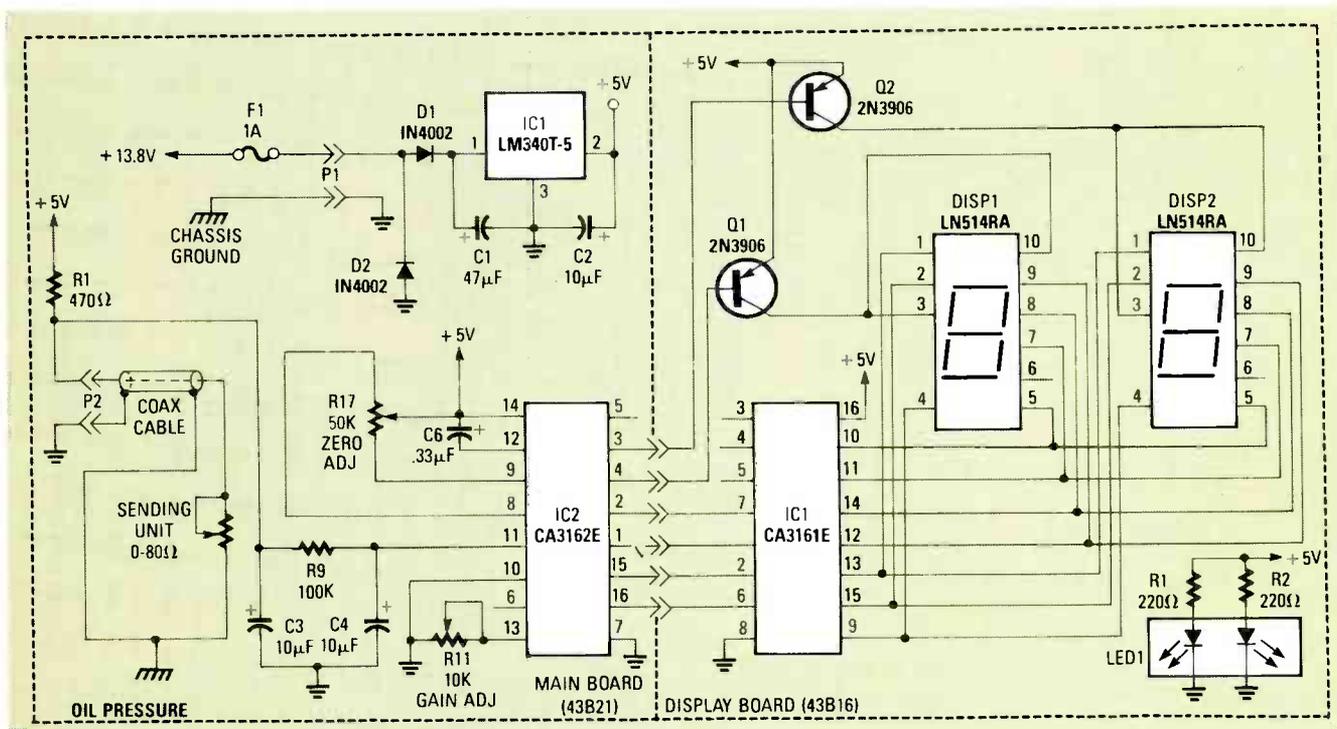


FIG. 3—THE OIL-PRESSURE GAUGE displays engine oil pressure from 0 to 80 psi with 1-psi resolution.

with an approximate 1:1 ratio. That is, with 60 pounds of oil pressure, the sender's resistance is approximately 60 ohms, with a 0.6-volt drop across it. With no oil pressure, the sender's resistance is zero ohms. The voltage drop across the sending unit is then filtered and read directly by the A/D converter. The regulator and A/D converter sections are similar to the voltmeter, and the display section is identical except for one less digit.

The sending unit and R1 on the main board form a resistive divider. The voltage drop across the sending unit equates to 0.01 volt/psi. That is, for every psi of oil pressure, the voltage across the sender increases by approximately 10 millivolts. The relative voltage across the sender is then filtered by C3, R9, and C4 to maintain a more stable reading. An "OIL" annunciator (LED1) specifies the reading of the gauge.

## Water

The water-temperature gauge, shown in Fig. 4, displays the automobile's coolant-system temperature on a three-digit readout with 1-degree resolution. The actual temperature is obtained by measuring the resistance across a standard automotive temper-

ature sending unit, which is essentially a thermistor contained in a brass enclosure. Because the sending unit's resistance is inversely proportional to temperature (the greater the temperature, the lower the resistance), the differential input of the A/D converter is used. That means that the A/D converter CA3161E measures the difference between its positive and negative inputs (pins 11 and 10, respectively).

A reference voltage, set by R6, R7, and R8 is applied to the positive input at pin 11. The negative input (pin 10) is connected to the temperature-sending unit via a resistor network. As the temperature of the sending unit increases, its resistance will decrease, lowering the voltage across it. When the lower voltage is seen at the negative input of the A/D converter, and compared to the level set at the positive input, the temperature reading will rise. The opposite happens as the sending unit cools; its resistance becomes greater and more voltage is applied to the negative input. The temperature reading then decreases as the negative input gets closer in potential to the positive input. A reading of 0 will result when the positive and negative inputs are equal. Note that

## WATER-TEMPERATURE GAUGE

All resistors are 1/4-watt, 5%, unless otherwise indicated.

- R1—100 ohms, 1/2-watt
- R2—430,000 ohms
- R3, R7—10,000 ohms, PC-mounted trimmer potentiometer
- R4, R8—22,000 ohms
- R5, R9, R11—R16—not used
- R6—470,000 ohms
- R10—2200 ohms
- R17—50,000 ohms, PC-mounted trimmer potentiometer

## Capacitors

- C1—47  $\mu$ F, 25 volts, electrolytic
- C2, C5—10  $\mu$ F, 35 volts, electrolytic
- C3, C4—not used
- C6—0.33  $\mu$ F, 50 volts, stacked film

## Semiconductors

- D1, D2—1N4002 diode
- IC1—LM340T-5, 5-volt regulator
- IC2—CA3132E, A/D converter

**Miscellaneous:** 43B21 main PC board, 14G11 water-temperature sender, 3-digit display board, in-line fuse holder, 1-amp fuse, four 6-32  $\times$  0.625" standoffs, eight 5/16-inch #6 screws, bronze or red plexiglass, mounting hardware, hookup wire.

the negative input is limited to a maximum of 1.2 volts.

The regulator and display sections

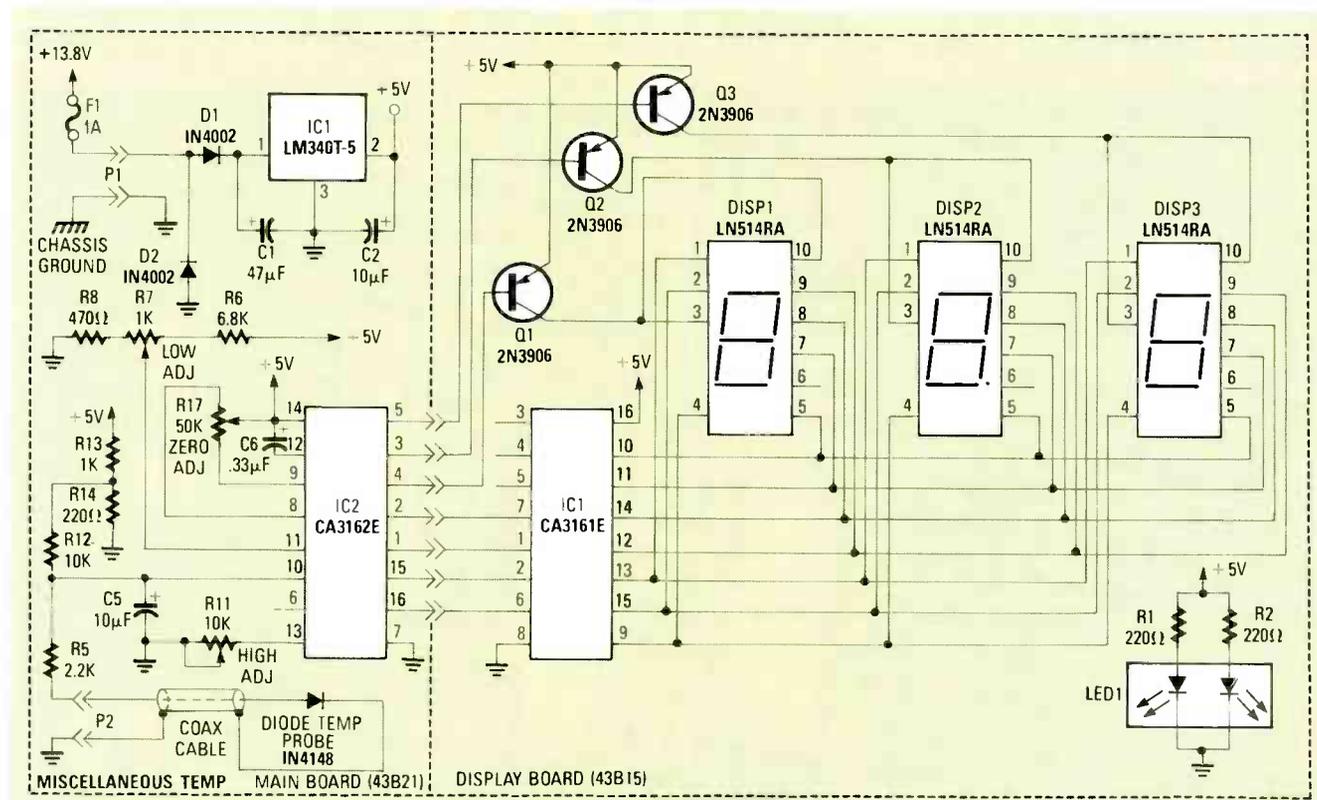


FIG. 4—THE WATER-TEMPERATURE GAUGE displays the automobile's coolant-system temperature on a three-digit readout with 1-degree resolution.

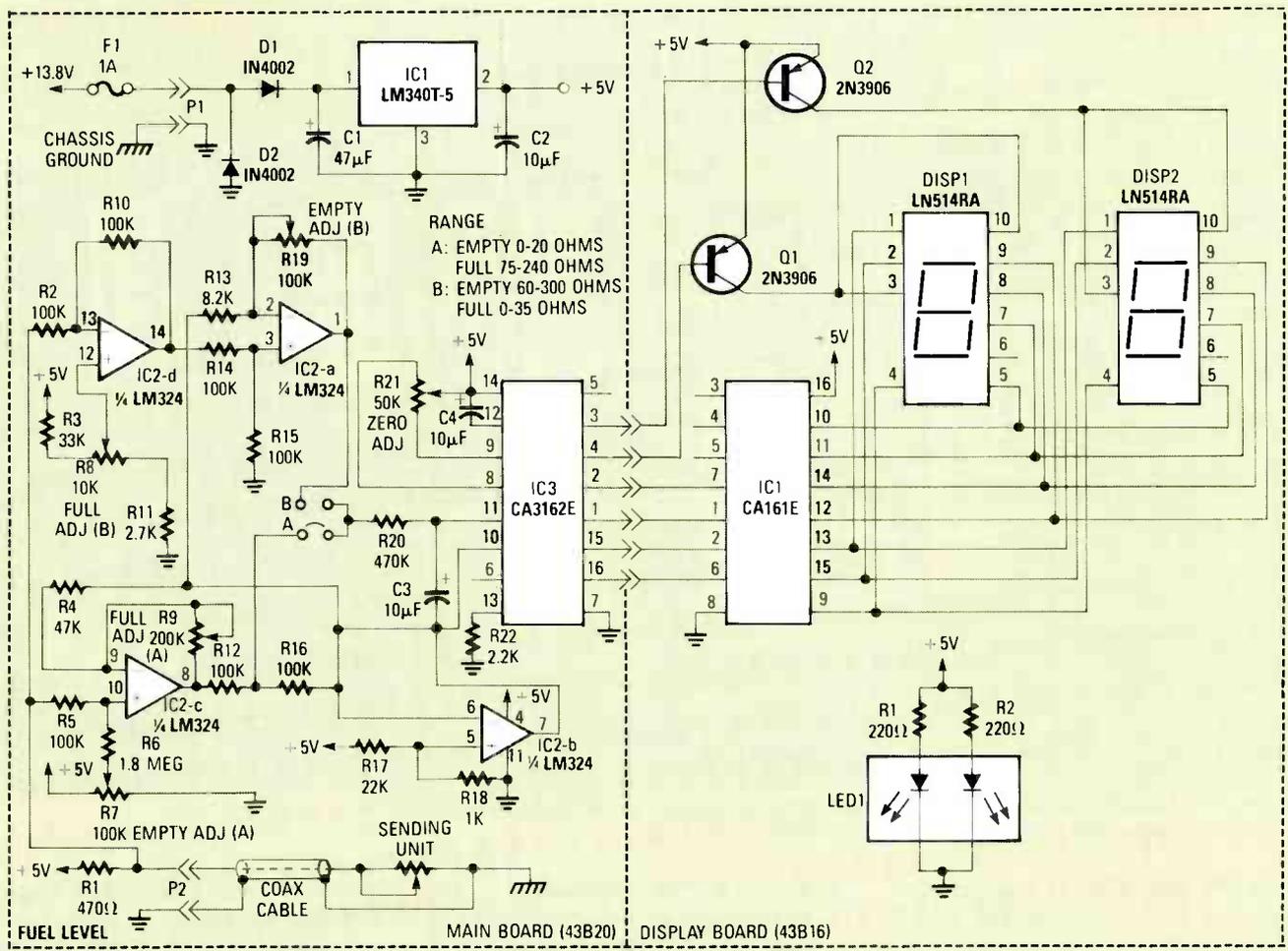


FIG. 5—THE FUEL GAUGE displays the level of fuel in your gas tank on a two-digit readout, which is interpreted as percentage of the fuel remaining.

are again similar to that of the voltmeter's. Looking at the A/D converter's input circuitry, note that R1 and the temperature sending unit form a resistive divider network with the sending unit connected through P2. The relative voltage at that point is then divided down by R2, R3, and R4. Potentiometer R3 provides the low-temperature calibration adjustment, and C5 filters the input voltage for stable readings. That voltage is then sent to the negative input of the A/D converter, IC2. Resistors R6, R7, and R8 form a resistive divider that sets the upper reference voltage, the high-temperature calibration is set by R7, and the A/D converter zero adjust is set by R17. A "WATER" annunciator is formed using LED1, R1, and R2.

**Fuel**

The fuel gauge displays the level of fuel in your gas tank on a two-digit readout (see Fig. 5). The readout's range is from 0 to 99, and is inter-

preted as percentage of the fuel remaining. The fuel gauge senses the resistance of the fuel sending unit located in the gas tank. Typical sending units consist of a potentiometer with its wiper connected to a float. As the fuel level rises and falls, the resistance of the potentiometer changes. Although sending units are not completely linear, due in part to the irregular shape of most gas tanks, their output resistance does go consistently from low to high. Some sending units have a high resistance when empty and a low resistance when full, as with most Ford, AMC, marine, and aftermarket senders, and some go from a low resistance when empty to a high resistance when full, as is the case with most GM sending units. By having two range settings, the fuel gauge can handle both kinds of sending units. The range settings (A and B) are shown in Fig. 5.

Current for the sending unit is derived from R1, which forms a voltage divider with the sending unit. The

voltage developed across the sending unit proportional to the fuel level. For sending units that increase in resistance as the tank is filled, the R5 path is taken. Because the voltage increases as the fuel level rises, we offset the empty reading and adjust the top scale for a "full" reading.

Because the gauge works from a single supply, and the A/D compares its positive input to its negative, we need to be able to reach zero volts in order to display a zero (0% fuel left). Most op-amps will work very close to their negative supply, which in this case is ground, but not completely. By biasing the negative input of the A/D converter to 0.21 volts, the ground reference for the op-amp "zero" level becomes 0.21 volts. The op-amp output can then easily reach the "ground" reference level to obtain a "00" on the display. All other voltage values are then referenced to the 0.21 volt "ground." Potentiometer R7, along with R6, is used to offset the output of IC2 (pin 8) to 0.21 volts.

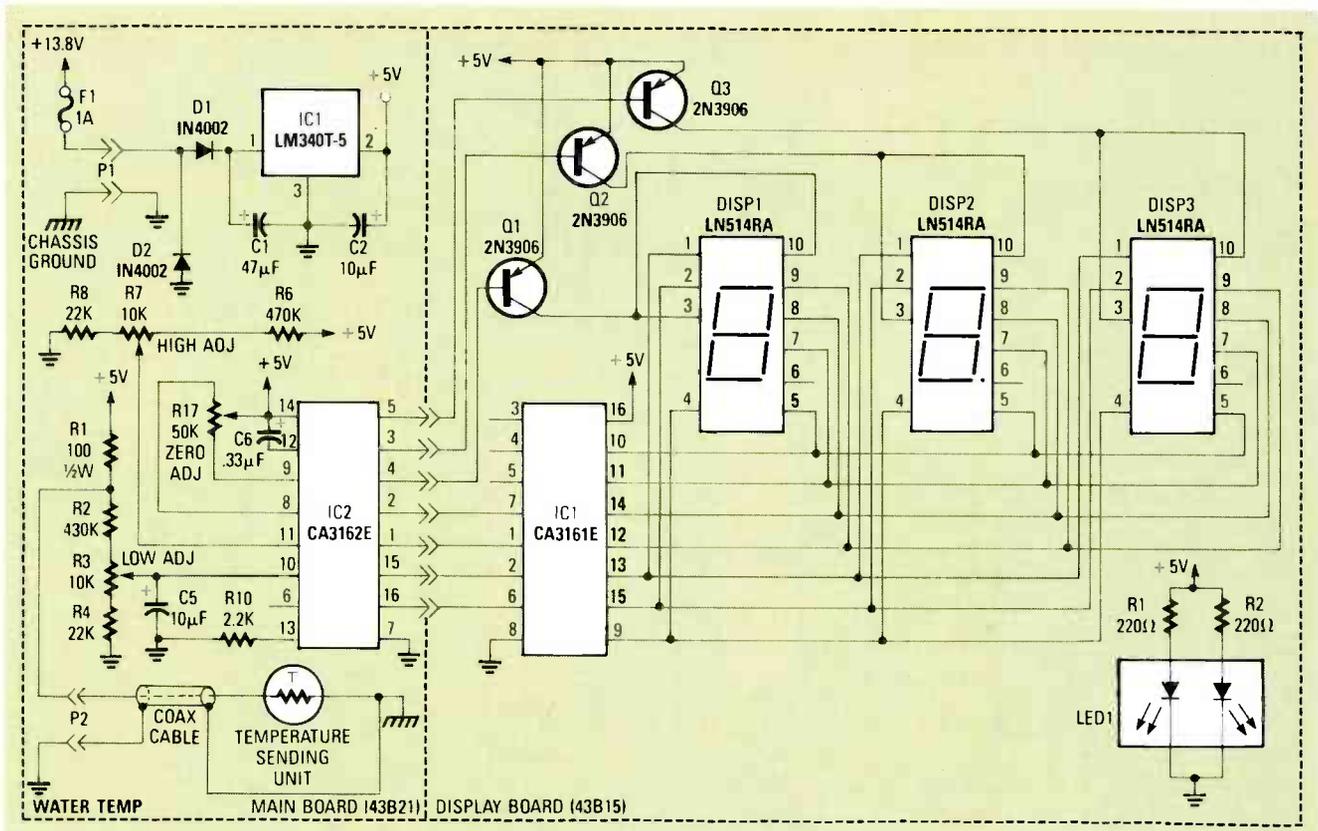


FIG. 6—THE MISCELLANEOUS TEMPERATURE GAUGE displays temperature by measuring the voltage drop across a typical silicon diode.

After the zero offset is adjusted, the next step is to adjust for the “full” reading. That is accomplished by changing the gain of IC2, by placing a

jumper in the “A” position.

When using a sending unit that decreases in resistance as the tank is filled, the “B” jumper is used. That

way, after passing through R2 and an inverting amplifier, the higher sending-unit voltage from an “empty”  
*continued on page 40*

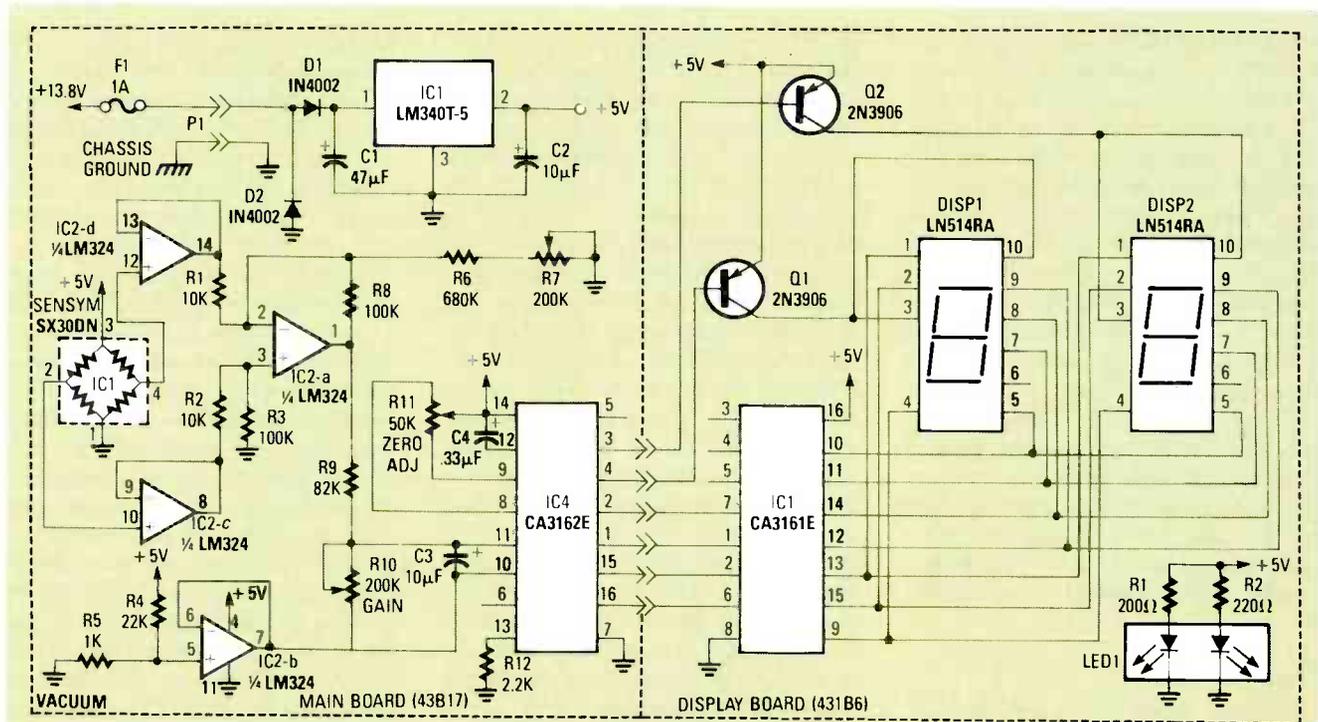


FIG. 7—THE VACUUM GAUGE uses a Sensym SX30DN solid-state vacuum/pressure sensor to monitor the intake-manifold vacuum during engine operation. Between 0 and 30 inches of mercury can be displayed.

# Discover Your Career Potential In The Fast Growing Field Of High-Tech Electronics!

CIE Gives You The Training You Need to *Succeed...*  
At Your Own Pace...& In Your Own Home!

If you're anxious to get ahead...and build a *real* career...you owe it to yourself to find out about the Cleveland Institute of Electronics!

CIE can help you discover *your* career potential in the fast growing field of high-tech electronics. A career that will challenge and excite you every day...reward you with a powerful feeling of personal accomplishment...and deliver a level of financial security you may have only dreamed of before!

As the leading school in home-study electronics, CIE has helped over 150,000 students in the U.S.A. and over 70 foreign countries get started in this exciting field. To find out how CIE could be helping *you*...read on...then send for a CIE catalog TODAY!

## A Growing Need For Trained Professionals!

The career opportunities shown here are only a few of the challenging, high-paying careers you could enjoy as an electronics technician.

You could be the "brains" behind the scenes of an exciting TV broadcast...trouble-shoot life-saving medical equipment...design exotic new aeronautics systems...CIE's job-oriented programs offer you the quickest possible path to the career of your dreams! And CIE also features military and union re-training, to build on what you already know.

## Dozens Of Fascinating Careers To Choose From!

Even if you aren't sure which career is best for you, CIE can get you started with core lessons applicable to *all* areas of electronics. As you advance, CIE makes job opportunities available to you through the bimonthly school paper, *The Electron*.



*Date Communications*



*Automotive Electronics*



*AVICS*



*Computer-Assisted Manufacturing*



*Consumer Electronics*



*Military Electronics*

## Personal Training From A Renowned Faculty.

Unlike the impersonal approach of large classroom study, CIE offers you one-on-one instructional help 6 days a week, toll-free. Each CIE lesson is authored by an independent specialist, backed by CIE instructors who work directly with you to answer your questions and provide technical assistance when you need it.

## Practical Training... At Your Own Pace.

Through CIE, you can train for your new career while you keep your present job. Each course allows a generous completion time, and there are no limitations on how fast you can study. Should you already have some electronics experience, CIE offers several courses which start at the intermediate level.

## "State-Of-The-Art" Facilities & Equipment.

In 1969, CIE pioneered the first electronics laboratory course, and in 1984, the first Microprocessor Laboratory. Today, no other home study school can match CIE's state-of-the-art equipment. And all your laboratory equipment is included in your tuition cost. There is no extra charge—it's yours to use while you study at home and on the job after you complete your course!

## Earn Your Degree To Become A Professional In Electronics!

Every CIE course you take earns you credit towards the completion of your Associate in Applied Science Degree, so you can work towards your degree in

stages. And CIE is the only school that awards you for fast study, which can save you thousands of dollars in obtaining the same electronics education found in four-year Bachelor's Degree programs! Write for details today!

## Send For Your Catalog Today!



### CIE World Headquarters

Cleveland Institute of Electronics, Inc.  
1776 East 17th St., Cleveland, Ohio 44114

ARE-167

**YES!** Please send me your independent study catalog (For your convenience, CIE will have a representative contact you—*there is no obligation.*)

Print Name \_\_\_\_\_

Address \_\_\_\_\_ Apt # \_\_\_\_\_

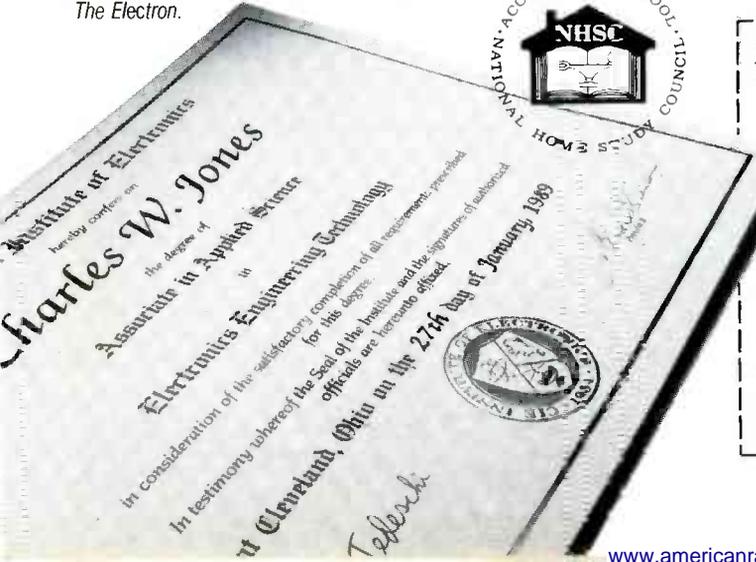
City/State/Zip \_\_\_\_\_

Age \_\_\_\_\_ Area Code/Phone No. \_\_\_\_\_

Check box for G.I. Bill bulletin on educational benefits:  Veteran  Active Duty

## Mail This Coupon Today!

ARE-170



**Note:** The following items are available from Dakota Digital, 11301 Kuhle Drive, Sioux Falls, SD 57107 (605) 332-6513: a PC-board set for each gauge (includes main PC board and display board) is \$6.95. A parts kit for each gauge (includes PC boards, components, and manual) is \$29.95. Each gauge assembled and tested is \$39.95. Stock numbers are as follows: voltage-gauge kit #2005-KIT, assembled and tested #3005-UNIT; oil-pressure gauge kit #2006-KIT, assembled and tested #3006-UNIT (order oil-pressure sender separately); water-temperature gauge kit #2007-KIT, assembled and tested #3007-UNIT (order water-temperature sender separately); miscellaneous temperature gauge kit #2008-KIT, assembled and tested #3008-UNIT; fuel-gauge kit #2009-KIT, assembled and tested #3009-UNIT; vacuum-gauge kit #2010-KIT, assembled and tested #3010-UNIT (order vacuum sensor separately). Oil-pressure sender (#15G5), \$15.50; water-temperature sender (#14G11), \$5.50; vacuum sensor (#69G18), \$19.95; RCA CA3161E driver (#69G16), \$1.95; RCA CA3162 A/D converter (#69G15), \$7.95. All orders add 4% shipping and handling (\$1.50 minimum), Visa and Mastercard accepted.

reading is offset by R8 to produce an output at pin 14 of IC2 that is near 0.41 volts. Divided down to 0.21 volts by R14 and R15, the output at pin 1 of IC2 is at the proper 0.21-volt zero reference. The "empty" voltage is adjusted by R19. Components R20 and C3 are used to average the input voltage to avoid erratic readings caused by the sloshing of gasoline in the fuel tank. The zero adjustment of the A/D converter is set by R17, and LED1, with an appropriate lens, is used as a "FUEL" annunciator.

### Temperature

The miscellaneous temperature gauge, shown in Fig. 6, displays temperature by measuring the voltage drop across a typical silicon diode, which is determined by the formula  $V_D = 2mV$  per degree Celsius, where  $V_D$  is the voltage drop. Because the temperature gauge is calibrated to read out in degrees Fahrenheit, the

voltage across the diode is scaled accordingly. The temperature is then displayed on a three-digit readout with 1-degree resolution.

Because the voltage across the diode is inversely proportional to temperature, the differential input of the A/D converter is used in the same manner as the water-temperature gauge. Note that the positive input at pin 11 is connected only to a reference voltage set by R6, R7, and R8. The negative input (pin 10) is connected to the 1N4148 diode temperature probe via a resistor network. As the temperature of the diode increases, the voltage across it will decrease resulting in a lower voltage at the negative input of the A/D converter and, when compared to the level set at the positive

divider network consisting of R12 and R5. That second divider scales the relative voltage developed across the temperature probe to coincide with the range of the A/D converter. It is also used to bias the temperature-probe diode. For example, suppose the voltage across the diode at 32 degrees Fahrenheit is 0.6 volts. Then, 0.654 volts would be delivered to the negative input of the A/D converter. With the positive input of the A/D converter calibrated to 0.686 volts, "032" would be displayed on the digital readout. As the temperature-probe diode heats to 212 degrees Fahrenheit, the drop is reduced to 0.4 volts. We would now have 0.49 volts at the negative A/D converter input. The display will now read "212."

Although the negative input is not a

### FUEL GAUGE

All resistors are 1/4-watt, 5%, unless otherwise indicated.

R1—470 ohms  
 R2, R5, R10, R12, R14, R15, R16—100,000 ohms  
 R3—33,000 ohms  
 R4—47,000 ohms  
 R6—1.8 megohms  
 R7, R19—100,000 ohms, PC-mounted trimmer potentiometer  
 R8—10,000 ohms, PC-mounted trimmer potentiometer  
 R9—200,000 ohms, PC-mounted trimmer potentiometer  
 R11—2700 ohms  
 R13—8200 ohms  
 R17—22,000 ohms  
 R18—1000 ohms  
 R20—470,000 ohms  
 R21—50,000 ohms, PC-mounted trimmer potentiometer  
 R22—2200 ohms

#### Capacitors

C1—47  $\mu$ F, 25 volts, electrolytic  
 C2, C3—10  $\mu$ F, 35 volts, electrolytic  
 C4—0.33  $\mu$ F, 50 volts, stacked film

#### Semiconductors

IC1—LM340T-5, 5-volt regulator  
 IC2—LM324, quad op-amp  
 IC3—CA3132E, A/D converter  
 D1, D2—1N4002 diode

**Miscellaneous:** 43B20 main PC board, 2-digit display board, 0.1" 3-conductor header, 2-conductor jumper, in-line fuse holder, 1-amp fuse, four 6-32  $\times$  0.625" standoffs, eight 5/16-inch #6 screws, bronze or red plexiglass, mounting hardware, hookup wire.

input, the reading will rise. Just the opposite happens as the diode cools.

Resistors R13 and R14 form a voltage-divider network that provides a reference of 0.9 volts for the second

### MISCELLANEOUS TEMPERATURE GAUGE

All resistors are 1/4-watt, 5%, unless otherwise indicated.

R1—R4, R9, R10, R15, R16—not used  
 R5—2200 ohms  
 R6—6800 ohms  
 R7—1000 ohms, PC-mounted trimmer potentiometer  
 R8—470 ohms  
 R11—10,000 ohms, PC-mounted trimmer potentiometer  
 R12—10,000 ohms  
 R13—1000 ohms  
 R14—220 ohms  
 R17—50,000 ohms, PC-mounted trimmer potentiometer

#### Capacitors

C1—47  $\mu$ F, 25 volts, electrolytic  
 C2, C5—10  $\mu$ F, 35 volts, electrolytic  
 C3, C4—not used  
 C6—0.33  $\mu$ F, 50 volts, stacked film

#### Semiconductors

IC1—LM340T-5, 5-volt regulator  
 IC2—CA3132E, A/D converter  
 D1, D2—1N4002 diode

**Miscellaneous:** 43B21 main PC board, 1N4148 diode for temperature probe, 3-digit display board, coax cable, in-line fuse holder, 1-amp fuse, four 6-32  $\times$  0.625" standoffs, eight 5/16-inch #6 screws, bronze or red plexiglass, mounting hardware, hookup wire.

full 180 millivolts lower than at 32 degrees, the gain control of the A/D converter compensates for that. The compensation also allows the converter to have an adjustment window so tolerance effects can be calibrated out. Looking at the remaining circuitry, C5 is used to filter the input voltage for stable readings. Resistors R6, R7,

*continued on page 61*

THERE ARE SEVERAL WAYS TO CAPTURE and listen to sounds at a distance. Obviously, you could always set microphones at a location of interest, and transmit the sounds by wire or radio to your position. However, that's not always convenient or practical in certain cases of surveillance, or when dealing with bird calls or animal sounds.

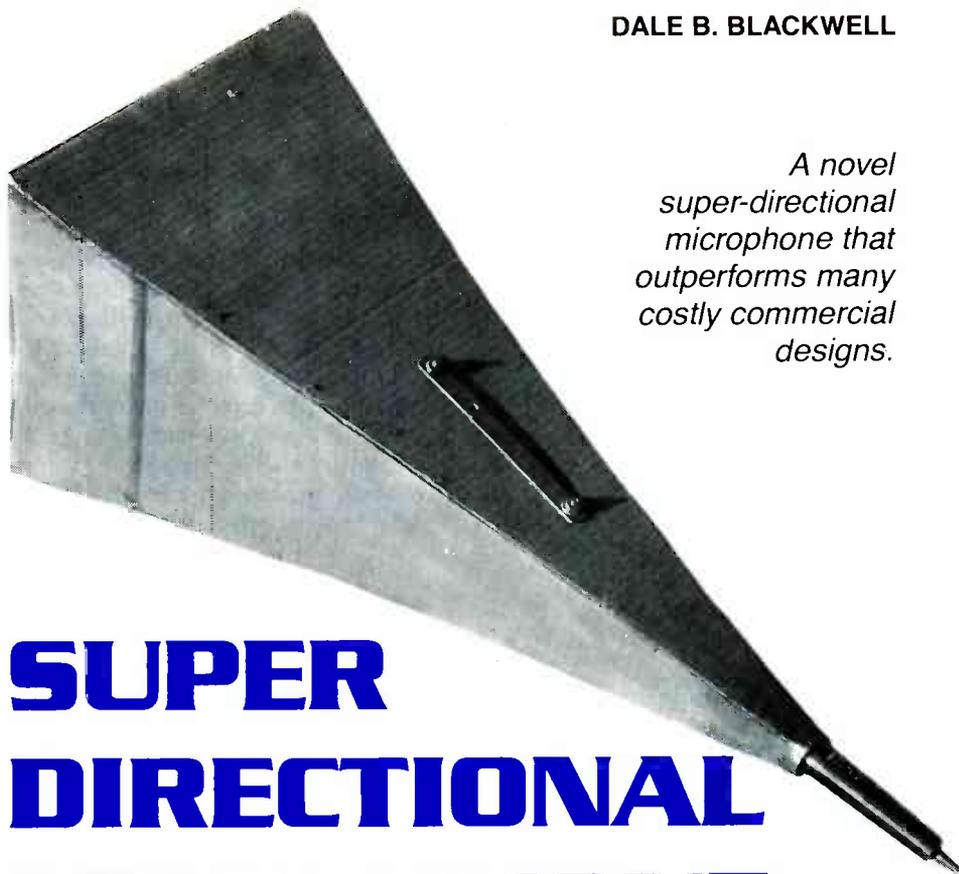
Another option is to use a sensitive, directional microphone similar to those used in network TV broadcasts of football or other sporting events. Such microphones typically have parabolic reflectors for focusing sound onto them. The microphone we'll describe here uses a different approach, yet is perfect for long-distance monitoring or surveillance.

### Theory

The major criteria that determine microphone performance are directional sensitivity and frequency response (bandwidth). Just as frequency response and directional sensitivity in antennas are changed by varying the lengths, diameters, and relative angles of metal radiators or reflectors, the analogous characteristics of microphones can be adjusted by similar geometric variations. One lesser known antenna type, normally used in microwave applications, is the horn antenna. The horn microphone presented in this article is designed using analogous principles which could, incidentally, also be applied with equal validity to the design of a loudspeaker, for reasons discussed below.

A very helpful concept in either acoustic or electromagnetic design is to think of a microphone, loudspeaker, or antenna, as just a transducer. This concept can be extended still further, if you consider a transducer of wave-propagated energy that focuses such energy onto a receptor to be a lens. Consider the similarities, taking the antenna first, since it's the more obvious. Both antennas and lenses focus and collect electromagnetic energy, the only difference being that light is at a much higher frequency range, and obeys the laws of optics. (Actually, microwave antennas also exhibit quasi-optical physical phenomena.)

Consider for a moment; don't both electromagnetic radiation and light exhibit the same phenomena of reflection, refraction, absorption or attenuation, and polarization? And in



*A novel super-directional microphone that outperforms many costly commercial designs.*

# SUPER DIRECTIONAL MICROPHONE

like fashion, acoustic energy also exhibits the same phenomena. Just as antennas are *electromagnetic* lenses, so too are microphones and loudspeakers *acoustic* lenses.

Not only are microphones and loudspeakers acoustic transducers or lenses, but also acoustic filters. Just as all filters have frequency and phase response, so too do microphones and loudspeakers. However, here, as with antennas, two types of filtering occur: directional and frequency.

Another term for directional sensitivity is directivity, often a desirable trait, since it prevents spurious sound from entering from undesired directions. A microphone with uniform directivity is termed omnidirectional; however, flat directional response doesn't imply flat frequency response. A microphone can either have a flat response over the audio spectrum (20 Hz–20 kHz), or be tailored for greater sensitivity over specific audio bands. The acoustic horn presented here has very high directivity over the entire audio spectrum.

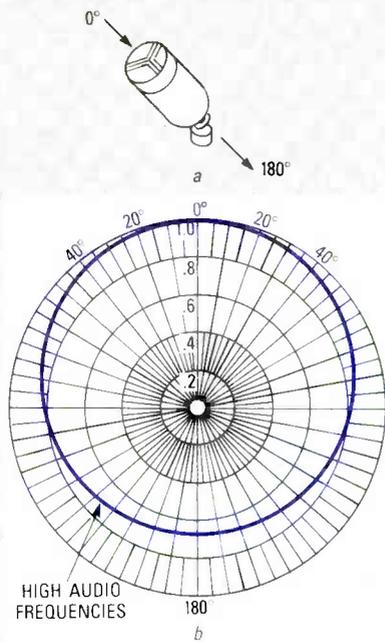
The last property microphones and speakers have in common is re-

iprocity, which lets a microphone work equally well as a loudspeaker of identical design, both directionally and in frequency response; this property also holds true for antennas.

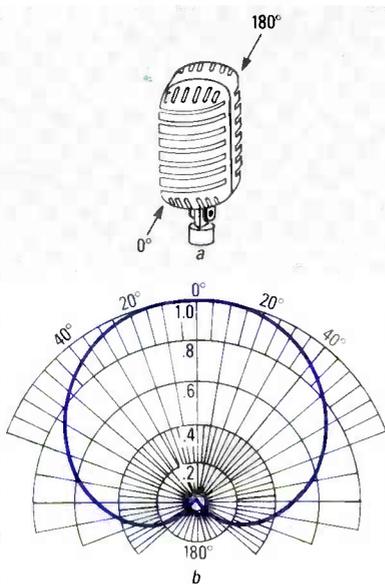
### Different microphone types

Most microphones are omnidirectional, as shown in Fig. 1. Figure 1-a shows the basic shape of an omnidirectional microphone with the main axis, while Fig. 1-b shows a linear polar plot of relative sensitivity  $P(\theta)$  (dynes/cm<sup>2</sup>) as a function of angle  $\theta$  about the main axis; all curves are normalized to 1 at the peak of the main beam. The main beam can be at any angle, although it's normally depicted at 0°. If several people sit around a table, an omnidirectional microphone at the center will pick them all up equally well. Any plane that passes through the main axis will exhibit this sensitivity response.

The second most common microphone type is the *cardioid*, shown in Fig. 2-a, which has greater directivity toward the front over most of the audio range. The sensitivity pattern shown in Fig. 2-b looks like the mathemati-



**FIG. 1—AN OMNIDIRECTIONAL** microphone, shown in (a), has uniform directional sensitivity to sound pressure  $P(\theta)$ ; the main axis is out the indicated. In (b) is shown a polar plot of directional sensitivity; the response is identical in any plane through the main axis.



**FIG. 2—A CARDIOID MICROPHONE**, shown in (a), has greater sensitivity from the front than the rear. The  $0^\circ$  and  $180^\circ$  directions are along its main axis, pointing through the main face. The sound pressure sensitivity  $P(\theta)$  shown in (b) was taken through a plane normal to the main axis.

cal curve called a cardioid (heart-shaped), hence the name. An orchestra in a night club might use a cardioid microphone so that only their music is picked up, not sounds

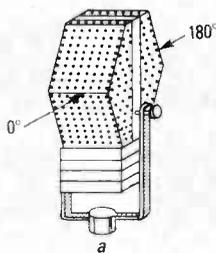
from the audience. The power function is of the form:

$$P(\theta) = P_{\text{ref}}[1 + \cos(\theta)],$$

$$= 2 \times P_{\text{ref}} \cos^2(\theta/2).$$

At  $\theta = 0^\circ$ , the sensitivity is maximized. The sensitivity goes to zero (a null) at  $\theta = 180^\circ$ .

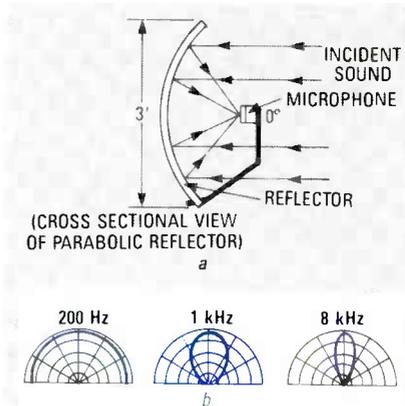
The ribbon element microphone shown in Fig. 3-a is the industry standard, well-known from all the photos of radio stars in front of them. It's sensitive from both front and rear, producing the figure-8 pattern shown in Fig. 3-b. A microphone that picks up equally well in opposite directions is advantageous in a talk show where the guest sits opposite the host.



**FIG. 3—A BIDIRECTIONAL** microphone, shown in (a), is uniformly sensitive to sound from front and rear, but less sensitive from the side; the main axis is the same as that for a cardioid microphone. Note, however, that  $P(\theta)$  in (b) has two lobes, not one, with two maxima and two minima (zeros, or nulls).

**Increasing directivity**

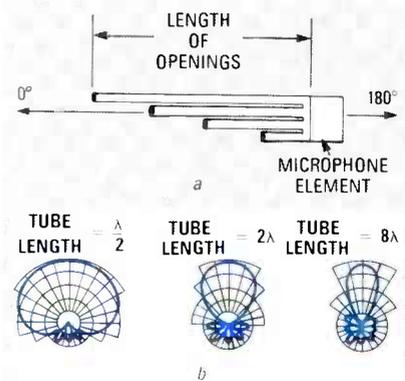
Experimenting with basic microphone directivity patterns yield more specialized designs that are much more sensitive from the front. Figure 4-a shows a parabolic reflector micro-



**FIG. 4—THE DIRECTIVITY OF A** parabolic reflector microphone increases with frequency. In (a), the incident parallel rays converge to the microphone at the focal point. In (b) are shown linear polar plots of acoustic power at four frequencies.

phone; all parallel rays, wherever they strike the curve, are reflected to the focal point, where the microphone is located. Parabolic microphones are also especially directive at higher audio frequencies, as shown in the sensitivity patterns of Fig. 4-b.

As shown in Fig. 5-a, the line (shotgun) microphone is another commercial directive version, albeit not quite as focused as a parabolic reflector. The line microphone has either a single long tube with spaced openings, or several tubes of increasing length, in front of the microphone element. The sensitivity patterns in Fig. 5-b aren't for differing frequencies, but for different tube lengths, being integral multiples of  $\lambda/2$ , or half a wavelength.



**FIG. 5—A LINE (SHOTGUN)** microphone becomes more directive as the length of its tubes increase. It's not as directive as a parabolic reflector, and either has one long tube with spaced openings, or several tubes of increasing length each with one opening, right in front of the diaphragm.

Both the reflector and line microphones are directive, but neither compares with the narrow beam of the horn shown in Fig. 6. Figure 6-a shows the geometry of the basic horn shell for the horn microphone prototype, without the screw-on extension piece, while Fig 6-b shows the directivity patterns for different frequencies.

All microphones, of whatever type, work equally well when the same basic shape is used in a loudspeaker due to reciprocity. The narrow beam of a horn stems from the ability to match the impedance between a small microphone diaphragm and free air, making the small microphone diaphragm (or receptor) seem as large as the mouth of the horn.

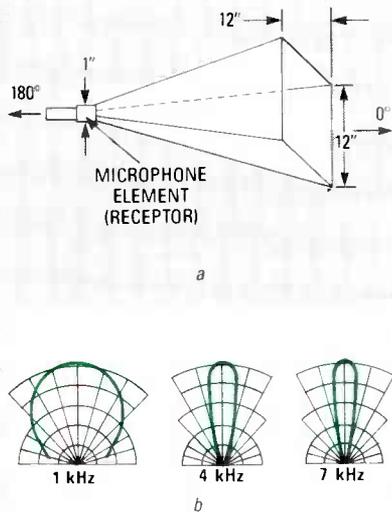


FIG. 6—HORN MICROPHONES ARE VERY directive; they match acoustic impedance from diaphragm to open air. In (a) are the prototype dimensions; the narrow beamwidth makes the receptor act as large as the mouth, due to phasing and pressure effects, so the incident volume is greater from the front, than sides or rear. In (b) are directivity plots for 1, 4, and 7 kHz.

### Horn microphone

The high directivity of all horn microphones stems from phasing and pressure effects, making the volume at the receptor greater from the front, than from the sides or rear. The mouth, length, shape, and frequency range to be received, all determine the directivity. One reason for the high directivity is that audio wavelengths are made comparable to the mouth size. The relation is  $\lambda = C/f$ , where  $\lambda$  is wavelength (cm),  $C$  is speed of sound (340 m/s), and  $f$  is frequency in Hz.

Since 1 ft = 30.48 cm, then from 20



FIG. 7—AS HORN MOUTH SIZE increases relative to wavelength, directivity increases, since audio wavelength is comparable to mouth size. Shown are directional patterns of decreasing beamwidth, for four horn diameters relative to  $\lambda$ .

Hz to a few hundred Hz, the wavelengths are over a foot. At  $f = 1.115483$  kHz, then  $\lambda = 1$  ft, so the 1-foot diameter horn presented here should be quite directive at that frequency. Figure 7 shows additional directivity patterns, but not for explicit frequencies. Note that those patterns are for various mouth sizes relative to wavelength. As the ratio of mouth size to wavelength increases, so does directivity. Another way to achieve higher directivity is to increase horn length for a given mouth size. As shown in Fig. 8, to achieve this, the horn angle  $\alpha$  must be reduced.

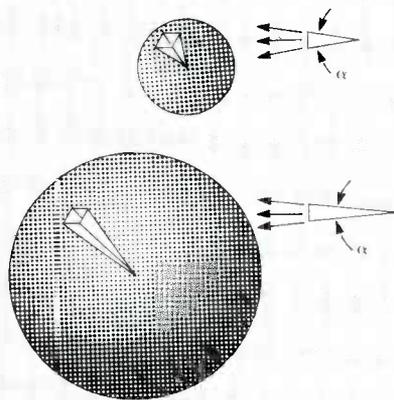


FIG. 8—ANOTHER WAY TO ACHIEVE directivity in a horn microphone is to increase length versus mouth size, requiring that horn angle  $\alpha$  be reduced.

Horns of different shapes are commonly used as loudspeakers, with the exponential, hyperbolic, and conical versions the most common, in that order. Horns are uniquely able to transform and match acoustic impedances. The horn loudspeaker is an acoustic transformer, changing large pressures and small volume currents in the throat to small pressures and large volume currents in its mouth; horn microphones do the reverse.

As shown in Fig. 9, the conical horn has a gradual impedance-trans-

formation curve as cutoff frequency is approached, with a smooth transition from a high-directivity pattern to one of lower directivity. Such smooth transitions are more desirable than the abrupt low-frequency cutoff of both exponential and hyperbolic horns.

In the horn of Fig. 6-a, the transition from square horn to receptor is smoothed into a cone using modeling clay. At the higher audio frequencies, the conical walls reflect the short wavelengths (a few inches or less) down to the microphone diaphragm, helping to optimize high-end audio directivity for a narrower beamwidth.

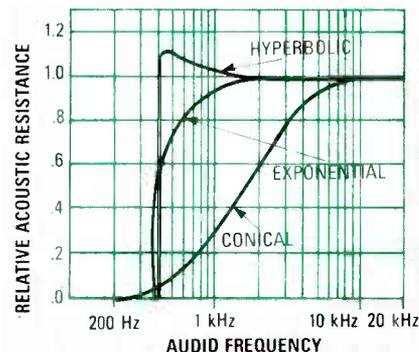


FIG. 9—RELATIVE ACOUSTIC resistance for several horn microphones of size and bandwidth similar to Fig. 6. Each works just as well as a loudspeaker by reciprocity, with the exponential, hyperbolic, and conical the most common.

### Construction

The horn presented here can be made using low-cost materials and a little time. Because sound pressure waves exert low force, light-weight materials can be used. Figure 10 shows the prototype, made from cor-

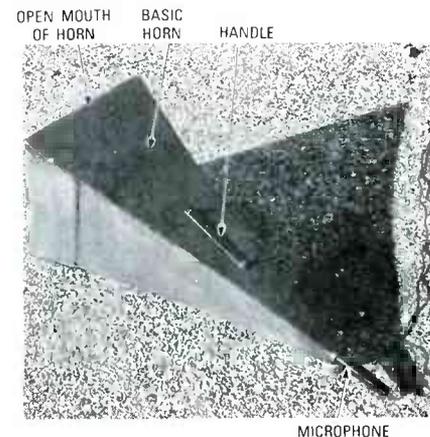


FIG. 10—THE PROTOTYPE HORN WAS made from corrugated cardboard; a removable extension with larger mouth and a carrying handle was added. At high audio frequencies, the walls reflect short wavelengths of a few inches or less to the diaphragm, to optimize directivity.

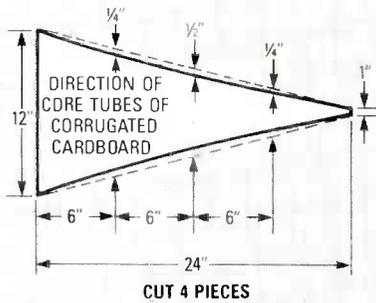


FIG. 11—HERE'S THE CUTOUT FOR ONE side of the basic horn; note the direction of the corrugated ribs. The edges have slight curvature so the sides have added strength, and don't resonate easily. The edges were taped, and paper glue was used on the inner and outer corners. The small end was cut to a 1-inch diameter, and the microphone slides in and is held by the four sides. A metal washer slipped into the throat face acts as a stop, yet lets the sound reach the diaphragm.

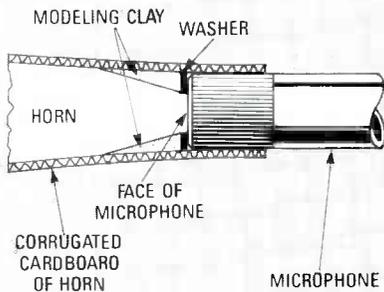


FIG. 12—WHEN MOUNTING THE microphone in the horn, the washer aperture should be at least 75% of the diaphragm diameter. The modeling clay smoothed the transition from the square horn to the washer opening, so that the sound wasn't restricted from reaching the diaphragm.

rugated cardboard, cut to the correct size and glued together, with a carrying handle added. The horn was constructed, assembled, and tested; then, a removable extension was added to gauge the benefits of a larger mouth.

The basic horn was built with four sides from the pattern in Fig. 11. The edges have slight curvature for additional strength, so they won't resonate easily. The edges were taped enough to hold them in place, and simple white paper glue was applied to both the outside and inside corners. The small end was cut to a 1-inch diameter, letting the microphone slide in and be held by the four cardboard sides. A metal washer slipped into the throat against the microphone face acts as a position stop, while letting the sound reach the diaphragm.

As Fig. 12 shows, modeling clay smoothed the transition from the

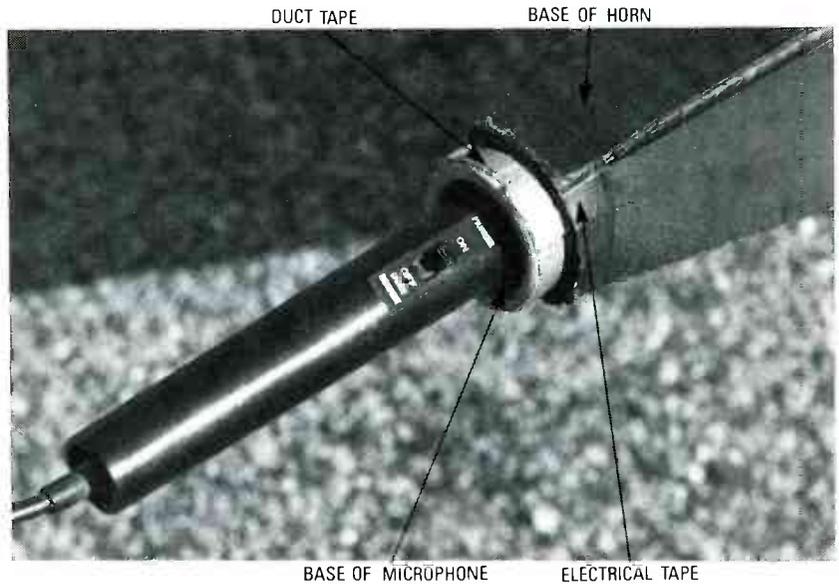


FIG. 13—A CLOSE-UP VIEW OF THE EXTERIOR of the neck. The cardboard is tapered, producing an opening of proper size for the microphone, and the microphone is inserted. Note the silvery ring at the base of the horn, just behind the base of the horn. The bottom of the microphone protrudes from the base of the horn, and was sealed mechanically and acoustically with duct tape, while the base of the horn was stiffened with electrical tape.

square horn to the round washer opening, so the sound wasn't prevented from reaching the diaphragm. The washer needs an opening at least 75% of the microphone diameter. Figure 13 shows a close-up view of the exterior of the neck of the horn. You can see how the cardboard is tapered to produce an opening of the proper size for the microphone, and how the microphone is inserted.

Note the silvery ring at the base of the horn in Fig. 13, just in front of where the microphone apparently ends. The base of the microphone protrudes from the base of the horn, and is sealed mechanically and acoustically with duct tape. The extension in Figs. 14 and 15 slips over the front of the basic horn, to extend the length and expand the mouth, and two 1/4-20 screws with washers hold both sections together.

By adding the extension, the mouth was increased in size from 1 × 1 ft to 2 × 2 ft, quadrupling the area. Also, the new size is one wavelength across at  $f = 557.742$  Hz, matching wavelengths down to lower audio frequencies and increasing directivity beyond that of the basic horn alone. The larger diameter and greater total area improves pick-up, raising the theoretical pressure level by 3 dB. In practice, the horn picks up more at lower frequencies because the impedance matching at those frequencies is improved.

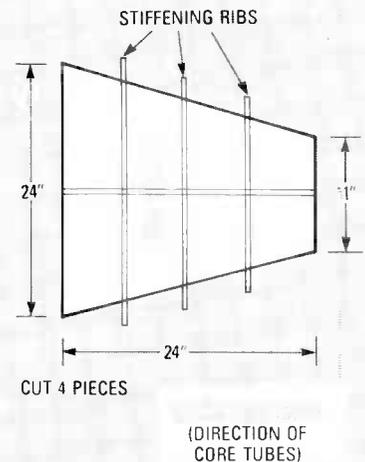


FIG. 14—HORN EXTENSION CUTOUT; the ribs stiffen the cardboard. The extension slips over the horn, extending its length and expanding its mouth, and two 1/4-20 screws with washers hold both together. The mouth is now 2 × 2 ft, one wavelength across at  $f = 557.742$  Hz, matching wavelengths down to lower audio frequencies, improving directivity, raising the pressure level by 3 dB, and providing better low-frequency pick-up, since impedance matching is improved.

### Testing

The preliminary tests were conducted at a large parking lot at a local beach. In actual use, aim the horn in the direction of the desired sound, and plug the microphone into a tape recorder, allowing playback later on. In evaluating the prototype, all tests were recorded to allow detailed sound pressure evaluation of an individual

(Continued on page 52)

LAST MONTH WE INTRODUCED YOU TO THE LAWN RANGER. THE world's first personal robotic lawn mower. For those of you who missed last month's issue, the Lawn Ranger is a computerized robot that can cut grass by itself. All you have to do is cut a boundary around the perimeter of your yard and around any obstacles using the manual controller, switch the mower to automatic, and watch in amazement as it completes the job.

*This month  
we discuss the  
motor-controller board.*

### **Control system**

Let's quickly review the block diagram of the electronic control system shown in Fig. 1. The grass-sensor assembly is used to detect the position of cut and uncut grass that lies beneath the Lawn Ranger. That information is amplified on the motor-controller board and then forwarded to the Central Processing Unit (CPU). The CPU will calculate the steering direction and send it to the motor-controller board. The motor-controller and power-switching circuitry will steer the robot in the direction defined by the CPU by varying the speed of the rear drive wheels. If the right wheel is made to spin faster than the left wheel, the robot will steer to the left—just as a tank works.

### **Motor-controller board**

Figure 2 shows a block diagram of the motor-controller board, which is used to control the speed of each drive wheel and to amplify the grass-sensor signals. The motor-speed control circuitry contained on the board is designed to increase or decrease power to the drive motors based upon the drive motor's actual speed. The circuitry has three major sections: the D/A converter, velocity-feedback loops, and Pulse-Width Modulators (PWM).

The D/A converter converts the Z80 micro-processor's digital steering command into an analog voltage. The D/A converter, hand-held manual controller, and speed-set adjustment provide steering reference signals to the velocity-feedback loops.

There are two feedback loops: one for the right wheel, and one for the left. The loops are designed to "lock on" to the reference-signal input and provide a constant motor speed. The D/A and the manual-controller outputs are designed to slow down the left or right wheel for steering purposes. When the robot is steering straight, the D/A and manual-control outputs will be zero and both drive wheels will spin at the same speed. If the actual wheel speed (from the velocity-feedback signal) is equal to the desired wheel speed, the error voltage will be zero. When the wheel speed is too slow, the velocity-feedback signal will cause the error voltage (reference input minus the feedback) to increase and additional power will be delivered to the drive motors. If the wheel speed is too

# **Build the Lawn Ranger**



**Raymond Rafaels**

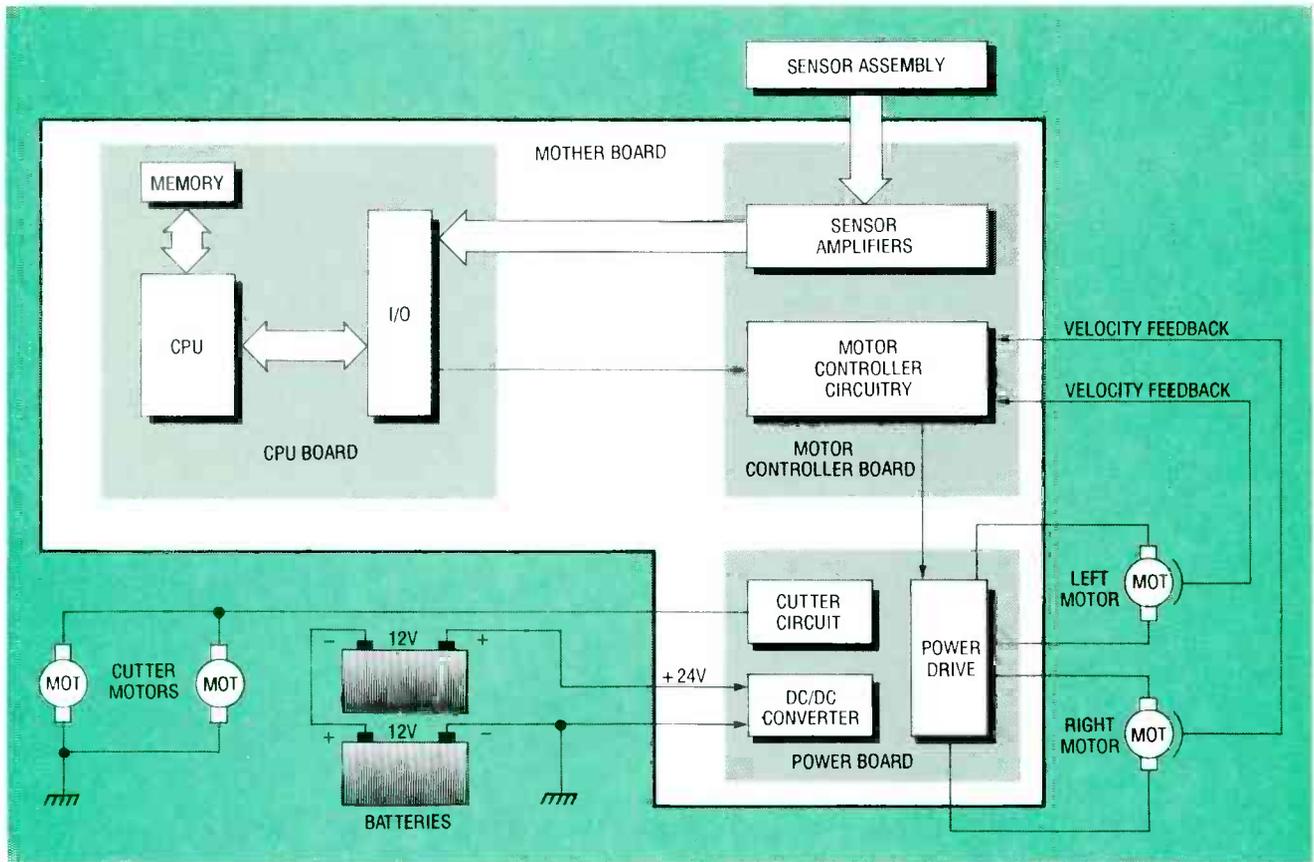


FIG. 1—BLOCK DIAGRAM of the electronic control system.

fast, the velocity-feedback signal will cause the error voltage to decrease and less power will be delivered to the drive motors.

The PWM circuitry is used to

achieve high-efficiency power amplification. The technique allows the +24-volt supply to be switched (applied and then removed) from the drive motors for the sake of increased

efficiency. The "on" and "off" times are precisely controlled and the effect on the motors is the same as if a lower voltage were continuously applied to them.

### PARTS LIST

#### MOTOR-CONTROLLER

All resistors are 1/4-watt, 5%, unless otherwise indicated.

- R1, R93—two 16-ohm, 1-watt resistors in parallel
- R2, R16, R28, R41—22,000 ohms
- R3, R17, R21, R25, R43, R55, R56, R59, R60, R73, R83, R86, R90—100,000 ohms
- R4, R5, R18, R19—2200 ohms
- R6, R30, R38, R39, R44, R45, R47, R50, R108, R110, R112, R115—1 megohm
- R7—806,000 ohms, 1%
- R8—402,000 ohms, 1%
- R9, R26, R27, R52—200,000 ohms, 1%
- R10—150,000 ohms
- R11, R23, R46, R53, R54, R62, R65, R69, R72, R75, R78, R79, R84, R89—10,000 ohms
- R12—499,000 ohms, 1%
- R13—180,000 ohms
- R14—604,000 ohms, 1%
- R15—4500 ohms, 1%

- R20—2.7 megohms
- R22, R36, R48—220,000 ohms
- R24—82,000 ohms
- R29—680,000 ohms
- R31—R35, R37, R104—R106, R117—R200—not used
- R40, R42—68,000 ohms
- R49—820,000 ohms
- R51, R57, R109, R111, R113, R114, R116—8200 ohms
- R58, R61—39,000 ohms
- R63, R64, R81, R82, R94—1000 ohms, 1%
- R66, R68, R74, R87—270 ohms
- R67, R70, R77, R80—3300 ohms
- R71, R76, R85, R88—2700 ohms (with 0.1  $\mu$ F capacitor in parallel, see text)
- R91, R92, R107—jumper
- R95, R98, R102—3900 ohms, 8-pin SIP resistor network
- R96, R97, R99—R101, R103—2200 ohms, 8-pin SIP resistor network
- R201, R202—2000 ohms, potentiometer
- R203—10,000 ohms, potentiometer

#### Capacitors

- C1, C5, C7, C10, C11, C16, C18—C21, C26, C42, C47—C51—0.1  $\mu$ F, 50 volts
- C2, C4, C8, C15, C43—C45—0.01  $\mu$ F, 25 volts, disc
- C3, C9, C27—C41—1  $\mu$ F, 35 volts, electrolytic
- C6, C17, C46—100  $\mu$ F, 35 volts, electrolytic
- C12—C14, C22—0.002  $\mu$ F, 25 volts
- C23—C25—10  $\mu$ F, 16 volts, electrolytic

#### Semiconductors

- IC1, IC12—IC14—74LS14N hex inverter
- IC2—74LS74N D-type latch
- IC3, IC11—not used
- IC4, IC7—LM324 op amp
- IC5, IC6—LM2907N-8 frequency-to-voltage converter
- IC8—LF13202 analog switch
- IC9, IC10—UC3637N pulse-width modulator
- IC15, IC18—LM339 comparator

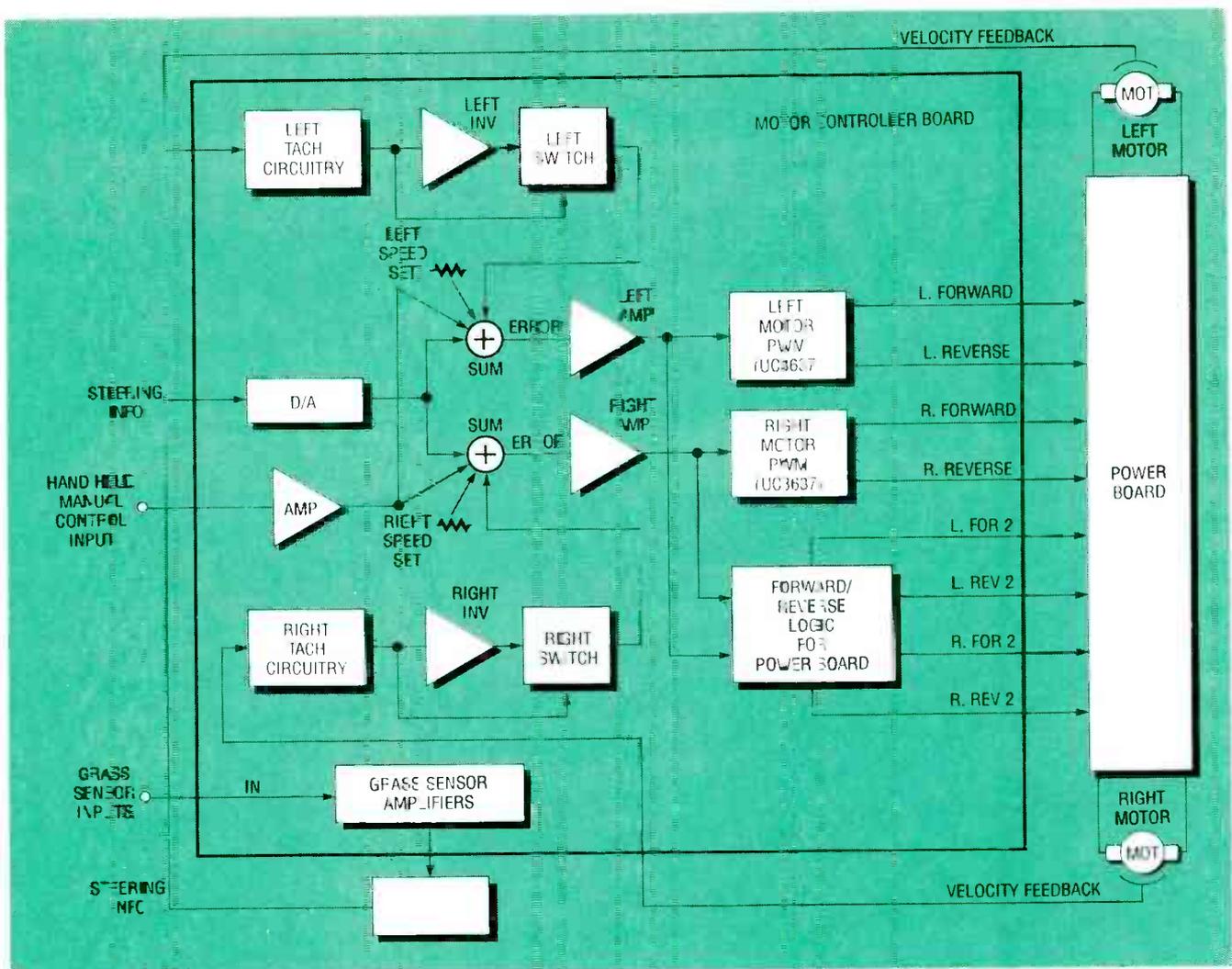


FIG. 2—THE MOTOR-CONTROLLER BOARD is used to control the speed of each drive wheel and to amplify the grass-sensor signals.

IC16, IC17—LLN2081A transistor array  
 IC19, IC20—OPB822S dual op-amp module  
 D1—D3, D6—D11, D13, D15, D17, D20—1N4148 diode  
 D4, D5, D12, D14, D16, D18, D19—not used  
 Q2, Q3, Q5, Q6, Q8, Q9, Q11—Q16—2N39C4 transistor  
 Q1, Q4, Q7, Q10—2N3906 transistor  
**Other components**  
 J1—20-pin DC connector  
 J2—not used  
 J3—10-pin DC connector  
 J4—16-pin DC connector  
**Miscellaneous:** PC board, IC sockets (two 8-pin, nine 14-pin, three 16-pin and two 18-pin), jumper wire, solder etc.

#### MOTHERBOARD

PC board; P21, P23—44-pin edge connector; P22—50-pin edge connector

**Note:** The following items can be purchased from Technical Solutions, Inc., P.O. Box 284 Damascus, MD 20872 (301-253-4933): PC boards for the CPU, motor-controller, power board, and motherboard, \$39 each; programmed EPROM, \$39 (contains computer program and firmware license); grass sensors \$8.99 each; hand-held manual controller kit, \$39; full CPU-board kit, \$129 (includes EPROM, PC board, and all parts); full kit for motherboard, \$69 (contains PC board and all parts); kit for power board, \$149 (contains PC board and all parts except DC/DC converters); full kit for motor-controller board, \$169 (contains PC board and all parts); Lawn Ranger demo VHS tape, \$13 (refundable for orders of \$100 or more). Please add \$8 for S/H (U.S. orders). Maryland residents add sales tax.

#### D/A converter

Figure 3 shows a detailed schematic diagram of the motor-controller board. The D/A circuit uses op-amp IC4-b, which is basically an inverting summing amplifier that adds the voltages from data bits DA0—DA5. The lower the amplifier input resistance, the higher the gain for that particular data bit line. The resistance (and gain) used to couple the six data lines to the input of the summing amplifier will vary by a factor of two. For instance, the resistance at DA0 (R12 and R20) will be twice as large as the resistance at DA1 (R6 and R14), which will be twice as large as DA2 (R7), etc. That allows the magnitudes of each binary number to be properly weighted with respect to each other. A small bias voltage is applied through R13 and R203 into the summing junction to force the D/A output to swing both positive and negative. Potentiometer R203 will adjust the level of the D/A

Text continued on page 71

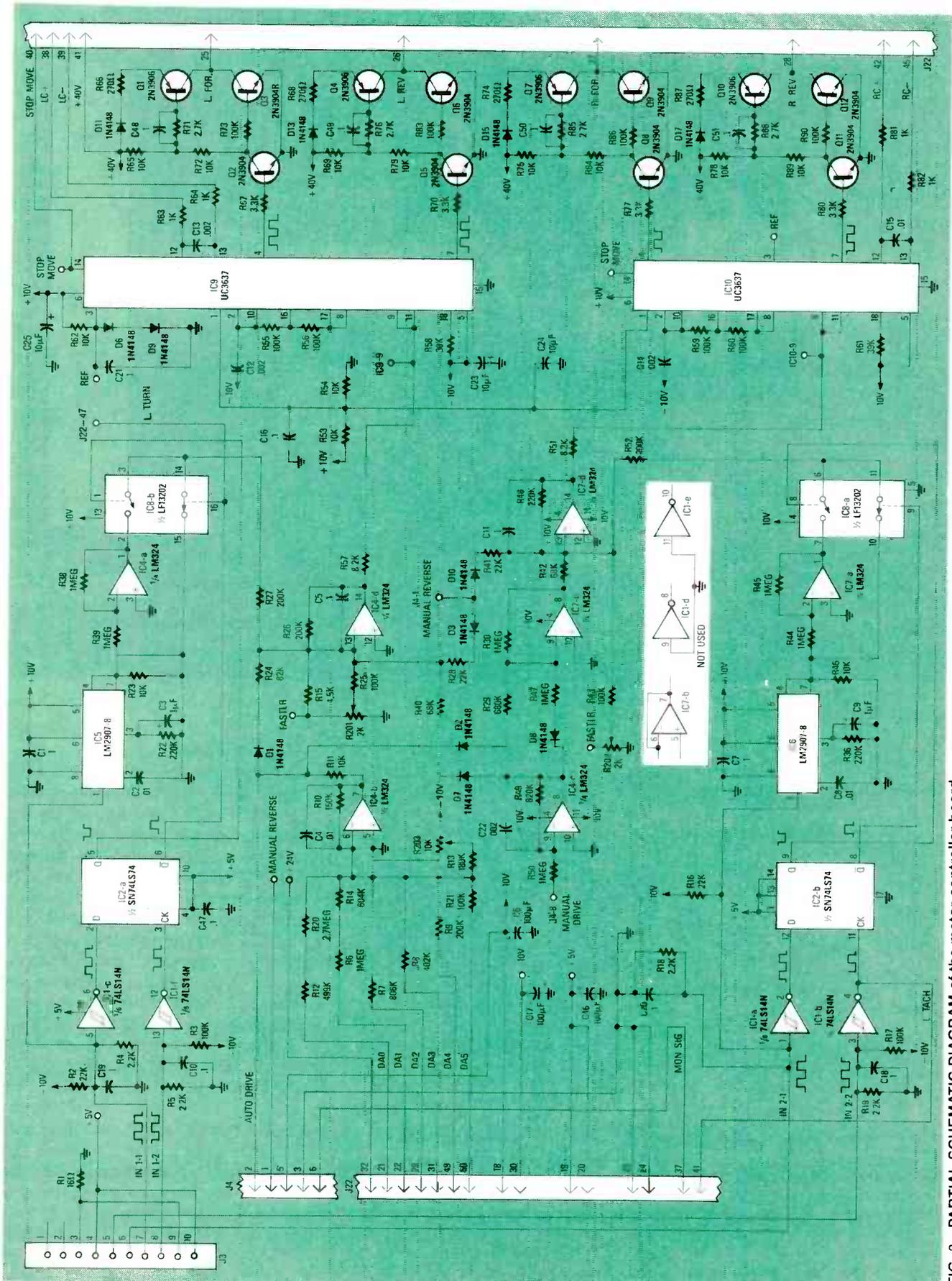


FIG. 3—PARTIAL SCHEMATIC DIAGRAM of the motor-controller board.

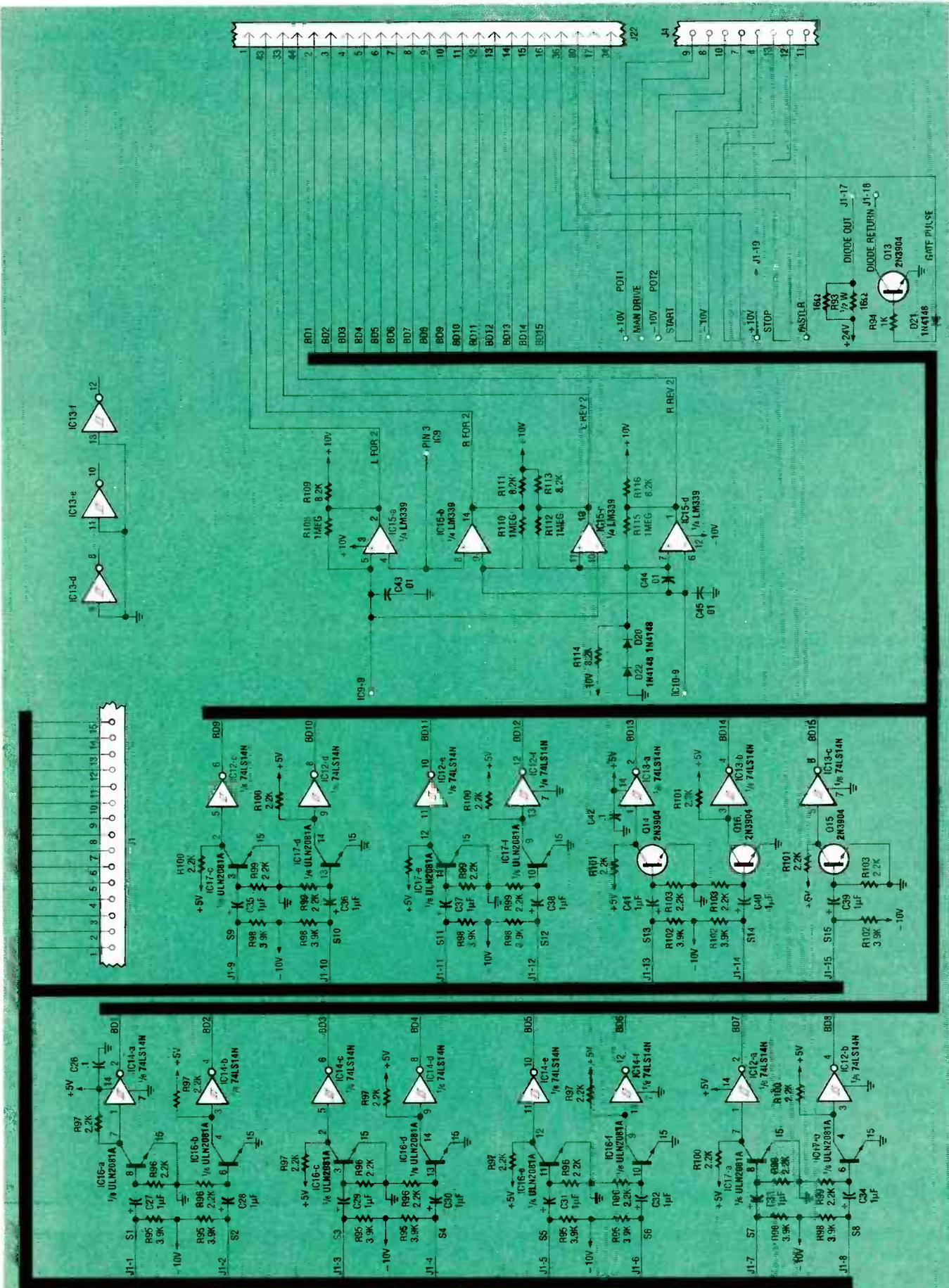


FIG. 4—THE GRASS-SENSOR AMPLIFIERS are located on the motor controller board.

ADD A DISPLAY TO  
YOUR PROJECT

*The days of LED indicators and segmented displays are numbered. Now you can add an alpha-numeric LCD to your home project easily and inexpensively.*

#### STEVEN AVRITCH

LAST MONTH WE BEGAN OUR DISCUSSION on alpha-numeric LCD's, and showed you how to use them in your own designs. We showed you how they can eliminate components and interconnections when used instead of 7-segment displays. Let's finish up now, so that you can actually use one in your next project.

#### Last month

Before we begin, though, there is something from the first half of this article (**Radio-Electronics**, June 1990), that should be pointed out. At the end of the story, we had said that once the display has been properly initialized, the ASCII codes must be written to the display with a series of Data Write operations. We told you that the "SET DD RAM ADDRESS" command must precede the data operations to ensure that the data goes to DD RAM and not CG RAM, and that data writes to CG RAM must be preceded by a "SET CG RAM ADDRESS" command. As an example, we said that the routine in Listing 6 would display the message "PLANE," assuming that the user-defined Character Generator RAM was set up as defined in Listing 5. Well, Listing 5 did appear in that article, but Listing 6 never made it to

print. We have therefore put Listing 6 in this second half of the article, shown below.

#### Hardware interface

There are a variety of ways to interface an LCD module to a host processor or microcontroller. A microcontroller such as a Motorola MC68705 (see **Radio-Electronics**, September 1989, for information on the MC68705) is easy to interface with because it has port pins that can

be dedicated to the LCD module. A processor that does not have dedicated port pins requires a small amount of additional decode logic in order to establish the LCD module as an I/O device.

LCD modules with an on-board HD44780 LCD controller chip have two hardware interface modes: a 4-bit mode and an 8-bit mode. In the 4-bit mode, each data byte is transferred to the LCD module with two write operations. The 4-bit mode utilizes only

#### LISTING 6

```

JSR  INIT      INITIALIZE DISPLAY
LDA  #S80      SET UP FOR DD RAM WRITES
JSR  CONTROL
LDA  #S02      RETURN DISPLAY TO HOME POSITION
JSR  CONTROL
LDA  'P'
JSR  DISLET
LDA  'L'
JSR  DISLET
LDA  'A'
JSR  DISLET
LDA  'N'
JSR  DISLET
LDA  'E'
JSR  DISLET
LDA  ' '
JSR  DISLET
LDA  #S02      ASCII CODE FOR AIRPLANE TAIL SECTION
JSR  DISLET
LDA  #S01      ASCII CODE FOR AIRPLANE BODY SECTION
JSR  DISLET
LDA  #S00      ASCII CODE FOR AIRPLANE NOSE SECTION
JSR  DISLET

```

LOAD AND DISPLAY EACH LETTER OF THE WORD 'PLANE'

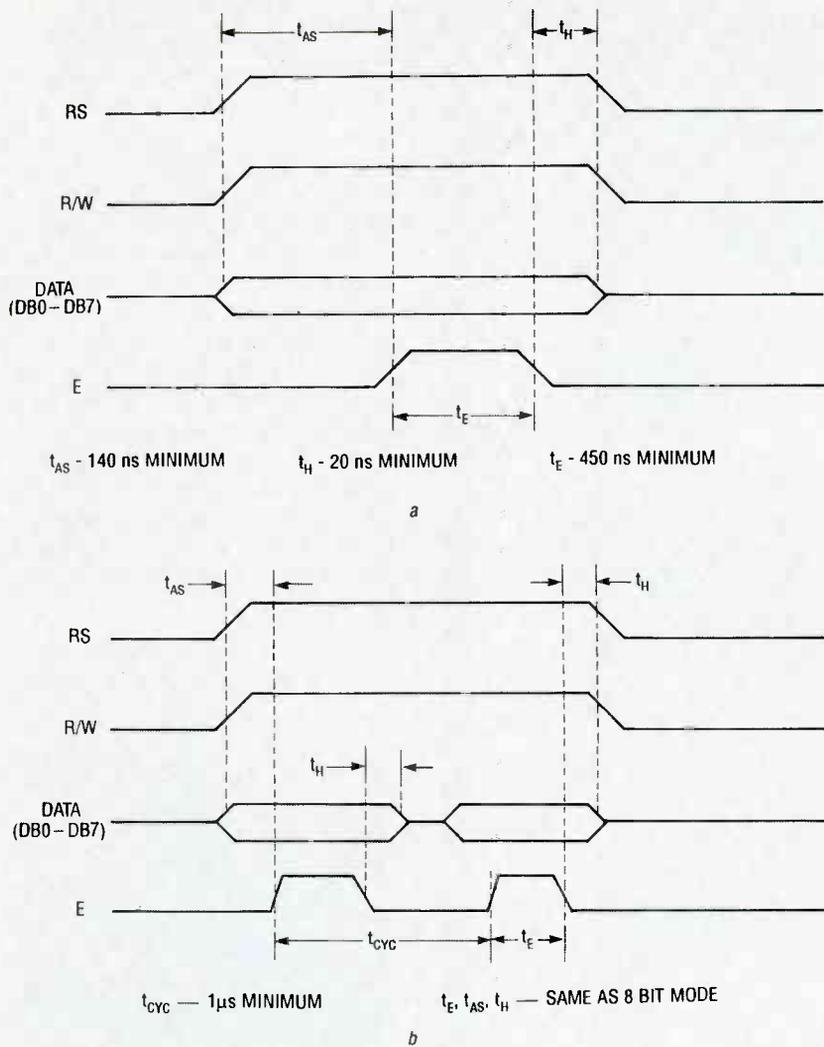


FIG. 4—THE TIMING REQUIREMENTS for the 8-bit mode (a) and the 4-bit mode (b).

the upper four data-bus lines (DB4-DB7). In the 8-bit mode, data bytes are transferred with a single write operation which saves time by using all eight data-bus lines (DB0-DB7). The only advantage to using the 4-bit interface mode is a

saving of four data-bus lines. The 8-bit mode is slightly easier to interface with (with respect to software), so you should therefore use the 8-bit mode unless the project that you've designed uses a microcontroller that has a limited number of available port pins. Figure 4 shows the timing requirements for both the 8- and 4-bit mode.

### ORDERING INFORMATION

The following items are available from Simple Design Implementations (SDI), P.O. Box 9303, Forestville, CT 06010 (203) 582-8526: Experimenter's kit (contains 16 × 1 OPTREX LCD module, programmed MC68705P3, contrast-control potentiometer, PC board, IC socket, software listings, schematic, and instructions), \$29.95 + \$3 S/H; Same experimenter's kit with 40 × 1 display, \$39.95 + \$3 S/H; Programmed MC68705P3 and instructions, \$15.95 + \$2.50 S/H.

### Microcontroller interface

Interfacing a microcontroller to a HD44780-based LCD module is as simple as connecting the control and data lines of the module directly to the port pins of the microcontroller as shown in Fig. 5. Note that R1 is the contrast-control potentiometer for the display.

### Microprocessor interface

Interfacing the HD44780-based LCD module to a processor (such as the Zilog Z80 8-bit CPU) requires

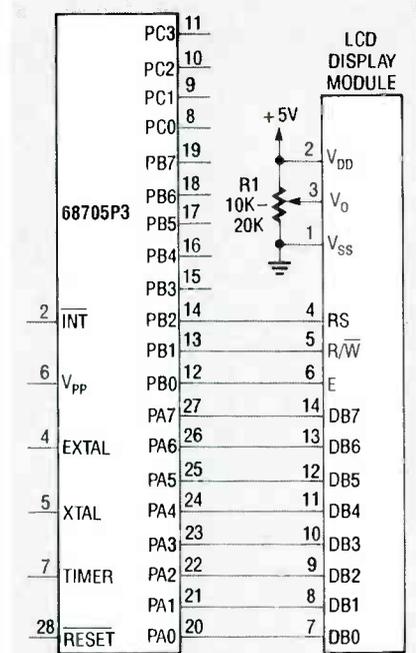


FIG. 5—TO INTERFACE A MICRO-CONTROLLER to a HD44780-based LCD module, simply connect the control and data lines of the module directly to the port pins of the microcontroller.

some additional logic as shown in Fig. 6. That logic establishes the LCD module as being an I/O device in addition to providing the required setup time on the RS line (The RS line must be stable for 140 nanoseconds before the ENABLE line is strobed). In that configuration, the LCD module is accessed using "IN" and "OUT" instructions respectively. Data operations are distinguished from control operations by the address of the I/O operation with address 00 (hex) being a control operation and address 01 (hex) being a data operation. The I/O address of the LCD module can be changed very easily by changing the chip-select decode logic.

### Sample project

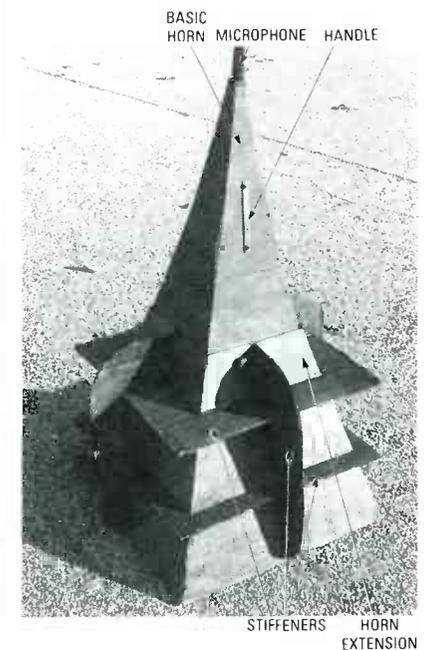
The prototype display module has been incorporated into an automated check list for airplane pilots. The check-list project uses an MC68HC701 (similar to the MC68705) for the host microcontroller, a series of pushbutton switches for scrolling up and down the check lists, and a small beeper that sounds every time a button is pressed. The LCD is 16 characters wide by 2 lines for a total of 32 characters. Since the current draw of the LCD was less than the load ca-

## MICROPHONE

continued from page 44

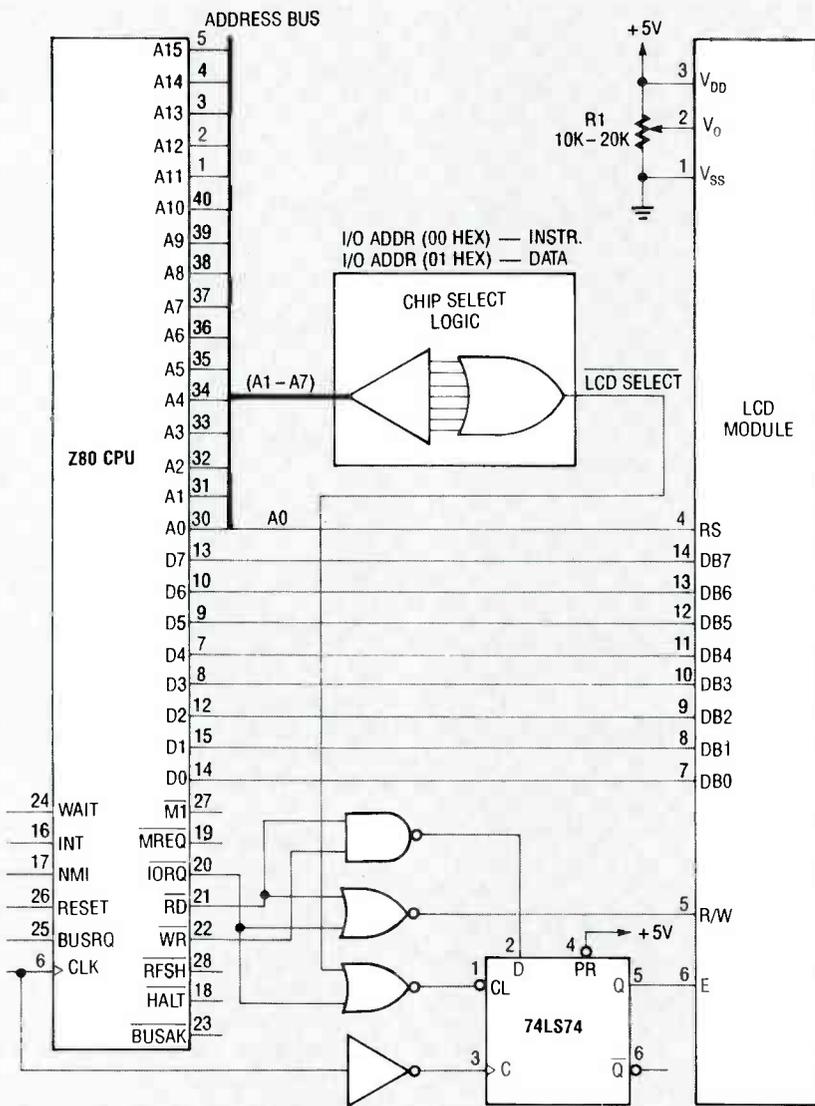
speaking, in a normal voice, 100 ft from the mouth. The resultant recording was quite intelligible even above seagulls squawking overhead, the surf, and car noises 500 ft away.

The higher audio frequencies so necessary for speech intelligibility tend to be very directive. Noticeable roll-off occurred 5° away from the main axis of the horn; in fact, speech wasn't understandable when the horn microphone wasn't pointed directly at someone. Beyond 10–15° off-axis, a voice vanished completely into background noise. However, seagulls and birds 75–100 ft away sounded like they were 2 ft in front of a regular microphone.

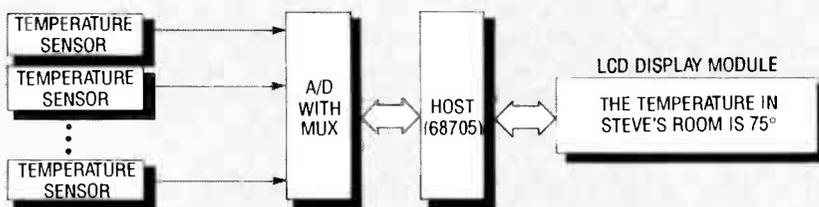


**FIG. 15—HERE'S THE COMPLETED HORN MICROPHONE.** At the top is the receptor microphone, then comes the basic horn, and lastly, the horn extension is shown with its support ribs.

Surprisingly, the extension didn't really improve directivity, and apparently wasn't worth the effort, given the time and effort needed, as well as its size. Frequency response tests with polar pattern measurements would be needed for verification of this, and to optimize the extension performance. However, recording bird calls and animal sounds is a perfect application for this horn, since both the horn and extension are small enough for field use, and give excellent performance over the full audio range. **R-E**



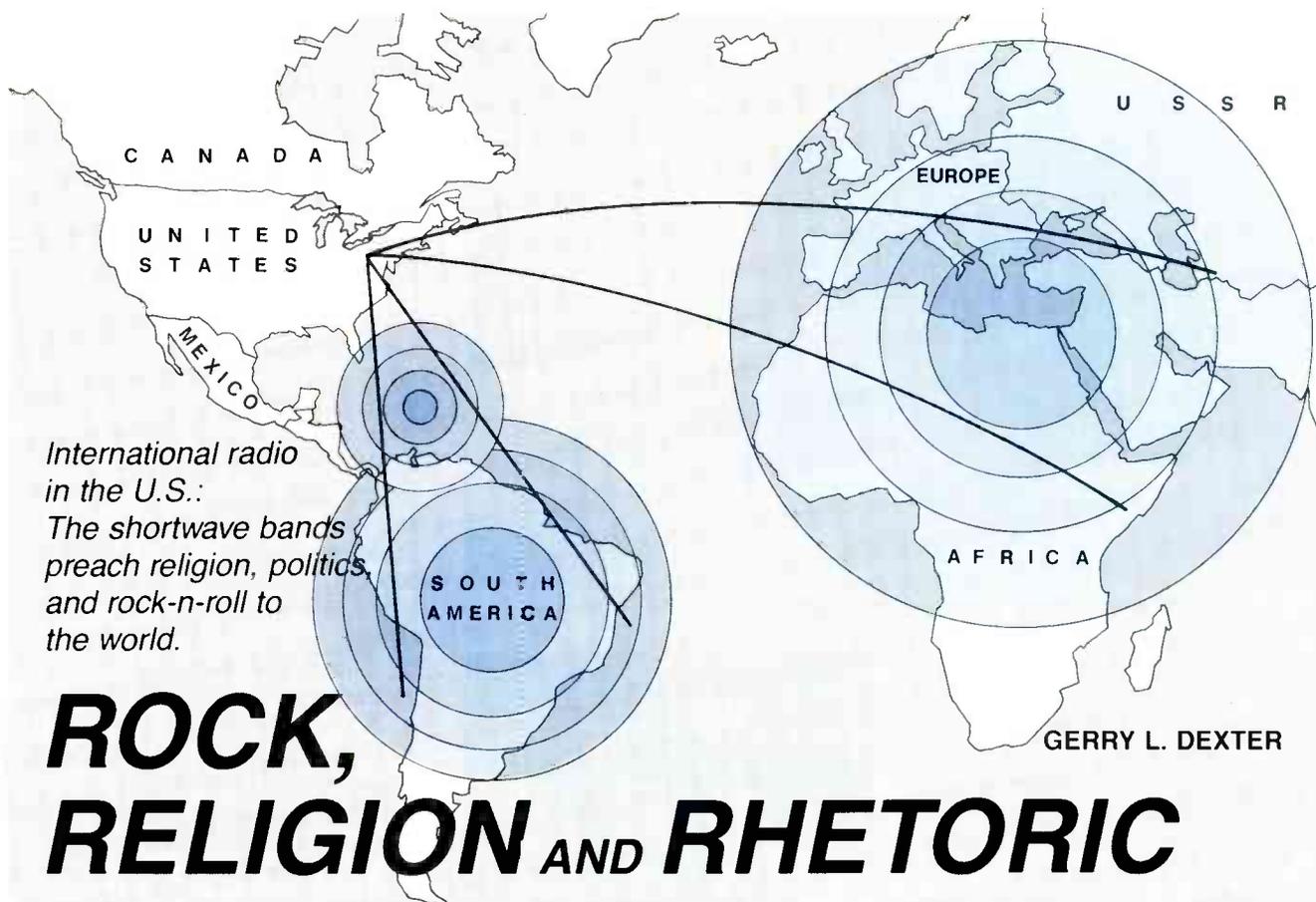
**FIG. 6—INTERFACING THE HD44780-BASED LCD module to a microprocessor requires some additional logic.**



**FIG. 7—TRY USING AN LCD MODULE to build a multi-zone thermometer that displays temperatures throughout your house with your own custom messages.**

ability of the port pins of the microcontroller, the LCD is powered directly from a port pin of the microcontroller. That allows the convenient feature of letting the microcontroller power down the display when it's not needed in order to conserve battery power. It should be noted that the entire design uses fewer than thirty interconnecting wires.

As a suggestion for your own project using an LCD module, why don't you try to build a multi-zone thermometer that displays temperatures throughout your house with simple, non-cryptic messages. For example, you could display "THE TEMPERATURE IN STEVE'S ROOM IS 72°." A block diagram of such a project is shown in Fig. 7. **R-E**



*International radio in the U.S.: The shortwave bands preach religion, politics, and rock-n-roll to the world.*

# ROCK, RELIGION AND RHETORIC

PRIVATE U.S. SHORTWAVE BROADCASTERS are a pretty select group. Out of a total of over 10,000 private broadcasters under FCC control, only about 15 of them use shortwave, or the *High Frequency* (HF) range from 2 MHz–30 MHz. However, while this overall number may seem small, the 1980's witnessed a 500% increase in U.S. shortwave stations, which is an outstanding growth rate.

In the 1930's, when radio had the potential and excitement that cable and satellite TV offer today, many U.S. broadcasters like GE, Westinghouse, and the major radio networks tried shortwave HF, in addition to AM. The potential U.S. audience was sizable because many old floor-standing living-room radios included shortwave bands. As shortwave radio developed, so did the potential audience for it.

Then, however, came World War II. The government soon recognized the obvious need for an international voice to combat Axis propaganda. There was no time to wait for facilities to be built, so the government nationalized private shortwave stations for the first Voice Of America (VOA) broadcasts.

In 1948, a new law governing U.S. shortwave broadcasting made the VOA a permanent government entity, but encouraged private broadcasting by forbidding a government monopoly on radio, and particularly shortwave. The law let the VOA lease private shortwave stations from NBC and Crosley Broadcasting; this practice continued until about 1960, when the VOA shortwave station in Greenville, NC was finished. As private leases expired, however, nearly all private firms opted to get out of the shortwave broadcasting business.

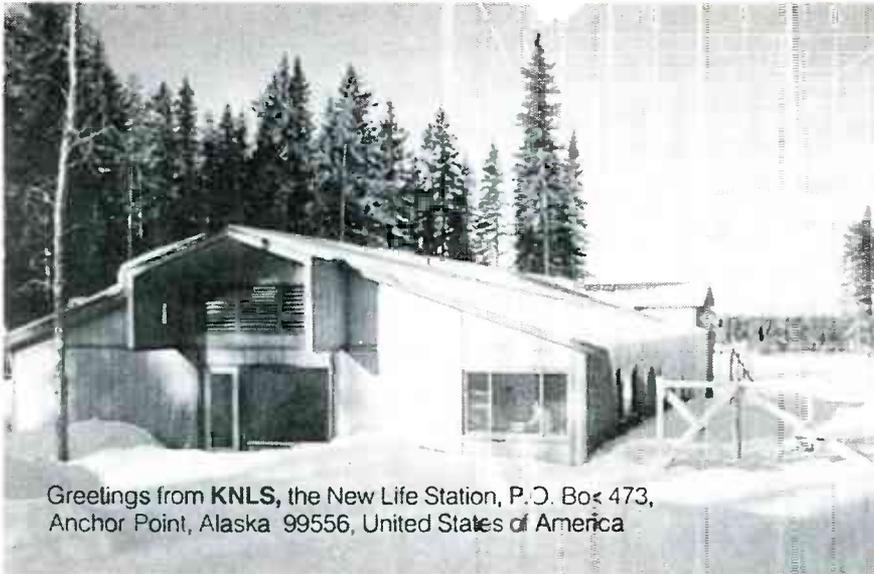
The postwar U.S. shortwave audience dropped drastically, mainly due to the popularity of television, and the elimination of shortwave bands on postwar home receivers. By 1960, the only two remaining private broadcasters were WRUL and KGEI, although WINB was added in 1963. That year, the FCC froze further applications for shortwave station licenses, until new rules could be written to account for changes in international shortwave broadcasting regulations.

That took 10 years, but afterward, four years elapsed before KTWR began broadcasting from Guam, which

went unnoticed. The first major change came in 1982, when WRNO Worldwide, of New Orleans, LA, began broadcasting, after which the FCC found itself granting licenses at an increasing rate fast. Here's a capsule look at the current private U.S. shortwave broadcasters:

- KGEI, of Redwood City, San Francisco, CA, was owned by GE for several years, then sold to Far East Broadcasting Company, a worldwide religious group. KGEI, "The Voice of Friendship," transmits mainly in Spanish to Latin America. It runs 50 and 250 kilowatts on 6.010, 6.075, 6.095, 6.150, 7.365, 9.615 and 15.280 Megahertz.

- WYFR, owned by Family Stations, Inc., of Oakland, CA, a large religious group, can trace its history back to WRUL of Massachusetts in the 1930's. The "Voice of Freedom" for the VOA in World War II, it moved to NY City and worked with the anti-Castro movement in the early 1960's. It was owned by CBS, the Mormon Church, and was WNYW (Radio NY Worldwide) for years. Family Stations bought it in 1972, changed to WYFR (Your Family Radio), closed WRUL, moved to Okeechobee, FL,



Greetings from KNLS, the New Life Station, P.O. Box 473, Anchor Point, Alaska 99556, United States of America

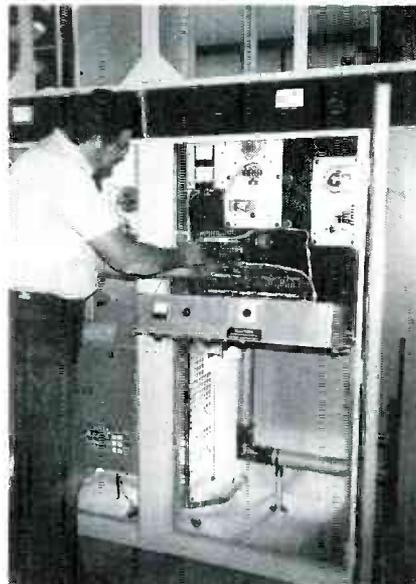
**FIG. 1—KNLS OPERATES FROM THIS BUILDING at Anchor Point, AK.**

and added several 100-kilowatt transmitters. Besides religious programs, WYFR works with Taiwan as VOFC (Voice of Free China), heard in the U.S. and Asia. Broadcasts go around the clock in many languages, on over 50 frequencies.

- WINB, owned by World Intl. Broadcasters, of Red Lion, PA, is a religious shortwave station. It uses 50 kilowatts, covering North Africa, Latin America, Western Europe, and the Mediterranean, in several languages, and broadcasts run 11 hours a day on 15.145, 15.150 and 15.185 MHz, and other frequencies.

- KTWR, on Guam, is run by Trans World Radio, a worldwide religious organization started in the 1950's. It has four 100-kilowatt transmitters covering China, Indonesia, India, Japan, SE Asia, and parts of the USSR. Trans World also has shortwave stations in Monaco, Swaziland, and Bonaire in the Dutch Antilles. KTWR airs in English and 10 other languages; English frequencies include 9.590 and 11.805 MHz.

- WRNO (Rock of New Orleans) is owned by Joseph Costello III, of New Orleans, LA, who also owns affiliated AM/FM stations there. Its early programs had FM simulcasts, but it's separate now and has some 40 religious programs, including rock, pop, New Orleans Saints football, and other sports. WRNO showed up in audience surveys halfway across the U.S., too far away to have been the AM station. It uses two 100-kilowatt transmitters, programs are nearly all English, and the main frequencies are



**FIG. 2—PART OF THE TRANSMITTING FACILITY at WHRI in Noblesville, IN.**



**FIG. 3—A CONTROL ROOM OPERATOR INSPECTING broadcast equipment at KUSW, in Salt Lake City, UT.**

6.185, 9.495, 11.965, 13.760 and 15.420 MHz.

- KYOI, owned by Marcom, Inc., on Saipan in the U.S. Northern Marianas Islands, wasn't as successful. It

aired 24-hour "Super Rock" music to Japan, was announced in Japanese, and was programmed in Los Angeles, CA. However, despite shortwave sets being fairly common in Japan, it lost money and was sold to Herald Broadcasting (WCSN). KYOI uses 100 kilowatts in English on main frequencies 9.670, 11.900, 15.405 and 17.780 MHz.

- KFBS, the second shortwave station owned by the Far East Broadcasting Company (FEBC), whose main shortwave station is KGEI, reaches Asia with religious programming. KFBS has three 100-kilowatt transmitters, one formerly used by VOA, and airs in Burmese, Indonesian, Mandarin, Malay and Vietnamese. Main frequencies are 7.365, 9.465, 9.575, 9.830, 9.840, 11.980, 12.025, 15.305, and 15.375 MHz. FEBC also has other large shortwave stations in the Philippines and Seychelle Islands.

- KSDA, on Guam, is owned by Adventist World Radio, another religious broadcaster. It uses two 100-kilowatt transmitters, aimed at Asia in several languages about 20 hours a day on main English frequencies of 11.965, 15.125 and 17.685 MHz. There are smaller shortwave stations in Italy, Guatemala, and Costa Rica.

- KNLS (New Life Station), owned by World Christian Broadcasting, of Texas, started in 1983 from Anchor Point, AK, after two staff members were killed in a plane crash, and an arsonist burned down the 100-kilowatt transmitter. Main frequencies are 6.095, 7.355, 9.535, 9.750, 9.870, 11.700, 11.820, 11.960, 11.930 and 11.980 MHz. KNLS airs to Asia in Chinese, Japanese, English and Russian, but hasn't reached Europe due to severe HF absorption and refraction at the North Pole. This occurs during solar events like aurora, sunspots, proton events, or geomagnetic substorms, which expands the ionosphere. The bottom moves closer to the Earth, the top elevates, and the charged particle density increases, degrading HF propagation. A picture of the station from a listener-confirmation card is shown in Fig. 1.

- WMLK is run by the Assemblies of Yaweh, Bethel, PA, a religious group that took two years to convert an old 50-kilowatt AM transmitter to shortwave. They transmit a few hours a day on 9.455 MHz from a converted gas station. Programming focuses on the premise that salvation awaits only

those who worship God by the Old Testament name, Yaweh. The station call sign is a contraction of "Malek," or "Messenger."

- WHRI (World Harvest Radio), of South Bend, IN, is owned by LeSea Broadcasting, part of Lester Sumrall ministries. They also have AM/FM and TV operations, and were badly damaged by fire last year. However, WHRI missed minimal air time, as broadcasts were switched to a standby transmitter in Noblesville, IN. There are two 100-kilowatt transmitters aimed at Latin America, the Middle East, and North Africa, on 6.100, 6.155, 7.355, 7.400, 9.455, 9.745, 9.765, 9.770, 11.770, 11.790, 11.980, 15.105 and 17.830 MHz. LeSea has several TV stations and a satellite up-link transmitter. Figure 2 shows an operator working on part of the transmitting facility at the station.

- KVOH (Voice of Hope), in Christian Southern Lebanon, is owned by High Adventure Ministries in California, and got started literally under the gun. Broadcasting has continued for several years, despite a rocket attack that destroyed the studios. They recently started KVOH from Rancho Simi, CA, in English and Spanish for the Americas using 50 kilowatts on 9.495 or 17.775 MHz. Their next project is to transmit from the Philippines to China.

- KUSW, of Salt Lake City, UT, is one of only two commercial U.S. shortwave broadcasters. It's part of Carlson Communications, which owns an AM/FM outlet there, and several others in the western U.S. KUSW runs a pop format, and runs several commercials, though really big accounts like Coca-Cola haven't yet been obtained. KUSW airs 18 hours a day on 5.980, 6.010, 6.185, 9.852, 11.980, 15.225, 15.580 and 17.715 MHz. Figure 3 shows a control room operator inspecting broadcast equipment at the station, and Fig. 4 shows the transmitting towers there.

- WCSN (Christian Science Network), of Scotts Corner, ME, is owned by Herald Broadcasting, part of Christian Science Monitor. It airs a two-hour English news/features segment several times a day around the world. On weekends, the program is the "Herald of Christian Science" in English, French and German. WCSN runs 500 kilowatts on 7.365, 9.465, 9.852, 15.280, 17.640 and 21.515 MHz. As noted earlier, WCSN

bought KYOI, which now carries WCSN via satellite. Next year, WCSN will add WSHB in South Carolina, with a pair of 500-kilowatt transmitters aimed at Latin America.

- WWCR (Worldwide Christian Radio), of Nashville, TN, is a new religious broadcaster that may be starting up any time, perhaps by the time you read this. WWCR will be part of a multi-station group of AM/FM outlets in the south, and will have a 100-kilowatt transmitter, and sell program time to churches, other religious groups, and maybe even political groups or other stations that can't reach North America.

In contrast with AM/FM stations, shortwave stations are much more complex and expensive. The FCC won't grant international shortwave

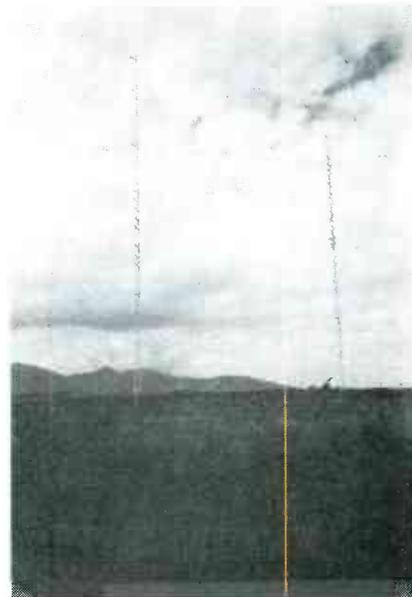


FIG. 4—TRANSMITTING TOWERS AT KUSW, IN Salt Lake City, UT.

broadcast station licenses unless applicants can prove there's a real need, that they have the technical, programming, and financial capability, and will serve the "public interest, convenience and necessity."

A key item in the FCC rules says that "any program solely intended for and directed to the U.S. doesn't meet the requirements for this service." Thus, these shortwave stations aren't supposed to broadcast to the U.S., but many obviously do. The key appears to lie in the use of the word "solely," which apparently allows a U.S. audience to listen in, so long as the programming is officially aimed elsewhere. Also, the physics of shortwave propagation make preventing

U.S. listeners from listening to the broadcasts impossible.

The FCC sets a minimum power level of 50 kilowatts as its requirements for international shortwave, whereas on AM, 50 kilowatts is the maximum; however, that's still small potatoes. WCSN is just one of many worldwide shortwave stations that now uses 500 kilowatts, and even 2.5 megawatt shortwave stations are common. The shortwave broadcaster needs complex directional HF antennas aimed at the desired area, along with requirements like minimum antenna gain, HF signal launch angle, bandwidth, and site selection. Once running, the right frequency has to be adjusted to reach a specific area, at a specific season and time of day. It's not just a case of needing only one transmitter, antenna pattern, and frequency, all the time.

An ordinary AM/FM station is expensive, but not when compared with a shortwave station. George Jacobs is a former official of VOA and Radio Free Europe (RFE), who now heads his own highly regarded broadcast-engineering firm, which acts as technical consultant to several U.S. shortwave broadcasters. According to him, a 50-kilowatt site with suitable antennas goes for about \$400,000, while a 500-kilowatt version can easily run \$2.5 million. And that's excluding the land, studio, and buildings, which can easily double the overall cost. He estimates the power cost for a 500-kilowatt site 18 hours a day for a year at over \$53,000.

So far, programming formats have been mostly of two types, and one has to wonder how much more audience potential exists for religious programming. Pop and rock formats, already filling AM/FM bands, are also heard on many foreign stations, both AM/FM and shortwave. The curtain hasn't fallen on this play yet, though. There are still a few more actors yet to arrive.

The oldest and largest religious shortwave broadcaster of all, HCJB of Quito, Ecuador, is planning a facility on Hawaii to better reach Asia and the Pacific. Other companies are reportedly considering shortwave stations California, Kentucky, and Florida. Beyond that, whether that strange world above AM, still alien to most in North America, will prove a good place for broadcasters in the 1990's, is yet to be seen.

## SECURITY-CIRCUIT COOKBOOK

*We continue our survey of home-security system principles by looking at sirens, and various types of "fault-indicator" alarms.*

RAY MARSTON

IN OUR MAY ISSUE WE REVIEWED THE basic operating theory and installation principles of home-security systems, and examined several practical security-alarm circuits that give a high degree of protection against fire, burglary, or intruders. All of them had a relay output that can activate an external siren via a pair of relay contacts.

In practice, the siren can also be a bell or buzzer, either electro-mechanical or electronic. The first half of this article describes ways of connecting sensor systems and sirens, and describes some practical circuits, while the second half describes various types of "fault-indicator" alarms.

### Siren configurations

A siren can use the same supply as the actual sensor system it's used with, or each may need separate power. All home-security systems should have battery backup for power outages. If the sensor system and siren use similar voltages, and the sensor system self-latches via relay, both can run off of the same supply, as shown in Fig. 1.

If, however, the sensor system and siren need different supplies or the sensor system doesn't self-latch, they absolutely must have separate supplies, as shown in Fig. 2. A siren induces considerable noise on its supply, which can cause a non-latching alarm to malfunction with one supply.

### Auto-turn-off alarm system

Once a self-latching sensor system is activated, it automatically sounds

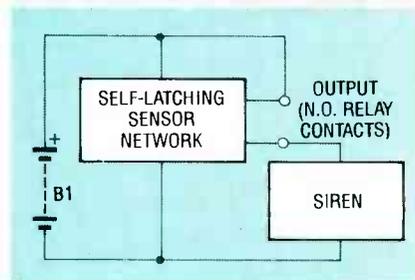


FIG. 1—HOW TO CONNECT A SIREN to a relay-output burglar alarm, with a single supply.

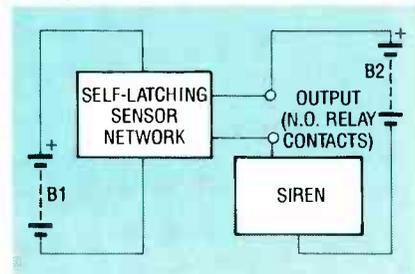


FIG. 2—HOW TO CONNECT A SIREN to a burglar alarm, with double supplies.

the siren until it's reset manually, or the supply is cut off. The main purpose of a siren is to scare off intruders, while alerting the owner and/or neighbors. If that isn't achieved in a few minutes after activation, there's clearly no point in letting the siren to continue to operate. Thus, simple self-latching action tends to be rather inefficient.

A far more efficient type of siren can be obtained by interposing an automatic turn-off timer between the sensor system and siren, as shown in Figs. 3 and 4. Both versions incorporate a relay that closes as soon as an

alarm occurs, but then automatically turns off and disables the siren after some preset period if manual reset hasn't occurred, typically 5–15 minutes maximum. The circuit of Fig. 3 shows how to interconnect the three units when a single supply battery is used, and the circuit of Fig. 4 shows how to accomplish the same for dual supplies.

The circuit of Fig. 5 shows a practical auto-turn-off circuit with a basic timing period of about 8 minutes. The period is proportional to  $C1$ , and can be doubled, for example, by using:  $C1 = 0.2 \mu\text{F}$ . Here, IC1 is a 17-Hz 555 astable multivibrator that feeds clock pulses to IC2, a 14-stage binary counter that changes state on the 8192nd clock pulse.

When power is first applied, the output of IC2 is set low via C2. As the output goes low, RY1 is driven on via Q1, closing the contact. That turns on IC1, which starts operating and feeding pulses to the input of IC2. When the 8192nd clock pulse arrives after about 8 minutes, the output of IC2 flips high and turns relay RY1 off via Q1, shutting off IC1 and the siren, completing operation.

The 8-minute period of the circuit shown in Fig. 5 is fairly long, but is accomplished without resorting to large electrolytic capacitors or resistors. The period is determined by time constant  $R2 \times C1$ , and has excellent repeatability and thermal stability. Note that LED1 is a visual intrusion indicator that lights as long as voltage is present, and it continues to glow even after the siren shuts off. It alerts the owner to the presence of an intruder after the fact, even if no overt disturbance occurred to cause one to take notice during the incident.

### Electronic siren circuits

A siren can be a bell, siren, buzzer, or other sound siren, whether electro-mechanical or electronic. In some cases, two sirens, connected either in parallel or via dual-contact relay may be a good idea. For example, an electronic siren could be used inside a house, while a bell sounds outside. Electronic sirens can take a number of different forms, and can generate very

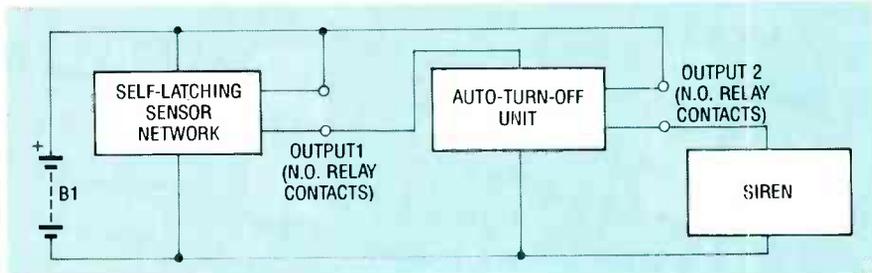


FIG. 3.—CONNECT A SIREN to a burglar alarm via auto-turn-off, with a single supply.

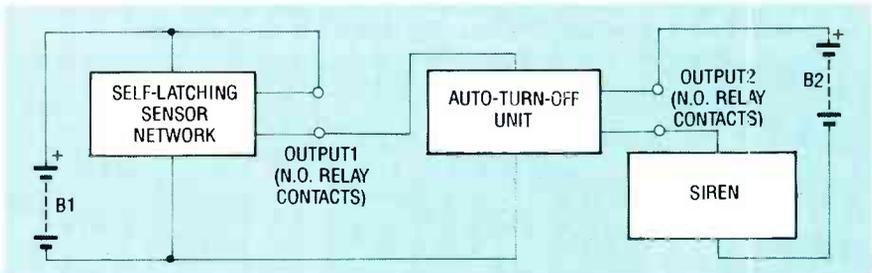


FIG. 4.—CONNECT A SIREN to a burglar alarm via auto-turn-off, with double supplies.

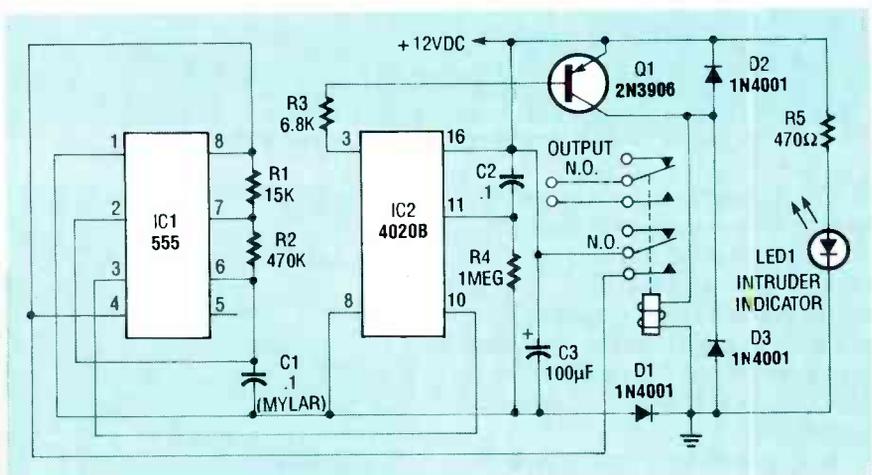


FIG. 5.—AN AUTO-TURN-OFF UNIT with 8-minute delay.

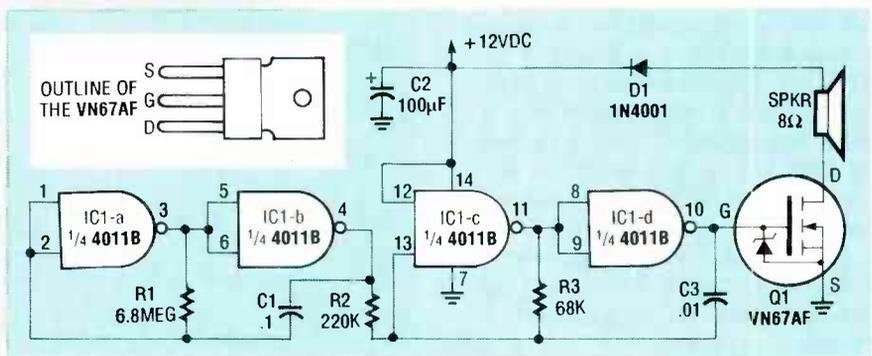


FIG. 6.—WARBLE-TONE 6-WATT SIREN with VMOS output.

distinctive and easily recognizable sounds. The circuits of Figs. 6–8 show three useful versions.

The circuit shown in Fig. 6 generates a warble tone siren. Here, IC1 is a quad CMOS NAND gate, and IC1-a and IC1-b are used to make a simple 1-

Hz astable multivibrator, that alternately gates the 1-kHz astable multivibrator made from IC1-c and IC1-d on and off via pin 8. The resulting warble-tone is amplified by a VN67AFVMOS output stage to generate 6 watts in an 8-ohm speaker.

You can greatly increase the maximum supply voltage and available output power by modifying the design to limit the supply to IC1 to 12 volts DC with a 12-volt zener diode while increasing the speaker supply to 30 volts DC. The version shown in Fig. 6 generates a “dee-dah” warble tone, similar to that of a British police car siren. It generates a maximum of 18 watts into an 8-ohm speaker using 24 volts DC.

The frequency-shift “symmetry” of the circuit shown in Fig. 7 depends somewhat on the individual performance characteristics of IC1. The circuit of Fig. 7 shows an alternate warble-tone generator that doesn’t suffer from this defect. The modulation frequency is varied via R2, and the tone frequency via R5. It uses a pair of 555’s, rather than a single CMOS IC.

Here, IC1 is a 1-kHz astable multivibrator, and IC2 is a somewhat higher-frequency astable multivibrator, around a few kHz. Note that this design is based on the use of a pair of 555 timers, rather than on a single CMOS IC. Here, IC1 is used as a 1-kHz astable multivibrator, while IC2 is used as a higher-frequency astable multivibrator, around a couple of kHz. Astable multivibrator IC1 frequency-shifts IC2 by feeding a square-wave to the pin-5 modulation terminal.

You can generate a variation on that theme, creating a “wailing” tone, alternately rising and falling like that of an American police siren, by using an emitter follower to buffer the 1-Hz “sawtooth” signal of IC1. The sawtooth signal is then fed to pin 5 of IC2, the modulation terminal of the higher-frequency astable multivibrator.

The circuit shown in Fig. 8 generates a “zeep-zeep” tone similar to the “Red Alert” signal on “Star Trek.” The period is varied via R2, and the tone via R6; this is an ideal hobby project. Here, D1 and C2 are used to ensure that the astable multivibrator isn’t adversely affected by voltage transients resulting from the inductive characteristics of the SPKR.

### Touch- and proximity-alarms

A commonly-used home-security technique is that of arranging baited “traps,” like door handles, clocks,

metal trays, etc., in such a way that they sound an alarm whenever they're touched. If the bait is a small metal object, one way of achieving this effect is to use a "hum-detecting" touch sensor system, of the type shown in the circuit shown in Fig. 9.

The circuit shown in Fig. 9 detects the AC hum that's picked up by an electrical contact when it's touched by a human finger, when the individual is in proximity to an AC power line. Here, one of the gates of a CD4001B is used as a simple pulse-inverting amplifier, and has its input terminal connected to the external metal object via R1. This gate is powered by 5 volts DC, derived from 12 volts DC via R2 and R3, and biased via R5 so that its output is normally low.

When a pick-up signal with a peak amplitude greater than a couple of volts appears at the input, the gate output is a 5-volt, 60-Hz square wave, that activates RY1 via Q1-Q2 and D1-C1-R4. Sensitivity-control R5 is adjusted so that RY1 turns on and sounds an alarm when the object is touched, and shuts off when the object is released. Note that the low side of the 12-volt DC supply must be properly grounded. The circuit draws a quiescent current of 1 milliamp. If the object is placed more than 10 cm from the input, the connections to it must use shielded leads, to prevent stray signal pickup.

The circuit of Fig. 10 shows another version; in that case, the object is part of the antenna of an RF oscillator. The circuit uses capacitive-loading, where the gain of the RF oscillator is adjusted so that oscillation is barely sustained, and the antenna is part of the tank circuit; as before, the low end of the supply must be properly grounded. Consequently, any increase in the antenna-to-ground capacitance, like that caused by touching or approaching the antenna, causes enough damping of the tank circuit to reduce the oscillator gain below critical level, cutting off the oscillator, and turning on the siren.

In this case, Q1 is a Colpitts oscillator running at about 300 kHz, with the gain adjusted by R9, and the antenna coupled to the tank circuit via C5. The output of the oscillator is buffered via Q2 and rectified via D1-D2, to produce a positive bias that's fed to the base of Q3. When Q1 is operating normally, Q3 is driven to saturation and Q4 is cut off, turning

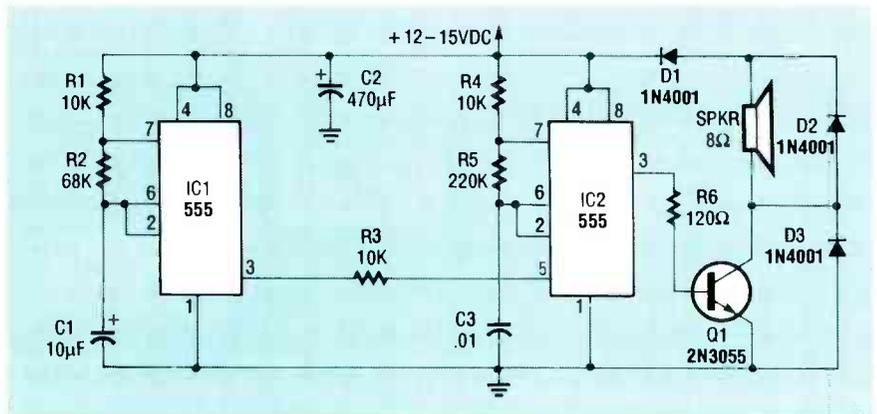


FIG. 7.—ALTERNATE WARBLE-TONE siren like that of a British police car.

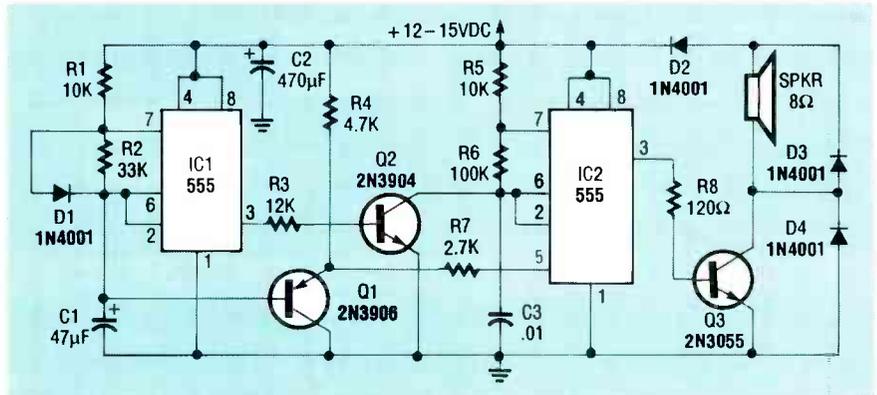


FIG. 8.—"RED-ALERT" SIREN simulating "Star Trek" alarm signal.

off RY1. When the antenna created by the external metal object is touched or additionally loaded, Q1 cuts off, cutting off Q3. In that case, Q4 is positively biased via R8, turning RY1 on and sounding an alarm. Note that transistors Q1 and Q2 are fed using 6 volts DC via D3, ensuring good oscillator stability.

The circuit of Fig. 11 shows an alternate output stage for the circuit shown in Fig. 10, for direct activation of a self-interrupting 12-volt bell or buzzer with a current rating of 2 amps or less via SCR1. Either version is very simple to set up. Connect a suitable antenna, and adjust R9 until RY1 turns on. Back off slightly on R9 so RY1 turns off, then check that the alarm is sounded when the antenna is touched or approached, and off when contact or proximity stops. If necessary, adjust R9 again for maximum sensitivity.

### Sound- and vibration-alarms

Sound-activated alarms can be made to activate when an intruder enters a protected area and creates noise. Vibration-activated alarms can be made to activate when a drawer or cabinet is opened, inducing a small vibration in a protected object. Both

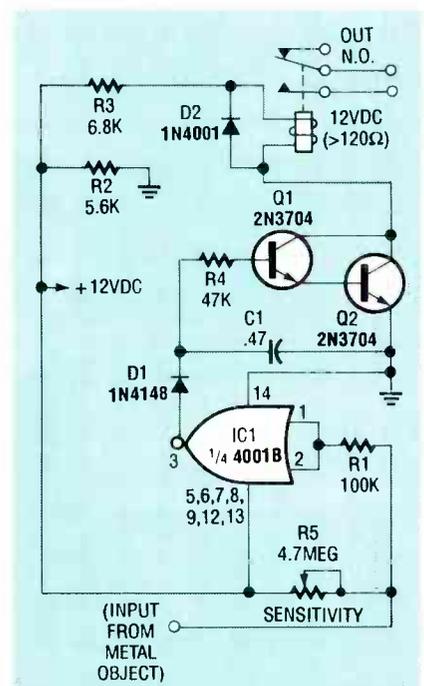


FIG. 9.—"HUM-DETECTING" TOUCH sensor system.

types use the same principle, as shown in the block diagram shown in Fig. 12. In this case, a microphone or other kind of similar transducer picks up the basic noise or vibration, which is then amplified and rectified, and the resulting DC is used to sound an

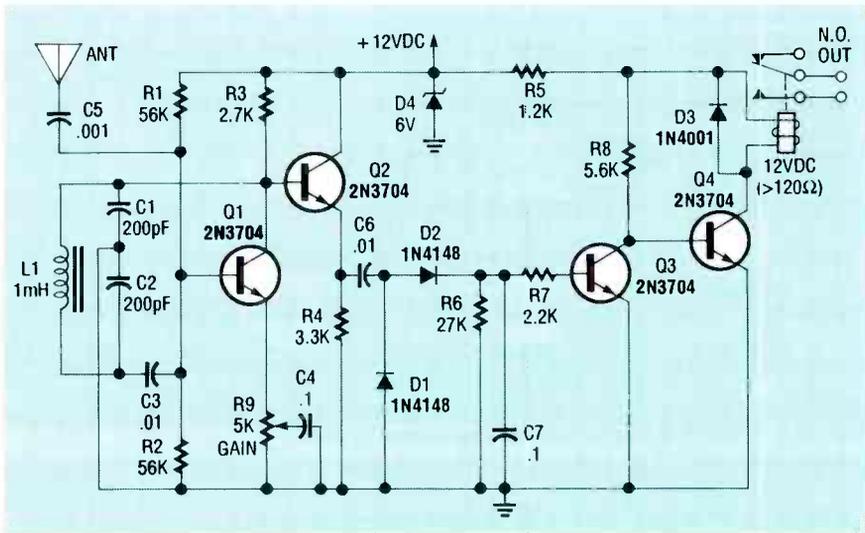


FIG. 10.—RELAY-OUTPUT "PROXIMITY" sensor system.

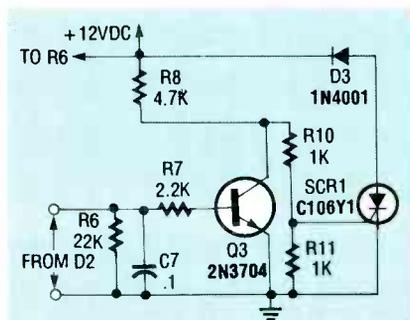


FIG. 11.—ALTERNATE DIRECT OUTPUT stage for the circuit shown in Fig. 13.

alarm.

The circuit of Fig. 13 shows a simple sensor system, that needs about 1-volt RMS to turn on RY1. The circuit action is such that RY1 turns on rapidly when a suitable input signal appears, but turns off slowly when the signal is removed. The turn-off time is determined by time constant  $R1 \times C2$ , which is most easily changed by varying  $C2$ .

That version can be made self-latching by using additional contacts for RY1, placed across Q2 as shown. It can be used as a sound- or vibration-activated sensor system by feeding AC from a pickup transducer, via a suitable amplifier. In vibration-alarms, the amplifier should have a low-pass response, while sound-alarms must operate with a band-pass response.

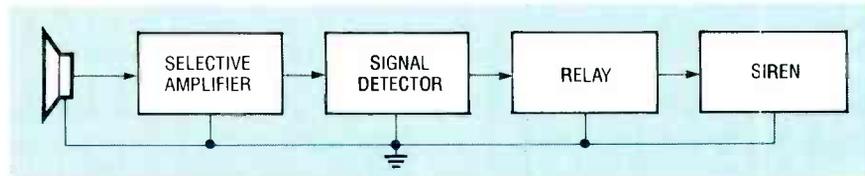


FIG. 12.—BLOCK DIAGRAM OF TYPICAL SOUND- or vibration-sensor system.

The circuit of Fig. 14 shows a practical speech-amplifier circuit to be used in conjunction with the circuit shown in Fig. 13 to make a sensitive sound-activated alarm. The RCA CA3035 IC is an ultra-high-gain wide-band amplifier array, with a voltage gain of 120 dB between pins 1 and 7. In that circuit, R1 and C1 perform biasing, R5 controls gain, and the other components determine bandwidth.

### Flood-alarm systems

One of the many dangers facing the house owner is flooding, like occurs when a water cistern overflows, a water pipe breaks, or rain leaks into a cellar. Fortunately, those dangers can be greatly reduced with the aid of a simple water-activated sensor system, of which the circuits shown in Figs. 15 and 16 are practical versions. Each of the two circuits uses the same basic operating principle, which involves using a pair of metal probes to resistively detect the presence or absence of liquid.

In the absence of liquid, the probes see near-infinite resistance, but when liquid appears across both probes simultaneously, the probe resistance falls to a low value, sounding an alarm. For rain or tap water, the resistance may be less than a few kilohms, but steam or oil may exhibit a higher

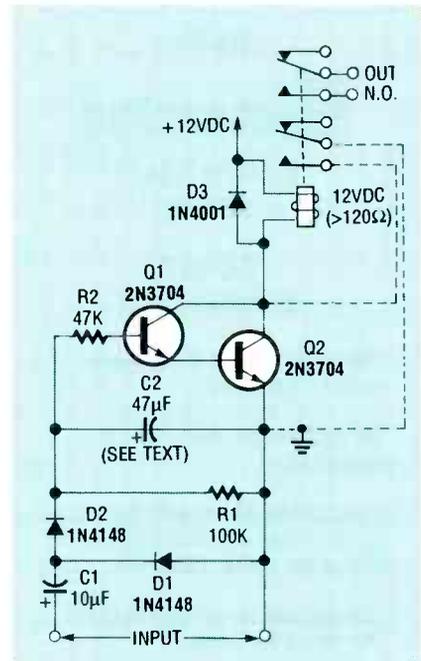


FIG. 13.—SIMPLE RELAY-OUTPUT sound- or vibration-sensor system.

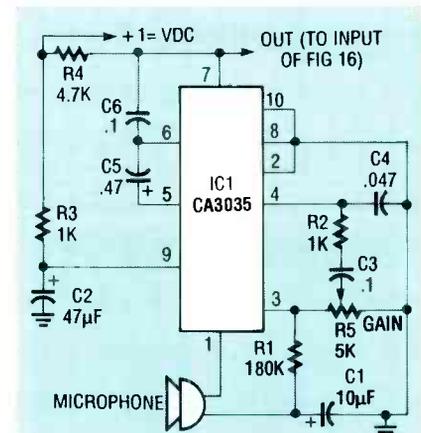


FIG. 14.—SPEECH-FREQUENCY Amplifier used in conjunction with the circuit of Fig. 16 to make a sound-activated sensor system.

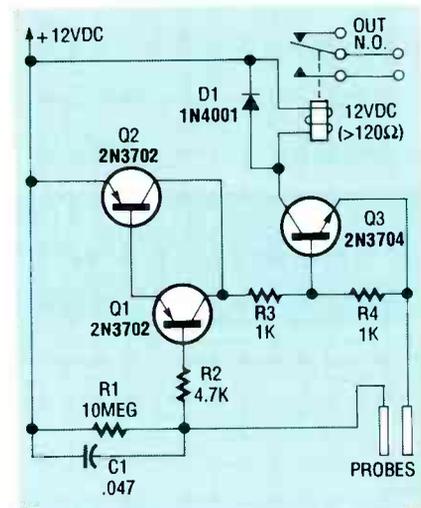


FIG. 15.—SENSITIVE FLOOD-ALARM system with relay output.

Try the  
**Radio-Electronics**

bulletin board  
system

(RE-BBS)  
516-293-2283

The more you use it the more  
useful it becomes.

We support 300 and 1200 baud  
operation.

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

Add yourself to our user files to  
increase your access.

Communicate with other R-E  
readers.

Leave your comments on R-E with  
the SYSOP.

RE-BBS  
516-293-2283

**CONSOLIDATED**  
ELECTRONICS



**THE ULTIMATE  
ELECTRONICS  
CATALOG**

Order your 260 page catalog and price list with over  
14,000 money saving electronic parts and equipment!  
Send \$3.00 in a check or money order, or call  
1-800-543-3568 today and use your Mastercard or Visa.  
Consolidated Electronics, Incorporated  
706 Watervliet Ave., Dayton, Ohio 45420-2599

Name \_\_\_\_\_  
Address \_\_\_\_\_  
City \_\_\_\_\_ State \_\_\_\_\_ Zip \_\_\_\_\_

CIRCLE 70 ON FREE INFORMATION CARD

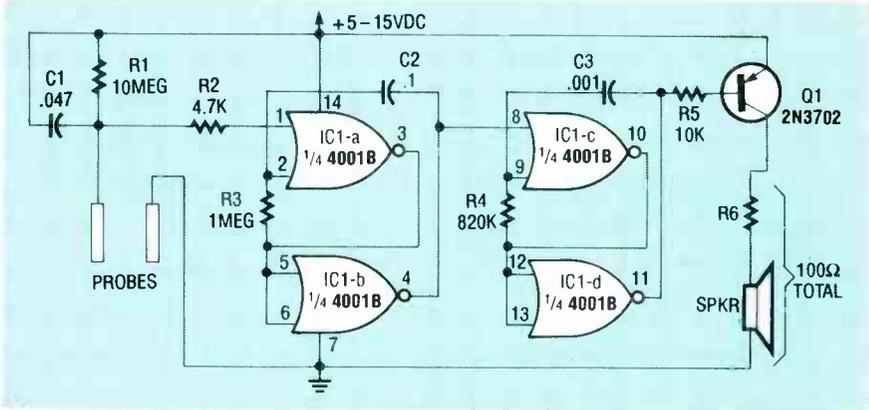


FIG. 16.—SENSITIVE PULSED-TONE flood-alarm system.

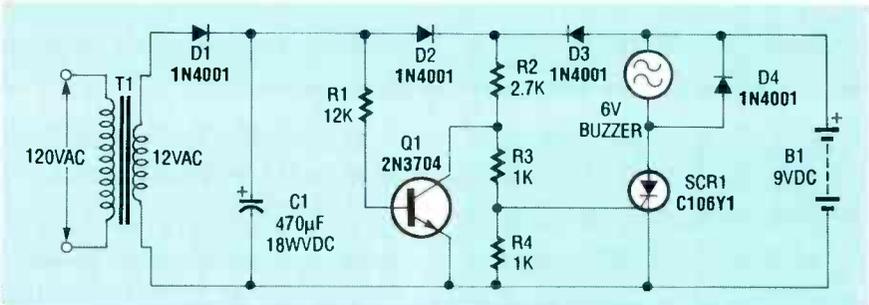


FIG. 17.—BELL/BUZZER POWER-FAILURE ALARM system.

resistance of as much as several  
megohms.

The operation of the circuit shown  
in Fig. 15 is very simple. In the absence of liquid, Q1 is held cutoff via  
R1-R2, so Q2 and RY1 are off also. In  
the presence of liquid, Q1 turns on,  
biasing Darlington pair Q1-Q2 on via  
R3 and turning on RY1, sounding an  
alarm. It turns on when the resistance  
between the probes is under about  
500K, and has a sensitivity of about  
10 megohms, by using a Darlington  
pair in place of Q1. Finally, the circuit  
shown in Fig. 16 generates a pulsed-  
tone alarm when activated, with a  
sensitivity of about 20 megohms,  
consumes about 1 µA of quiescent  
current, and generates an 800-Hz tone  
that's pulsed on and off at a rate of 6  
Hz.

**Power-failure alarm systems**

Electrical-power failure alarms can  
be made to activate when power is  
removed from an electric major appli-  
ance like a freezer, either due to a  
downed power line, or when fuse  
blows. The circuit shown in Fig. 17  
shows a version that trips an alarm via  
RY1. The output winding of trans-  
former T1 is 12-volts RMS, which is  
half-wave rectified by D1, smoothed  
by C1, and fed directly to RY1.

The contacts of RY1 can sound an  
alarm if Normally-Closed (N.C.) are

used. When 120 VAC is applied, RY1  
turns on, the N.C. contacts open, and  
the siren stays off; when power cut  
off, RY1 turns off and the contacts  
close, sounding an alarm. Here, RY1  
can be any 12-volt type with a coil  
resistance of at least 120 ohms, with  
one or more N.C. contacts; trans-  
former T1 needs a current rating of at  
least 100 milliamps.

The secondary winding of trans-  
former T1 is rectified and smoothed  
by D1-C1 to 12-volts DC at the junc-  
tions of D1-D2 and D2-D3. The siren  
is a self-interrupting bell or buzzer  
with current rating of 2 amps or less,  
and is the anode load of SCR1,  
powered by B1.

Normally, when 12-volts DC ap-  
pears at the junctions of D1-D2 and  
D2-D3, Q1 saturates via R1, and the  
junction of R2-R3 junction goes to  
ground. In that case, no drive is ap-  
plied to the gate of SCR1, so the siren  
is off, D3 is reverse-biased, so no cur-  
rent is drawn from B1. When the  
power cuts off during a failure, the  
junction of D1-D2 goes to ground,  
cutting off Q1. That feeds current to  
the SCR gate from B1 via D3-R2-R3,  
turning on SCR1 and sounding an  
alarm. Next month, we'll conclude  
this look at security devices, by exam-  
ining some practical smoke and heat  
alarms, and several different car  
alarms.

R-E

## GAUGES

continued from page 40

### VACUUM GAUGE

All resistors are 1/4-watt, 5%, unless otherwise indicated.

- R1, R2—10,000 ohms
- R3, R8—100,000 ohms
- R4—22,000 ohms
- R5—1000 ohms
- R6—680,000 ohms
- R7, R10—200,000 ohms PC mounted trimmer potentiometer
- R9—82,000 ohms
- R11—50,000 ohms PC mounted trimmer potentiometer
- R12—2200 ohms

### Capacitors

- C1—47  $\mu$ F, 25 volts, electrolytic
- C2, C3—10  $\mu$ F, 35 volts, electrolytic
- C4—0.33  $\mu$ F, 50 volts, stacked film

### Semiconductors

- IC1—Sensym SX30DN vacuum sensor (Dakota Digital #69G18 includes mounting bracket)
- IC2—LM324, quad op-amp
- IC3—LM340T-5, 5-volt regulator
- IC4—CA3132E, A/D converter
- D1, D2—1N4002 diode

**Miscellaneous:** 43B17 main PC board, 2-digit display board, in-line fuse holder, 1-amp fuse, four 6-32  $\times$  0.625" standoffs, eight 5/16-inch #6 screws, bronze or red plexiglass, mounting hardware, hookup wire.

and R8 form a resistive divider that sets the upper reference voltage, with a range of 0.284 to 0.889 volts. The low-temperature calibration is adjusted via R7, while the high-temperature calibration is adjusted via R11. A three-digit display is used, and the annunciator can be anything you "OIL," etc..

The vacuum gauge, shown in Fig. 7, uses a solid-state vacuum/pressure sensor (IC1, Sensym SX30DN) to monitor the intake-manifold vacuum during engine operation. Between 0 and 30 inches (in.) of mercury (Hg.) can be displayed with 1 in. Hg. resolution. The sensor consists of a piezo resistive element housed in a dual ported plastic enclosure. The piezo element changes its resistance as it is flexed or bent. Because a specific amount of flexing is caused by a specific force or pressure, the value of that pressure can be determined by measuring the sensor's resistance. Vacuum has the same effect as it pulls the element instead of pushing it.

The pressure/vacuum sensor (IC1)

### 3-DIGIT DISPLAY BOARD

All resistors are 1/4-watt, 5%, unless otherwise indicated.

- R1, R2—220 ohms
- R3—220 ohms (voltmeter only)

### Semiconductors

- IC1—CA3161E, Display driver
- DISP1—DISP3—0.43" 7-segment C.A. LED display (Panasonic LN514RA)
- Q1—C3—2N3906 PNP transistor
- LED1—5-  $\times$  15-mm LED, (Panasonic LN0202RP)

### 2-DIGIT DISPLAY BOARD

All resistors are 1/4-watt, 5%, unless otherwise indicated.

- R1, R2—220 ohms

### Semiconductors

- IC1—CA3161E, display driver
- DISF1, DISP2—0.43" 7-segment C.A. LED display (Panasonic LN514RA)
- Q1, Q2—2N3906 PNP transistor
- LED—5-  $\times$  15-mm LED, (Panasonic LN0202RP)

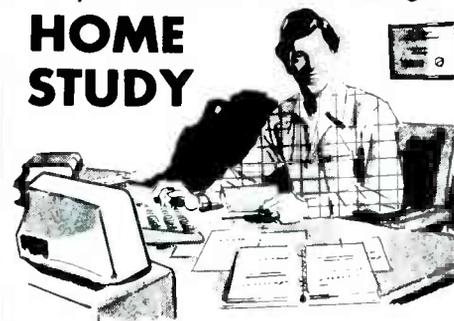
is essentially a bridge circuit with its outputs at pins 2 and 4. Because it is a bridge, its outputs change proportionally to one another when vacuum or pressure is applied. When both ports have the same pressure, the outputs at pins 2 and 4 are identical. As vacuum is applied to port 2, the output at pin 2 rises while pin 4 is reduced. There is now a difference between the two outputs of the bridge, and that difference represents how much vacuum is present.

The first two sections of IC2 are used as buffers to isolate the bridge circuit of IC1. IC2-a is used as a differential amplifier, and R1-R3 and R8 determine the gain. Resistors R6 and R7 are used to offset the differential amplifier so that its normal "zero" output is 0.21 volts above ground. The gain of the differential amplifier is set to give an output approximately 60% higher than that needed by the A/D converter. The voltage level is then reduced by R9 and R10, which is also used to set the full scale of the gauge. The input voltage to the A/D converter is averaged by C3 for stable readings. Resistors R4 and R5 set the 0.21-volt "ground" reference which is buffered at the output of IC2, pin 7. The vacuum value is displayed on a two digit readout. A "VAC" annunciator on the display board indicates the reading of the gauge.

That's all we have room for this month. Next month we'll build and install the gauges.

R-E

## Put Professional Knowledge and a COLLEGE DEGREE in your Technical Career through HOME STUDY



Add prestige and earning power to your technical career by earning your Associate or Bachelor degree through directed home study.

Grantham College of Engineering awards accredited degrees in

**electronics and computers.**

An important part of being prepared to *move up* is holding the right college degree, and the absolutely necessary part is knowing your field. Grantham can help you both ways—to learn more and to earn your degree in the process.

Grantham offers two degree programs—one with major emphasis in **electronics**, the other with major emphasis in **computers**. Associate and bachelor degrees are awarded in each program, and both programs are available completely by correspondence.

No commuting to class. Study at your own pace, while continuing on your present job. Learn from easy-to-understand lessons, with help from your Grantham instructors when you need it.

Write for our free catalog (see address below), or phone us at toll-free 1-800-955-2527 (for catalog requests only) and ask for our "degree catalog."

Accredited by  
the Accrediting Commission of the  
National Home Study Council

**GRANTHAM**  
College of Engineering  
10570 Humbolt Street  
Los Alamitos, CA 90720

JULY 1990

# HARDWARE HACKER

Electronic Melody Chips  
Unusual Book Resources  
Ten Speed Blender Control  
Power Control Fundamentals  
Hacker Interchange Standard

DON LANCASTER

## Power-control fundamentals

AS WE'VE SEEN IN PAST COLUMNS, WITH-  
in a decade we just may reasonably  
expect electronic hardware having  
computation abilities that are as  
complex as those of the human  
brain. Driven primarily by ultra-  
cheap and ultra-dense dynamic  
RAM technology.

Now, admittedly, my timing on  
this might be off by as much as  
twenty minutes in either direction.  
But, things seem to be going even  
faster now than they were even a  
few issues ago.

Several Japanese outfits have now  
actually firmly scheduled their fu-  
ture production of new 256 Meg  $\times$   
17 SIMM chips. And it appears an-  
other level of *threshold effect* just  
might have been crossed with the  
concept of *OOPS* or *object oriented*  
*programming* which is spreading  
like wildfire.

So how can you tune yourself into  
and profit from this near-term in-  
evitability of human brain computer  
functionality?

As usual, those free industry trade  
journals are the answer. In this case,  
the *E.E. Times* is a very good choice.  
They are very big on dynamic RAM  
developments, on neuron comput-  
ing, and on "fuzzy logic" in general.

Cold fusion. This is being written  
on cold fusion's first birthday. Ac-  
cording to today's *Wall Street Jour-  
nal* (April 3, 1990, page B4), "a small  
but growing number of scientists  
believe they are seeing an entirely  
new phenomenon," and "There is  
now a growing consensus that you  
can't explain the excess energy by  
errors." It appears, in fact, that sev-  
eral distinct and valid cold-fusion  
mechanisms might be involved. Six-  
teen laboratories have recently re-  
ported fresh and positive new  
results.

A very interesting report titled as  
*Electricity by Serendipity* appeared  
in the *March 2, 1990* issue of  
*Science*. It describes a new type of  
fuel cell which permits the  
*premixing* of the hydrogen and oxy-  
gen gases, something previously  
thought to be utterly impossible.  
These cells also involve hydrogen  
being absorbed or adsorbed into  
palladium, in cells remarkably sim-  
ilar to the cold-fusion setups.

The obvious unanswered ques-  
tion is "how much of cold fusion's  
excess heat is really this previously  
unknown type of fuel cell?" And  
vice versa.

Our usual reminder here that  
most of the resources mentioned  
have been gathered together into  
the *Names and Numbers* or the  
*Unusual Book Resources* sidebars.  
You can contact all the listees di-  
rectly for more info.

Let's start with a lively topic...

### Printed circuit standard

The editors at *Popular Electronics*,  
*Radio-Electronics*, *Probe*, *Midnight*  
*Engineering*, *Computer Shopper*,  
*Nuts and Volts*, *Byte*, *Audio Ama-  
teur*, and *Circuit Cellar Ink* have all  
been separately grappling with a  
common problem: How can clean  
and accurate printed-circuit layouts  
get easily and cheaply put in the end

user's hands?

Or dialplates, drilling templates,  
detailed test and debug info, soft-  
ware listings, or most any other tech  
writing or tech illustrations?

Putting any of those in the maga-  
zine does take up valuable space,  
and the third-generation pho-  
tocolopies or litho negatives you  
sometimes end up with are often of  
low accuracy and quality. And it sure  
gets hard to make a correction three  
months later on 360,000 already  
printed pages, some of which are  
buried in a lesser-known suburb of  
Moose Jaw, Montana.

On the other hand, the BBS  
downloading will work only if the  
sender and sendee do have fully  
compatible hardware and software.  
What to do?

I would like to suggest an obvious  
solution. It is called an EPS file, and  
is short for *Encapsulated PostScript*.

An EPS file can easily handle any  
printed-circuit board layout, sche-  
matic, isometric or perspective  
drawing, dialplate, or text or graph-  
ics of any sort to any arbitrarily high  
resolution.

The EPS files are extremely device  
independent. Since an EPS file is an  
ordinary ASCII text file, it could easi-  
ly be used with any word processor  
or any editor with any brand of per-  
sonal computer of any age and CPU.

At the output end, an EPS file can  
be used directly on a laser printer,  
by a typesetter, or by a photoplotter.  
With simple and crude emulators  
such as *Freedom of the Press*, *Go-  
Script*, and *UltraScript*, you can also  
print your results on ordinary dot-  
matrix or ink-jet printers, albeit to a  
lower resolution. The latest of fax  
machines are set up to directly han-  
dle EPS files, some to device-inde-

### NEED HELP?

Phone or write your **Hardware  
Hacker** questions to:

Don Lancaster  
**Synergetics**  
Box 809-RE  
Thatcher, AZ, 85552  
(602) 428-4073

pendent resolutions that can exceed 2650 DPI. There is no high-end limit to print quality.

Better yet, practically all of those CAD/CAM and illustration packages either now use PostScript internally or at the very least are capable of generating EPS output files.

The EPS files can also be extremely compact. For instance, a fancy circuit schematic should need no more than a 10K textfile maximum. So, EPS stores cheap and downloads fast.

But what if you are using an expensive or proprietary CAD/CAM or layout package? Surely you could not provide a free copy of these to every reader in the country, could you? Especially if you are on a Mac and they are on a PC.

There is a simple little trick you can pull that is called *pseudo-compiling*. With pseudo-compiling, you might convert any source of PostScript code into a *Just the facts, Ma'am* form that uses nothing except the simplest of put-and-place PostScript commands. Anyone can run a pseudo-compiled EPS file, and absolutely nothing will remain of the original code or the way it was generated.

Better yet, that pseudo-compiled PostScript often will run ridiculously faster than the original. And pseudo-compiling is easily and quickly done by using Adobe System's brand new and cheap *Distillery* program, by one of my *gonzo justification* routines, or your own custom code.

What about screen images? In any broad based user interchange standard, you certainly would not want to use any screen images if they hurt the device independence in any way.

Fortunately, systems using display PostScript or the display PostScript emulation are now becoming readily available, as is software that returns printer bitmaps for screen display. So are programs and applications that internally capture and display EPS.

How does an EPS file differ from an ordinary PostScript textfile listing? Actually by very little. There are a few required remarks at the start of your file plus a few optional ones. And a very few PostScript commands (such as *initgraphics*) are not allowed if they would somehow cor-

rupt the program or system that the EPS file is being imported into. Several other obscure commands (such as *settransfer*) must be carefully saved and restored if they are altered. EPS files are also limited to a single page each, but you can use as many of them as you like.

To get started on all of this, get yourself copies of the *Encapsulated PostScript Files Specification*, v 2.0, and the *Document Structuring Conventions Specification*, v 2.1. Both of them are available free upon request through Cynthia Johnson at *Adobe Systems*, or else through one of the PostScript BBS systems. You should not create or use any EPS files without having these two on hand.

The fundamentals on PostScript are covered by Adobe's blue *PostScript Tutorial* and red *PostScript Reference Manual*, while ready-to-use printed-circuit layout, schematic, isometric, and perspective routines are found in my *PostScript Show and Tell*.

Let me know your thoughts on a standardized hacker interchange approach based on standard EPS file formats.

### AC power control

Most hackers have observed at one time or another, that your typical semiconductor will instantly vaporize if you connect it across the AC power line. Obvious problems here are that the power line is high voltage, high current, and either polarity.

One popular semiconductor that can easily be used as a high-power AC line switch is called a *triac*. A typical on-off circuit is shown in Fig. 1.

A triac has two power terminals called *T1* and *T2*, and a control terminal called the *gate*. A triac remains off until a low-level pulse (usually 5 volts at 50 mA) of either polarity is applied to the gate. The triac then turns on its main terminals and remains on so long as the main current continues flowing in the same direction.

Thus, a triac turns on very shortly after it receives a gate pulse. It stays on until the next zero crossing of the main AC current through it.

When off, the triac can block the full applied line voltage. When on, the triac can conduct several am-

peres with a drop of only a volt or two. A modest heatsink is usually needed to handle the current. Figure a square inch or so for each 50 watts of load.

As a long-term solid-state on-off switch, a triac can handle most any AC load within its current rating, and still work equally well with any style lamp, heater, or motor.

You can pick up an 8-amp triac at *Radio Shack* for \$1.40, and you'll find several low-cost triac selections among our many **Radio-Electronics** advertisers. Three major suppliers of triacs include *Motorola*, *SGS*, and *Texas Instruments*. While all three have lots of triac data books and application notes available, none could even think of holding a candle to the original and classic *GE SCR Manual*, which, sadly, is long out of print.

While triacs are fun to experiment with and easy to use, do note that you are dealing directly with the AC power line. You have an extreme, and possibly lethal, shock hazard.

**NEW FROM  
DON LANCASTER**

**HANDS-ON BOOKS**

Hardware Hacker Reprints II	24.50
Ask The Guru Reprints I or II	24.50
CMOS Cookbook	18.50
TTL Cookbook	16.50
Active Filter Cookbook	15.50
Micro Cookbook vol I or II	16.50
Enhancing your Apple I or II	17.50
AppleWriter Cookbook	19.50
Apple Assembly Cookbook	21.50
Incredible Secret Money Machine	10.50
LaserWriter Reference (Apple)	19.50
PostScript Cookbook (Adobe)	16.50
PostScript Ref. Man. (Adobe)	22.50
PostScript Prog. Design (Adobe)	22.50
Type I Font Format (Adobe)	15.50
Real World Postscript (Roth)	22.50

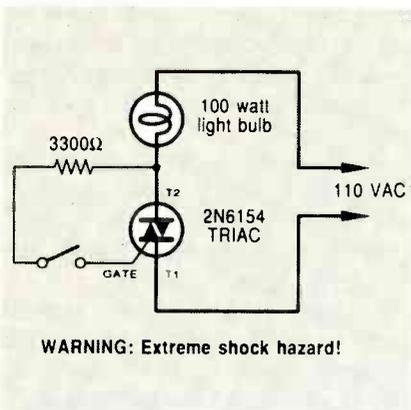
**UNLOCKED SOFTWARE**

LaserWriter Secrets (Ile/Mac/PC)	29.50
PostScript Show & Tell	39.50
Intro to PostScript VHS Video	39.50
PostScript Beginner Stuff	39.50
PostScript Perspective Draw	39.50
PostScript Technical Illustrations	39.50
PostScript BBS stuff	19.50
Absolute Reset Ile & Ilc	19.50
AppleWriter/Laserwriter Utilities	49.50
Enhance I or II Companion Disk	19.50
AppleWriter CB or Assy CB Disk	24.50

FREE VOICE HELPLINE      VISA/MC

**SYNERGETICS**  
Box 809-RE  
Thatcher, AZ 85552  
(602) 428-4073

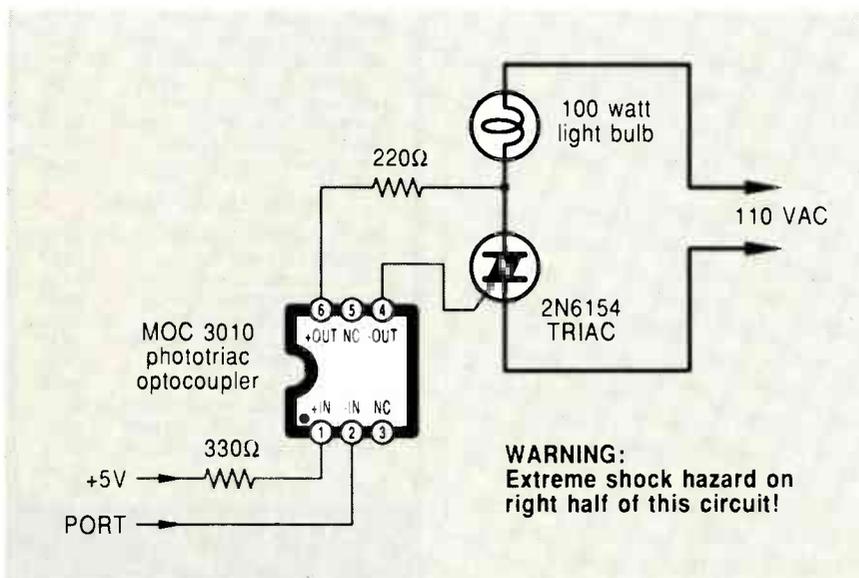
CIRCLE 83 ON FREE INFORMATION CARD



**FIG. 1—A TRIAC CAN BE USED** as a line-operated AC power switch that can directly control lamps, heaters, or motors. A brief and small current pulse into the gate turns the triac on; it remains on until the main current reverses.

Always keep one hand behind your back. Never leave power applied after a test or experiment. And always use an isolation transformer should you want to view any scope waveforms.

Figure 2 shows you one simple computer-to-AC-power interface. You take a special optocoupler known as a *phototriac isolator* and use it as a safety interface. When your computer port goes low, an LED in the isolator turns on, which fires up an internal baby phototriac, that in turn whumps the main triac. That safety isolates your computer from the power line, yet still allows a small logic signal to directly control a kilowatt or more of AC line power.



**FIG. 2—A MICROCOMPUTER-TO-TRIAC** interface uses a phototriac optoisolator to let safety-isolated logic signals directly control high-power loads. Depending upon the input waveforms and the load, this same circuit can be used for either an on-off or a proportional phase control. A low input powers the lamp.

Even with the safety isolation, you still have a severe shock hazard on the right side of Fig. 2.

Observe that the interface works backward from what you'd expect. A low input powers your load, and vice versa. That makes far better use of the micro's current-sinking ports.

Under certain conditions, a triac can be used to control the brightness or speed of your power load. One way to do that is by using *phase control*, such as is shown in Fig. 3. If you precisely delay the gate pulse to some point in the AC half cycle, only partial AC half cycles will get through to the load. Since full power is applied for only part of the time, you end up with an average lower power sent to the load.

But note that phase control will not work with any old power load. Phase control is fine for heaters, soldering irons and other resistive loads, and is really great for incandescent lamp dimming. While phase control can be used to control the speed of a universal AC-DC motor which uses brushes, a slightly fancier feedback circuit that senses the motor back EMF will often work considerably better.

Note that a simple phase control absolutely, positively must *never* be used with a fluorescent lamp or an AC induction motor. While it is possible to use triacs to dim a fluorescent or to control the speed of an induction motor, they need much

fancier and carefully crafted circuits.

Here is how your simple dimmer control works: The *diac* shown consists of two four-layer diodes back to back. It behaves sort of like a neon lamp. It is an open circuit until its terminal voltage gets up to fifty volts or so. Then it will suddenly turn on, dumping the capacitor charge into the triac gate. The diac turns back off when your capacitor is discharged. Varying the brightness control decides how fast the capacitor charges, and thus when in the cycle the triac fires.

The later in the cycle, the less the percentage of the time that power is applied to the load, and the dimmer the lamp. Since this all happens 120 times per second, the repeated off-on actions are well beyond your critical persistence of vision limit, and no flicker will be noticeable. The long thermal inertia of the lamp filament also helps eliminate flicker.

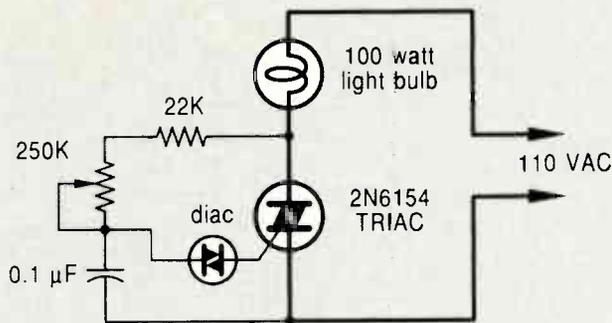
Diac trigger diodes are usually sold by the same sources who supply triacs. These days, though, it is far better to digitally generate all the power line phase delays by either using a micro-processor or a custom power control chip. One example might be...

### Touch-controlled blender

Certainly one of the most obscure and low-profile IC chip houses is *LSI Systems*. Yet, those folks do have an outstanding selection of the low-cost hacker integrated circuits. They are particularly strong in AC power controls, counters, timers, delay circuits, electronic locks and melody chips.

Figure 4 shows you their LS3714 chip as it's used for a ten-speed touch-controlled blender. It can also be used for a ten-level dimmer. Cost in singles is a mere \$2.75, dropping to seventy cents in production quantities.

There are eleven touch plates used; touching any one sets that selected power level to the load. Their circuit consists of a touch-sensitive one-of-eleven latch which selects and remembers your desired power level. That level is converted into a phase angle which determines when to fire the main power-control triac. A reference input on pin 12 synchronizes an internal phase locked loop to the power line zero crossings. Double resistors are



**WARNING: Extreme shock hazard!**

**FIG. 3—A PHASE-CONTROLLED DIMMER** delays the triac turn-on to a selected point in each successive AC half cycle. Use this circuit **ONLY** for incandescent lamps, heaters, soldering irons, or “universal” motors that have brushes.

used on the touch plates as a safety feature.

The active touch-plate inputs can also double as LED output drivers,

thus lighting one-of-ten selected LED lamps to show your current power or speed level. I have left the RFI noise filter off the output to

keep our circuit simple here. You can also customize all of your firing angles to improve linearity for your selected load. Consult the data sheet for full details on these extras.

### Play a simple melody

As an entirely different LSI Systems circuit, Fig. 5 shows you a LS3404 melody chip. There are 31 melodies in stock, and you can also customize your own (in large quantities) tunes up to 255 notes long.

The envelope of each note gets adjusted to an exponential decay to produce a high-quality, chime-like tone. The circuit shuts off after each tune. The operating current is five mils. Pitch is set by the RC values at pin 5. Decay time is set at pin 3. Pin 4 sets the tempo.

Be sure to get a complete set of LSI data sheets. These folks do have over three dozen low-cost chips that cry out for new hacker uses. What can you come up with here?

## UNUSUAL BOOK RESOURCES

### Antique Radio Books

498 Cross Street  
Carlisle, MA 01741  
(508) 371-0512  
CIRCLE 226 ON FREE INFORMATION CARD

### AEE Energy Books

PO Box 1026  
Lilburn, GA 30226  
(404) 925-9558  
CIRCLE 227 ON FREE INFORMATION CARD

### ASM International

9639 Kinsman Road  
Materials Park, OH 44073  
(800) 368-9800  
CIRCLE 228 ON FREE INFORMATION CARD

### Computer Literacy Bookshop

2590 N First Street  
San Jose, CA 95131  
(408) 435-1118  
CIRCLE 229 ON FREE INFORMATION CARD

### Dialog Information Service

3460 Hillview Avenue  
Palo Alto, CA 94304  
(415) 858-2700  
CIRCLE 230 ON FREE INFORMATION CARD

### Educational Products

PO Box 606  
Mineola, NY 11501  
(516) 689-8409  
CIRCLE 231 ON FREE INFORMATION CARD

### Frontier Space Books

240 Foshay Tower  
Minneapolis, MN 55402  
(800) 245-8627  
CIRCLE 232 ON FREE INFORMATION CARD

### H&A Industries

Rt 2 Box 35E  
Bowling Green, MO 63334  
CIRCLE 233 ON FREE INFORMATION CARD

### Lindsay Publications

PO Box 12  
Bradley, IL 60915  
(815) 468-3668  
CIRCLE 234 ON FREE INFORMATION CARD

### MIX Bookshelf

6400 Hollis St Ste 12  
Emeryville, CA 94608  
(800) 233-9604  
CIRCLE 235 ON FREE INFORMATION CARD

### Omega Engineering

One Omega Drive  
Stamford, CT 06907  
CIRCLE 236 ON FREE INFORMATION CARD

### Real Goods

966 Mazzoni Street  
Ukiah, CA 95482  
(800) 762-7325  
CIRCLE 237 ON FREE INFORMATION CARD

### SAE

400 Commonwealth Dr  
Warrendale, PA 15096  
(412) 776-4841  
CIRCLE 238 ON FREE INFORMATION CARD

### SignCraft

1938 Hill Avenue  
Fort Myers, FL 33901  
(813) 939-4644  
CIRCLE 239 ON FREE INFORMATION CARD

### Singing Wind Bookshop

Ocotillo Road Box 2197  
Benson, AZ 85602  
(602) 586-2425  
CIRCLE 240 ON FREE INFORMATION CARD

### Stanford Bookstore

135 University Avenue  
Palo Alto, CA 94305  
(800) 533-2670  
CIRCLE 241 ON FREE INFORMATION CARD

### Synergetics

Box 809  
Thatcher, AZ 85552  
(602) 428-4073  
CIRCLE 242 ON FREE INFORMATION CARD

### Whole Earth Review

27 Gate Five Road  
Sausalito, CA 94965  
(415) 332-1716  
CIRCLE 243 ON FREE INFORMATION CARD

**PACKARD BELL**  
America grew up listening to us. It still does.

**PACKMATE 286 COMPUTER WITH HIGH RESOLUTION VGA COLOR MONITOR**



- 80286 microprocessor (operates at 12 MHz).
- One 3-1/2" 1.44 MB floppy drive.
- One 5-1/4" 1.22 MB floppy drive.
- 30 MB hard drive.
- 1 MB RAM on motherboard expandable to 3 MB.
- High resolution monitor: 640 x 480. 256 colors.
- Includes VGA 14" color monitor & VGA card.
- IBM compatible.
- AT compatible.
- 8 expansion slots.
- Dual FDD/HDD controller.
- 2 half height drive cavities exposed.
- 1 half height drive cavity enclosed.
- 2 serial ports.
- 1 parallel port.
- Zero wait state.
- Real time clock/calendar.
- System configuration in CMOS with battery back-up.
- AT style 101 key professional keyboard.
- Small footprint.
- Included software: MS DOS 3.3 and GW BASIC.
- 145W Universal power supply.
- Socket for 80287 co-processor on motherboard.
- One Year Warranty!
- Factory New!
- Factory Perfect!

Manufacturer's Suggested Retail

**\$3,499.00**

**DAMARK PRICE:**

**\$1499<sup>99</sup>**

Item No. B-2093-132142  
Insured Ship/Hand.: \$40.00

**FOR FASTEST SERVICE CALL TOLL FREE**

**1-800-729-9000**



DAMARK INTERNATIONAL, INC.  
6707 Shingle Creek Parkway, Minneapolis, MN 55430  
Customer Service • 612-566-4940

Please rush me:  Packard Bell Computer(s)  
@ \$1499.99 each, plus \$40.00 s/h each.  
Item No. B-2093-132142  
MN res. add 6% sales tax.

Name \_\_\_\_\_  
Address \_\_\_\_\_  
City, State, Zip \_\_\_\_\_  
 Check/MO  VISA  MasterCard  Discover  
Card No. \_\_\_\_\_  
Exp. Date \_\_\_\_\_ / \_\_\_\_\_ Ph. # ( ) \_\_\_\_\_  
Signature \_\_\_\_\_

**DELIVERY TO 48 U.S. STATES ONLY**

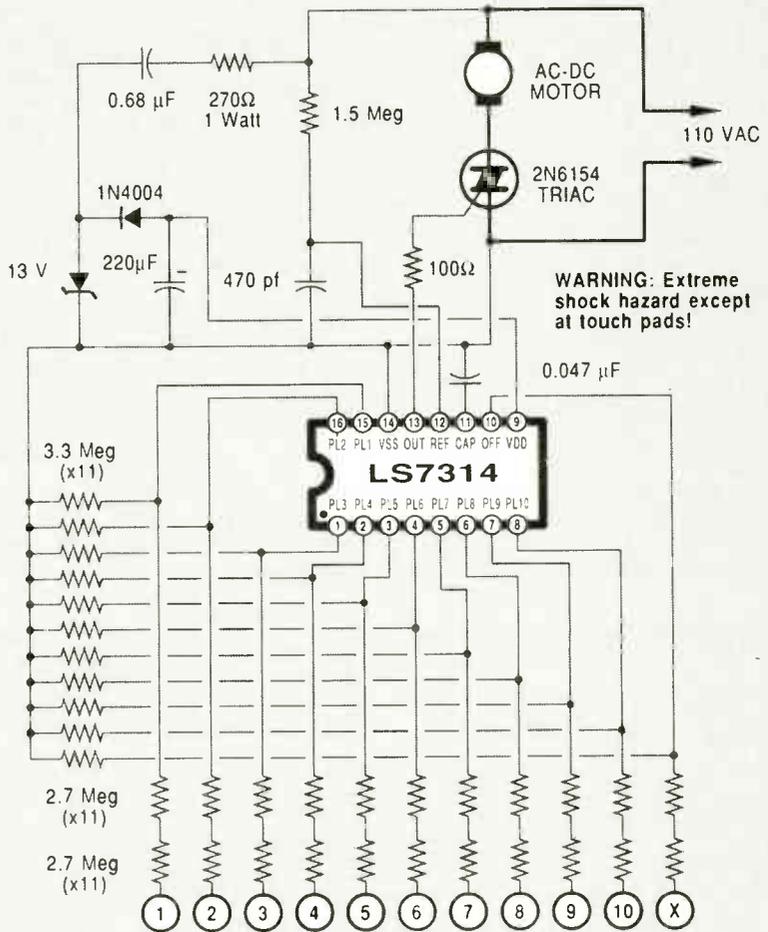


FIG. 4—A 10-SPEED TOUCH-CONTROL BLENDER circuit that uses the low-cost LS7314 chip by LSI Systems. The eleventh touch pad is for power off.

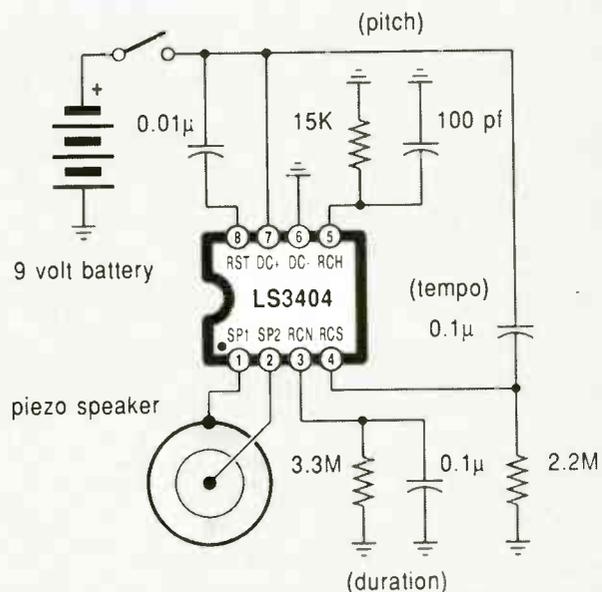


FIG. 5—A HIGH-QUALITY MELODY circuit. The slow decay waveforms produced will create chime-like notes. Pitch, tempo, and duration are all adjustable.

**Unusual book resources**

I feel that the best possible way for hackers to keep and stay in-

formed is to aggressively expose themselves to the industry trade journals. And the second best is

through creative use of on-line access services, most especially the *Dialog Information Service*.

But technical and any other un-

usual books certainly have their place. As you might have noticed, mall storefronts that have a sign out front that says "book store" are

#### NAMES AND NUMBERS

##### Adobe Systems

1585 Charleston Road  
Mountain View, CA 94039  
(415) 961-4400

CIRCLE 245 ON FREE INFORMATION CARD

##### Celtec/Vycom

Greenwood Ave & Warner St.  
Scranton, PA 18505  
(717) 346-8254

CIRCLE 246 ON FREE INFORMATION CARD

##### Ron Charles & Associates

PO Box 805  
Wilmette, IL 60091  
(708) 251-4777

CIRCLE 247 ON FREE INFORMATION CARD

##### Compliance Engineering

629 Massachusetts Ave.  
Boxborough, MA 01719  
(508) 264-4208

CIRCLE 248 ON FREE INFORMATION CARD

##### EE Times

600 Community Drive  
Manhasset, NE 11030  
(516) 365-4600

CIRCLE 249 ON FREE INFORMATION CARD

##### Freedom of the Press

900 Tech Park Drive #8  
Billerica, MA 01821  
(800) 873-4367

CIRCLE 259 ON FREE INFORMATION CARD

##### GoScript/LaserGo

9369 Carroll Park Dr. #A  
San Diego, CA 92121  
(619) 450-4600

CIRCLE 260 ON FREE INFORMATION CARD

##### Hosfelt Electronics

2700 Sunset Blvd  
Steubenville, OH 43952  
(800) 524-6464

CIRCLE 261 ON FREE INFORMATION CARD

##### Intel

3065 Bowers Ave  
Santa Clara, CA 95051  
(408) 987-8080

CIRCLE 262 ON FREE INFORMATION CARD

##### JerryCo

601 Linden Place  
Evanston, IL 60202  
(708) 475-8440

CIRCLE 263 ON FREE INFORMATION CARD

##### Komacel, Inc

535 N Midland Ave  
Saddle Brook, NJ 07662  
(201) 791-1511

CIRCLE 264 ON FREE INFORMATION CARD

##### Lazer Products

12741 East Caley Ave #130  
Englewood, CO 80155  
(303) 792-5277

CIRCLE 265 ON FREE INFORMATION CARD

##### LSI/CSI

1235 Walt Whitman Rd  
Melville, NY 11747  
(516) 271-0400

CIRCLE 266 ON FREE INFORMATION CARD

##### Motorola

5500 E McDowell Road  
Phoenix, AZ 85008

CIRCLE 267 ON FREE INFORMATION CARD

##### NEC

401 Ellis Street  
Mountain View, CA 94039  
(800) 632-3531

CIRCLE 268 ON FREE INFORMATION CARD

##### SGS-Thompson

1000 E Bell Road  
Phoenix, AZ 85022  
(602) 867-6259

CIRCLE 269 ON FREE INFORMATION CARD

##### Surplus Center

1015 West "O" Street  
Lincoln, NE 68501  
(800) 228-3407

CIRCLE 270 ON FREE INFORMATION CARD

##### Texas Instruments

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

CIRCLE 271 ON FREE INFORMATION CARD

##### Ultrascript/QMS

PO Box 81250  
Mobile, AL 36689  
(205) 633-4300

CIRCLE 272 ON FREE INFORMATION CARD

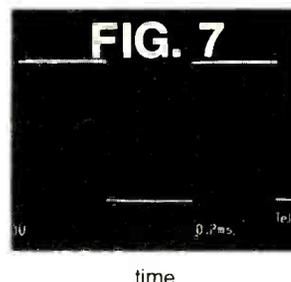
##### Unitrode

580 Pleasant Street  
Watertown, MA 02172

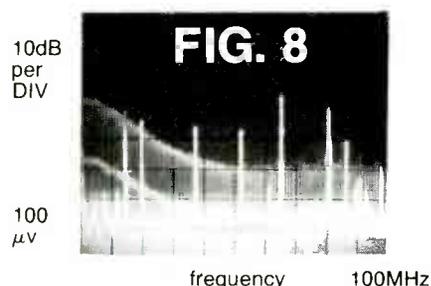
CIRCLE 273 ON FREE INFORMATION CARD

## finding DIGITAL waveform PROBLEMS

The frequency domain approach can often show problems clearly, which only close examination in the time domain with exotic equipment will reveal.



For example, a circuit used for digital scope evaluation appears to produce the square wave of a 4-bit counter. The signal has a fast risetime (around 1 ns.) and some overshoot like that found in any digital system. This viewed on an analog 100 MHz scope is shown in fig. 7. Looks conventional, doesn't it?



The same signal is then applied to the Spectrum Probe™. (20 dB atten. added to keep RF components within the logarithmic range.) Two major problems are visible in fig. 8. Why are very high spectral line levels present which are approximately 15 MHz. apart? The other problem, which can't be shown easily in the photo, is the alternating amplitude of the spectral line components — which indicates that significant low frequency components are present in the signal.

**107 SPECTRUM PROBE<sup>®</sup>**

converts your scope into a  
**100MHz spectrum analyzer**

**\$199** direct

**Smith Design** 1324 Harris  
Dresher, PA 19025 (215) 643-6340

CIRCLE 182 ON FREE INFORMATION CARD

## DIGITAL VIDEO STABILIZER ELIMINATES ALL VIDEO COPY PROTECTIONS



While watching rental movies, you will notice annoying periodic color darkening, color shift, unwanted lines, flashing or jagged edges. This is caused by the copy protection jamming signals embedded in the video tape, such as Macrovision copy protection. Digital Video Stabilizer: RXII completely eliminates all copy protections and jamming signals and brings you crystal clear pictures.

### FEATURES:

- Easy to use and a snap to install
- State-of-the-art integrated circuit technology
- 100% automatic - no need for any troublesome adjustments
- Compatible to all types of VCRs and TVs
- The best and most exciting Video Stabilizer in the market
- Light weight (8 ounces) and Compact (1x3.5x5")
- Beautiful deluxe gift box
- Uses a standard 9 Volt battery which will last 1-2 years.

### WARNING :

**SCO Electronics and RXII dealers do not encourage people to use the Digital Video Stabilizer to duplicate rental movies or copyrighted video tapes. RXII is intended to stabilize and restore crystal clear picture quality for private home use only.**

(Dealers Welcome)

To Order: \$49.95 ea + \$4 for FAST UPS SHIPPING

**1-800-445-9285 or 516-694-1240**

Visa, M/C, COD M-F: 9-6 (battery not included)  
SCO ELECTRONICS INC.

Dept. CBY7 581 W. Merrick Rd. Valley Stream NY 11580  
Unconditional 30 days Money Back Guarantee

CIRCLE 193 ON FREE INFORMATION CARD

## CABLE TV DESCRAMBLER



	1 Unit	10 +
Jerrold S.B. ....	\$74	.....\$55
Jerrold SB w/Trimode.....	\$90	.....\$70
Oak N-12 (w/VS).....	\$89	.....\$65
Scientific Atlanta.....	\$109	.....\$75
Pioneer.....	\$109	.....\$75
Panasonic converter.....	\$98	.....\$79
73 channel converter.....	\$79	.....\$59

### We Beat Anyone's Price!

30 Days Money Back Quaranty

Free Catalog

Visa, M/C, COD or send money order to:

**US Cable TV Inc.** Dept. KCT7  
4100 N. Powerline Rd., Suite F-4  
Pompano Beach, FL 33073

**1-800-445-9285**

Please have make and model number of the equipment used in your area ready.

**No Florida Sales!**

It's not the intent of US Cable TV Inc. to defraud any pay TV operator and we will not assist any company or individual in doing so.

CIRCLE 194 ON FREE INFORMATION CARD

often less than useless. And publisher's catalogs carry only their own titles, many of which may be "me too" or appallingly bad.

Instead, you really have to expose yourself to sources that have a vested interest in stocking a wide selection of the best books on special topics.

As your resource sidebar for this month, I have tried to show several sources of unusual books that I've personally found of interest. Let's do a quick rundown...

The foremost source for hacker titles has to be *Lindsay Publications*, who stock an amazing variety of mechanical, machine shop, antique radio, craft, and weird science titles. For automotive electronics, nobody can beat *SAE*. And for electronic music, the *MIX Bookshelf* is first rate.

For astronomy and space books, try *Frontier Space Books*. For robotics, use *Educational Products*. For all the alternate energy and self-reliance, try *Real Goods*. For establishment energy and conservation stuff, *AEE Energy Books*. For signmaking, it's *SignCraft*. For metals and properties of materials, *ASM International*.

It appears that two of the finest technical bookstores in the country are across the street from each other. So, you will want to check out both the *Stanford Bookstore* and the *Computer Literacy Bookshop*. For a direct-mail source of most technical and industrial titles, you also may want to check out *Omega Engineering*.

By far the best place I've found for in-depth reviews of all unusual and genuinely useful books is the quarterly *Whole Earth Review*. I cannot say enough good things about these wonderful folks.

I try to stock my own titles and only the very best PostScript titles of others in my own *Synergetics*.

It seems I've always been attracted to what I call "Tain't Likely McGee" publications on Tesla-was-an-alien free energy, perpetual motion, Pogue carburetors, Newmann engines, and similar off-the-wall goodies. Although Lindsay stocks and honestly reviews a few of these titles, a second and more typical source would be *H&A Industries*.

As a final favorite of mine, *Singing Wind* does specialize in the West-

ern Americana, Southwest Literature, lost mine lore, and an otherwise amazingly eclectic collection of arcania. Since *Singing Wind* has an unlisted address, getting there is half the fun. If you're not one of their kind of people, you'll never find the place.

Well, maybe one hint. Go north on Ocotillo Road out of Benson, Arizona till it feels about right. Then turn right just beyond the seventh cow. Keep the gates the way you find them.

Tellyawhat. I'm sure I've missed plenty of good sources for unusual books. For this month's contest, just tell me about some other genuinely useful place to find specialized or oddball titles. Do include a mailer if possible. We will have a dozen *Incredible Secret Money Machine* book prizes, along with an all-expense-paid (FOB Thatcher, AZ) *tinaja quest* for two going to the very best.

As usual, send all of your written entries directly to me at *Synergetics*, rather than to **Radio-Electronics**.

### New tech literature

Free data books for this month include the *Product Selection Guide* from *NEC* on memory, micros, peripherals, and telecom chips; the *i486 Microprocessor* from *Intel*; and the new *Semiconductor Databook and Application Notes* from *Unitrode*.

Two surplus catalogs having great pricing are available through *Hosfelt Electronics* for electronic goodies; and *Surplus Center* for pneumatics, hydraulics, and larger motors.

*Compliance Engineering* is an unusual trade journal aimed at helping you meet FCC and similar specs. They have a free supplement *Direct Connection: Interfacing to the Telephone Network* available just for you. Ask for Application Note #102.

Reasonably priced vacuum forming machinery is available through *Ron Charles & Associates*. While intended for hobby modelmaking, there should be lots of hacker uses involving prototypes and limited production runs.

Two interesting new prototyping and model materials are the *Komacel* and *Celtec* foamed vinyls. Free samples are available.

The bargain of the month has to  
(Continued on page 81)

# AUDIO UPDATE

## Taking care of your tapes

CONSIDERING THE RECENT FLOOD OF audio-video components into the marketplace and the very successful efforts made to upgrade video sound, I think it is not inappropriate to devote a column to the care and storage of audio *and* video tapes. Current opinion is that, given reasonable care, the audio and video tapes you made last month should be playable by your children's children—assuming that compatible machines are still available. The major causes of tape deterioration—which I'll discuss in order—are heat, humidity, dirt, stray magnetic fields, and improper handling.

### Heat

Whether blank or recorded, tapes ideally should be stored at a *constant* temperature of, say, 21° Celsius (70° Fahrenheit). The constancy of the temperature is more important than its actual value, because large temperature swings cause expansion and contraction of the tape's base (backing) material. That could result in its permanent deformation as well as oxide shedding. So, avoid leaving tapes in attics or locked cars and keep them away from air conditioners, radiators, heating vents, and direct sunlight.

### Humidity

For archival storage, a *constant* humidity of about 15 percent is recommended, but in a typical home the humidity is likely to be far lower in winter and higher in summer. In any case, don't store your audio and videocassettes in a damp basement, and if you've been videotaping out of doors on a cold day, give your tape (and recorder) an hour or so to



FIG. 1—THESE VIDEOCASSETTE REWINDERS will save your VCR from excess wear and tear.

reacclimate to the indoor temperature before use.

### Dirt

Storage sleeves are designed to guard videocassettes against the intrusion of dust and dirt, and they do a pretty good job. But when a cassette is loaded into a VCR, its tape and internal mechanisms are somewhat exposed. It follows, therefore, that it's wise to keep the VCR (and tape-storage area) as dust-free as possible. It also follows that you shouldn't leave a tape "stored" in the VCR unless, of course, you have it set up for timer recording.

There's a certain amount of oxide-coating shedding from any tape during the recording and playing process, but the better the tape, the less it sheds. Modern high-grade audio and videotapes are extremely "clean" in this regard. Unfortunately, the tape stock used for some prerecorded audio and video cassettes is not as high a quality as it might be.

Although there are perhaps a

dozen different brands of video head cleaners on the market, most from reputable companies, many technicians strongly advise against their use. In their view, the only way to thoroughly clean a VCR while avoiding excessive head wear or damage is to return the machine to a factory-authorized service center for cleaning. My own view is that a wet or dry head-cleaning videocassette from a reputable company is unlikely to cause problems if used precisely according to instructions and *only* when a grainy or lost picture shows that its services are needed. As I mentioned, head clogging is rare when new high-grade tapes are used.

If I had followed the advice of those who advocate factory service, by now I would have paid for at least seven or eight cleanings of my old VCR (at perhaps a \$50 to \$75 a shot) in addition to the inconvenience of getting it to and from the service organization, and not having it available for use while being serviced. Since my older machine doesn't



LARRY KLEIN,  
AUDIO EDITOR

# Be an FCC LICENSED ELECTRONIC TECHNICIAN!



No costly School. No commuting to class. The Original Home-Study course prepares you for the "FCC Commercial Radio-telephone License". This valuable license is your "ticket" to thousands of exciting jobs in Communications, Radio-TV, Microwave, Computers, Radar, Avionics and more! You don't need a college degree to qualify, but you do need an FCC License. **No Need to Quit Your Job or Go To School** This proven course is easy, fast and low cost! **GUARANTEED PASS** — You get your FCC License or money refunded. **Send for FREE facts now. MAIL COUPON TODAY!**

## COMMAND PRODUCTIONS

FCC LICENSE TRAINING, Dept. 90  
P.O. Box 2824, San Francisco, CA 94126

Please rush FREE details immediately!

NAME \_\_\_\_\_  
ADDRESS \_\_\_\_\_  
CITY \_\_\_\_\_ STATE \_\_\_\_\_ ZIP \_\_\_\_\_

seem to have suffered any ill effects from years of at-home cleanings, it's clear that the money saved by a good head-cleaning cassette more than compensates for any additional head wear it might cause.

### Stray magnetic fields

Because the video picture and audio sound are embodied on a tape in the form of complex magnetic patterns, anything that disrupts those patterns—such as strong external magnetic fields—should be avoided. Therefore, don't store tapes close to or on top of sources of magnetic energy such as loudspeakers, amplifiers, and any other electronic component that has a large power transformer. A distance of two to three feet from potential problem areas should be more than adequate. Incidentally, I've heard of cases in which vacuum-cleaner motors caused partial tape erasure, so be careful when cleaning the tape-storage area.

### Handling

Some experts advise that stored open-reel tapes and audio and video cassettes be "exercised" by fast-

forwarding and rewinding them at least once a year. The purpose is to prevent possible print-through of the audio track and/or adhesion between tape layers. It seems to me that there is no harm in such a tedious procedure, but before you embark on such a long-and-winding road for video, I suggest investing in a videocassette winder, which will speed the process and save wear and tear on your VCR.

The ultra-cautious also suggest storing audio and video tapes in just-played condition (rather than rewound to the beginning, as video-rental places prefer). Their reasoning is that during normal play, tape tension is better distributed throughout the tape layers because of the slow playing speed and because video play is under direct servo control by the VCR, unlike during tape winding. Storage after play *without* rewinding is the practice followed by audio recording studios with their open-reel master tapes. However, its relevance to cassettes, audio or video, is unclear.

It's also generally advised that tapes be stored vertically to avoid possible damage to the tape edges. However, I suspect that the advice is simply a holdover from open-reel days when the tape "pack" would droop toward the bottom flange if the tape were stored horizontally. The tape pack in cassettes is smaller, lighter, and better positioned by its enclosing shells.

I should admit that I tend to leave my tapes unexercised, sometimes half-wound, out of their storage cases, and stored every which way. And in thirty-odd years I've never experienced any audio or video tape problems clearly caused by my negligence. Then again, maybe I've been lucky or simply haven't noticed. **R-E**



"What's the penalty for not rewinding tapes?"

# VALUE PRICING ON KENWOOD OSCILLOSCOPES FROM Joseph ELECTRONICS

- DIGITAL READOUT
- DELAYED SWEEP
- VIDEO CLAMP
- CURSOR FUNCTIONS
- HIGH SENSITIVITY
- AUTOMATIC TRIGGERING
- HIGH RESOLUTION 12 KV CRT
- 2-YEAR WARRANTY

Model CS-5170



Call Joseph Electronics for value quotes on all KENWOOD models.

KENWOOD "The Company You've Been Listening To For Years."

**40 MHz DUAL-CHANNEL OSCILLOSCOPE**

VERTICAL MODE CH1, CH2, DUAL (ALT, CHOP), ADD  
SENSITIVITY 1mV/DIV to 5 V/DIV IN 12 RANGES  
HORIZONTAL MODE A, ALT, B, X-Y  
SWEEP TIME A 0.2µS TO 0.5 S/DIV ±3% (20 ranges)  
B 0.2µS TO 50mS ±3% (17 ranges)

TRIGGER SOURCE VERT MODE, CH1, CH2, EXT, LINE  
TRIGGER MODE AUTO, NORM, FIX, SINGLE-RESET  
COUPLING HF rej, DC, TV FRAME, TV LINE  
PROBES 2 PC-33 PROBES Included

**100 MHz 2-CHANNEL 4-TRACE OSCILLOSCOPE**

VERTICAL MODE CH1, CH2, ALT, CHOP, ADD  
SENSITIVITY 1mV/DIV to 5 V/DIV IN 12 RANGES  
HORIZONTAL MODE A, ALT, B, X-Y  
SWEEP TIME A 0.5µS TO 0.5 S/div ±3% (22 ranges)  
B 0.5µS TO 50mS/div ±3% (19 ranges)

TRIGGER SOURCE VERT MODE, CH1, CH2, EXT, LINE  
TRIGGER MODE AUTO, NORM, FIX, SINGLE-RESET  
COUPLING AC, HF rej, DC, TV FRAME, TV LINE  
PROBES 2 PC-31 PROBES Included

Model CS-5130  
Reg. \$1095 **\$899**

**\$1399** Model CS-5170  
Reg. \$1695

Call or write for our 528 pg. Catalog. Only \$4.95 — FREE with order.

CALL TOLL-FREE • SAME-DAY SHIPPING

**Joseph ELECTRONICS**

8830 N. Milwaukee Av. Niles, IL 60648  
708-297-4200 FAX:708-297-6923

**1.800.323.5925**

Add \$7.50 Shipping and Handling for each unit ordered. IL Residents add 7% Sales Tax

VISA

MasterCard

DISCOVER

CIRCLE 191 ON FREE INFORMATION CARD

[www.americanradiohistory.com](http://www.americanradiohistory.com)

# R-E Engineering Admart

Rates: Ads are 2 1/4" x 2 7/8". One insertion \$950. Six insertions \$925. each. Twelve insertions \$895. each. Closing date same as regular rate card. Send order with remittance to Engineering Admart, Radio Electronics Magazine, 500-B Bi-County Blvd., Farmingdale, NY 11735. Direct telephone inquiries to Arline Fishman, area code-516-293-3000. Only 100% Engineering ads are accepted for this Admart.

## MIDI PROJECTS

MIDI Projects

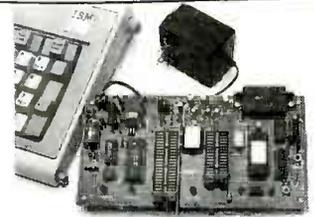
**BP182**—MIDI interfacing enables any so equipped instruments, regardless of the manufacturer, to be easily connected together and used as a system with easy computer control of these music systems. Combine a computer and some MIDI instruments and you can have what is virtually a programmable orchestra. To get your copy send \$6.95 plus \$1.25 for shipping in the U.S. to Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.

## FCC LICENSE PREPARATION

The FCC has revised and updated the commercial license exam. The **NEW EXAM** covers updated marine and aviation rules and regulations, transistor and digital circuitry. **THE GENERAL RADIOTELEPHONE OPERATOR LICENSE - STUDY GUIDE** contains vital information. **VIDEO SEMINAR KITS ARE NOW AVAILABLE.**

WPT PUBLICATION  
979 Young Street, Suite A  
Woodburn, Oregon 97071  
Phone (503) 981-5159

CIRCLE 180 ON FREE INFORMATION CARD



## 6805 MICROCOMPUTER DEVELOPMENT SYSTEM

The MCPM-1 system allows the IBM PC and compatibles to be used as a complete development system for the Motorola MC68705P3, P5, U3, U5, R3 and R5 single chip microcomputers. The system includes a cross assembler program, a simulator/debugger program and a programming board that connects to a serial port. Price—\$449.00 VISA and MASTERCARD accepted.

**TECI** THE ENGINEERS COLLABORATIVE, INC.

RR#3, BOX 8C Barton, Vermont 05822  
Phone (802) 525-3458 FAX (802) 525-3451

CIRCLE 184 ON FREE INFORMATION CARD

## LAWN MOWER

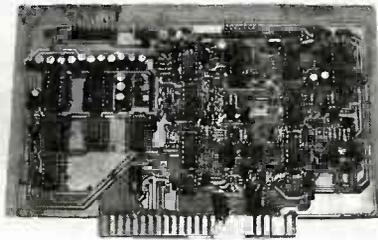
continued from page 47

output (pin 7 of IC4-b) in the positive direction by a few volts. Capacitor C4 is used to create a low-pass filter at the output stage of the D/A circuit. The D/A circuitry and the manual-control input (J4 pin 8) provide the steering input reference to the velocity-feedback loops.

### Velocity-feedback loops

Each loop consists of a summing junction, amplifier, PWM, velocity feedback, tachometer circuitry, and inverter/switch. Since the right and left velocity-feedback loops are basically identical, we will discuss the details of the left velocity loop only. Op-amp IC4-d acts as the summing junction and amplifier. The steering reference signals are coupled to the op-amp's inverting input (pin 13) through resistors R24-R28 and R40. Capacitor C5 is used to create a low-pass filter at the amplifier's output (pin 14). After the signals are added and amplified, they are passed through R57 to IC9, a UC3637 Pulse Width Modulator (PWM) IC, that sends PWM signals to the power board for running the drive motors.

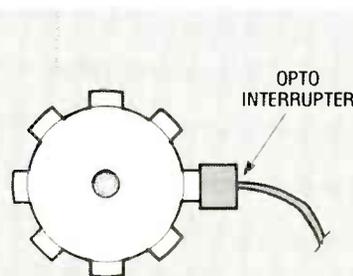
Also contained on the motor-controller board are the grass-sensor amplifiers, which are shown in Fig. 4 —



**FIG. 5—THE MOTOR-CONTROLLER board fits in one of the motherboard's slots.**

we will discuss them shortly. A photograph of the motor-controller board is shown in Fig. 5.

Within the motor housing is a chopper wheel that is used for sensing wheel (and motor) speed. The chopper wheel is shown in Fig. 6. The wheel has gear-like teeth that move through a dual opto-interrupter module as shown in Fig. 7. As the teeth



**FIG. 6—THE CHOPPER WHEEL has gear-like teeth that move through a dual opto-interrupter module.**

move through the opto module, they'll intermittently break the two light beams causing the module's internal phototransistor to turn on and off. The process creates two square-wave outputs, IN 1-1 and IN 1-2, that have pulse widths that are proportional to the speed of the chopper wheel, motor, and drive wheel. Since one light beam is broken before the other, IN 1-2 will always lead IN 1-1 in phase by 90 degrees when the motor is in moving in the forward direction. Figure 8 shows the two square-wave outputs from the dual opto-interrupter module. When the wheel spins in the reverse direction, the phase of the two square waves will switch. In that case, the square wave at IN 1-1 will lead in phase by 90 degrees. That tells the motor-controller circuitry if the drive wheels are moving forward or backward.

The square-wave outputs for the left drive motor are fed to the motor controller board via J3, pins 7 and 8. The signals are buffered by inverters IC1-c and IC1-f and then sent to D-type flip flop IC2-a. The flip flop is used to determine motor direction: forward or reverse. Since the flip flop clocks in data during the 0-to-+5-volt transition at pin 3, 0 volts will be indicated at the Q output (pin 5) when the motor is moving forward. Conversely, +5 volts will be at the Q output when the motor is in reverse.

continued on page 74

# DRAWING BOARD



ROBERT GROSSBLATT,  
CIRCUITS EDITOR

## Scrambling and Macrovision

IF YOU'VE BEEN ALONG WITH US ON OUR magical trip through videoland, you've had enough basic video stuff jammed down your throat to get a high-level executive job at the local network. If you've built the hardware as well, you're in line for the network presidency. The most important thing you should have picked up from everything we've been doing is that the video signal is an extremely complex waveform with strictly defined timing parameters. As with most complex things, however, it's a lot harder to put it together than is to take it apart. Just like a jigsaw puzzle, it may take three weeks to build but it takes only three milliseconds to wreck.

Modern art aside, the only way you can get an image on the screen is by having all the right signals show up at the right place at the right time. Leave out just one of the required control pulses and the TV set will turn up its nose at the entire signal. If you don't have all of it, you might as well have none of it.

And, before I forget, several people have written asking where they can get the 8284 we used as the master clock generator. Frankly, I'm a bit surprised anyone had any trouble finding it since the chip is carried by most of the mail order houses that advertise in **Radio-Electronics**. All I can say is that even though the 8284 isn't listed in their ads, I know for a fact that it's part of the inventory. Just give any of them a call and, as the man said, ask for it by name.

### The picture area

The sync signal we've been studying and building is only one part of the NTSC signal - let's not forget that there's no point to having

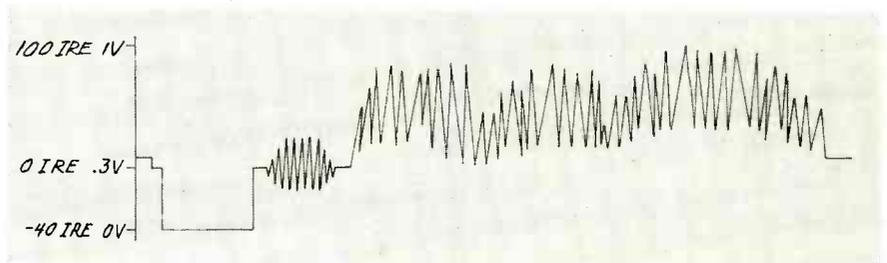


FIG. 1

the control signals if there isn't picture there as well. I suppose that some people are such hard-line couch potatoes (now where did that come from?) that they even enjoy an evening of staring at a blank screen. Come to think of it, some of the stuff that shows up regularly on the tube isn't much better. But, then again, four hours of a blank screen means four hours without commercials so maybe it's really not so bad after all.

Since we now know that everything in the NTSC signal is predefined, it shouldn't be any surprise to learn that there are rules for picture information, as well. The illustration of a line of video in Fig. 1 should be an old friend by now, but this time we're going to talk about the picture area rather than the horizontal interval.

The basic idea behind the NTSC standard is the vertical division of the 1-volt video signal into a control area and a picture area. While there are rules for the picture information (just as there are rules for the stuff in the horizontal interval), things are a lot looser when you're talking about pictures. Sync signals have requirements covering placement, amplitude, and width, but picture signals are required only to meet placement and amplitude requirements.

Although there's no real data shown in the video information part of Fig. 1, a typical line of real video might look exactly like that. The thing that should be obvious in the drawing is that the video information has to be placed outside the horizontal interval and it can't go below 0 IRE units (about 0.3 volts) or above 100 IRE units (about 1 volt). A level of 0 IRE produces a black signal and a level of 100 IRE produces white.

The reason that video levels are usually referred to in terms of IRE units is that, while the signal is supposed to be 1 volt peak-to-peak, some VCR's and other equipment put out different levels. The manufacturers calibrate them before they leave the factory but, as we all know, stuff happens. Most video inputs are clamped by one means or another so that the video signal being fed to it is chopped down to 1 volt but the ratio of picture data to video data is still at the IRE standard. Zero IRE is defined to be roughly one third of the complete peak to peak voltage swing regardless of the actual voltage. A level of zero volts is always -40 IRE units and 100 IRE units (100% white) is always the upper level of the input voltage swing.

Picture information can have an amplitude of slightly less than 100

IRE units. That's because it starts at 7.5 IRE units rather than at 0 IRE units. The area from 0 to 7.5 IRE units are reserved for what is officially referred to as the "set-up level." The top of that (7.5 IRE units) is the black threshold and the bottom (0 IRE units) is the top of sync. You can see that in Fig. 2. Having that small buffer area is a way of acknowledging that things don't always work in real life as nicely as they do on paper. The 7.5-IRE unit gap is best understood by realizing it's just adding a bit of hysteresis to the system. Real-world signals don't always pay absolute attention to the written NTSC video standard.

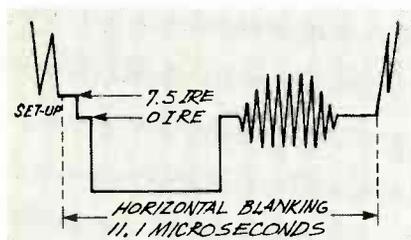


FIG. 2

### Making pictures

If you're into abstract impressionism, it's really easy to make video appear on the screen. The only requirements you have to follow are to gate the picture signal with sync and limit the amplitude to the upper 100 IRE units. I don't know what you'll see on the screen but the chances are that if you take pictures of it you'll be able to sell them for some outrageous amount of money. However, if you're into structure, it's going to take a bit more work to have something recognizable show up on the screen.

If you've been around since we started this video stuff, then you already know enough to make something appear on the screen. What's key here is exactly what's meant by the word "something." Getting a screen full of bars or dots is possible with a handful of standard parts. The approach to the design is simple since it's really the same as the one we went through when we were designing the hardware to generate sync.

The simplest case would be a series of vertical bars. All that's needed is circuitry that goes high and low at periodic intervals and is gated by horizontal sync. If it puts out highs at the same place on each line of

video you're going to see a series of vertical bars on the screen. If you want to break the lines vertically and wind up with a series of squares, you'll have to keep track of the number of lines and enable the production of highs only on certain lines. It would also be a good idea to reset the entire circuit during the vertical interval so the squares don't do a vertical creep on the screen.

In the interest of space, I'm going to leave the design of the circuit to you. As a matter of fact, it's time for another contest anyway so let's make one out of this. The rules are simple. All you have to do is put an image on the screen. The ones who put the most interesting image on the tube in the most interesting manner will be the winners. What I'm looking for is slick circuitry more than art but I'll take both into account when judging the entries. Since there's an artistic side to this contest, and the difference between garbage and gorgeous is in the eyes of the beholder, there will be several free subscriptions to **Radio-Electronics** available.

### Scrambling pictures

Now that we know how video is made, it's worth spending some time to see how it's unmade. Of course I'm talking about some of the stuff that the friendly folks at your local cable company do to the images they send to your house. Unless you've spent the last couple of years with the fish faced people of Neptune, you're aware of the nasty art of video scrambling—both on cable TV and commercial video-tapes.

Let's take these one at a time.

Cable companies make extra money selling subscription services and most of them are scrambled to keep you (at least in theory) from being able to watch them without paying. Before we get into what they do to video, I want to make a couple of philosophical points.

The people at the cable companies seem to go absolutely non-linear whenever someone builds their own descrambler and watches their stuff without paying. As far as I'm concerned, any cable company executive who thinks that way is full of...errors in judgment.

At a certain point on the cable, signal ownership transfers from the

cable company (that's them) to the subscriber (that's us). The same sort of argument used to be used by the phone company. I'm sure that everyone remembers the days when adding your own extension phone meant risking the wrath of the phone company. They finally got smart enough to drop that attitude and limit their sphere of responsibility to bringing a line into your house. The cable TV companies are still working on the original telephone standards.

If you have cable TV service, it's reasonable to agree that they own the signal as long as the signal is running through their own equipment. That includes their cable, their tuner, and an argument can even be made that they own it all the way to the input jacks of your VCR or TV. Once the signal gets into your stuff however, as far as I'm concerned, it's yours.

If you modify your television to unscramble cable signals, that should be nobody's business but yours. And if that still seems to be questionable, let's suppose you were able to make some kind of optical screen that went in front of the TV and unscrambled the picture, how could the cable companies complain about that? And if you had built a device that scrambled clear reception, you can bet your bottom dollar that the cable companies wouldn't care about that either.

The point I'm making is simple: if the cable company doesn't want me to watch something I haven't paid for, don't put the signal on the line in the first place. The cable company argument that anything I do to unscramble the picture, even inside my own TV, is a theft of service, is covering up the fact that it's cheaper for them to scramble the signal than it is to send it only to people who pay for it.

I must have had this discussion with just about everyone I know and I'm interested in finding out what you think of it. Write in and let me know what you think.

We'll get to the basics of video scrambling next month. First, let's move on to another unpopular video topic: Macrovision.

We've all been hounded by Macrovision and had to live with copies that blink constantly when they're viewed. Since there's lots of easy to

get (and legal) equipment around to beat Macrovision, I don't see any reason other than greed for the fact that it's still used. If you want to make copies of tapes that have been infected with Macrovision you can buy (or build) circuitry to eliminate it, but there's a much easier way to do it, and it shouldn't take you more than a few minutes to make Macrovision a thing of the past.

Since the idea behind Macrovision is to put pulses in the vertical interval that confuse the AGC (Automatic Gain Control) of the VCR used to record the copy, all you have to do is locate the AGC trimmer in the VCR and turn it down. As soon as you kill the AGC, the Macrovision pulses won't have any effect at all. People make arguments that you need the AGC to protect the video circuitry in the VCR, but the video output of most consumer equipment is clamped to about one volt so the chances are that you can live very well without it. If you're really not sure about killing it completely, move the trimmer to the front panel of the VCR. Most VCR's use DC control lines so there's not even a noise problem by adding some wire and a potentiometer to the circuit.

If you're nervous about that, remember that some VCR's don't get messed up by Macrovision. The reason is that either their AGC has been turned way down, isn't working, or isn't there. Save yourself some money by getting the service manual for your VCR and making the adjustment yourself. It's easy to do, and, once you've done it, you probably won't see any difference in the way the VCR behaves and you'll more than likely forget about it.

Macrovision was designed to keep people from making and selling pirated copies of videotapes. Since it's so easy to beat, there's no reason for keeping it around. The real protection for the people selling commercial tapes is the obvious difference in quality between the original and the copy.

Macrovision makes commercial tapes more costly to produce and more expensive for the consumer—and that's all it does. It was a stupid idea when it first appeared, is even more stupid now, and it's time to get rid of it.

Write letters, sign petitions, and I'll talk to you next month. **R-E**

## LAWN MOWER

*continued from page 71*

The square-wave signal IN 1-1 is tapped off IC1 pin 5 and sent to IC5, a frequency-to-voltage converter that produces an analog voltage that repre-

signal in order to maintain negative feedback; that inverted signal is produced by IC4-a.

### Pulse-width modulators

The pulse-width-modulator function is performed by two UC3637 PWM IC's, IC9 and IC10. Pins 9 and

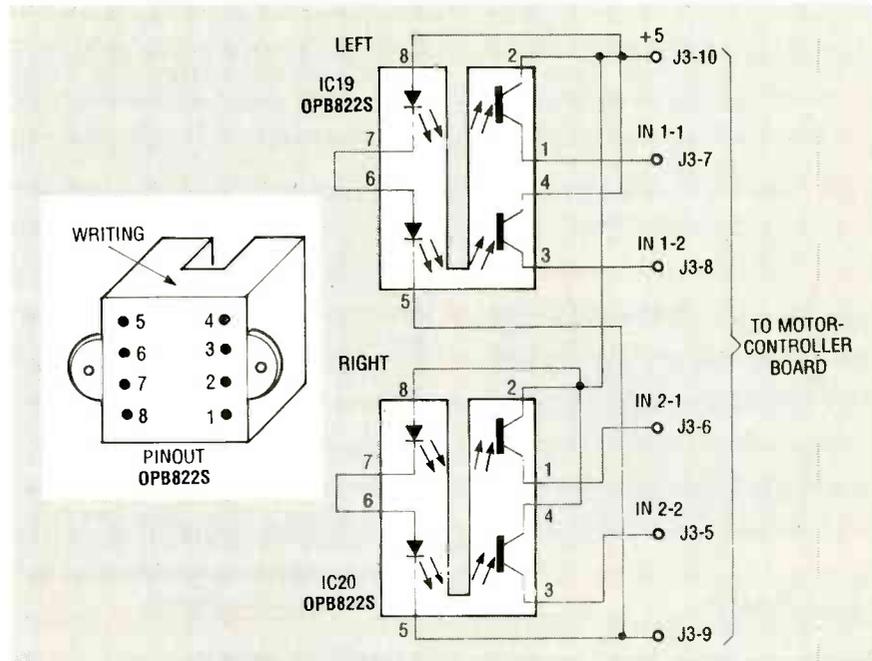


FIG. 7—THE OPTO-INTERRUPTER MODULES keep track of wheel movement.

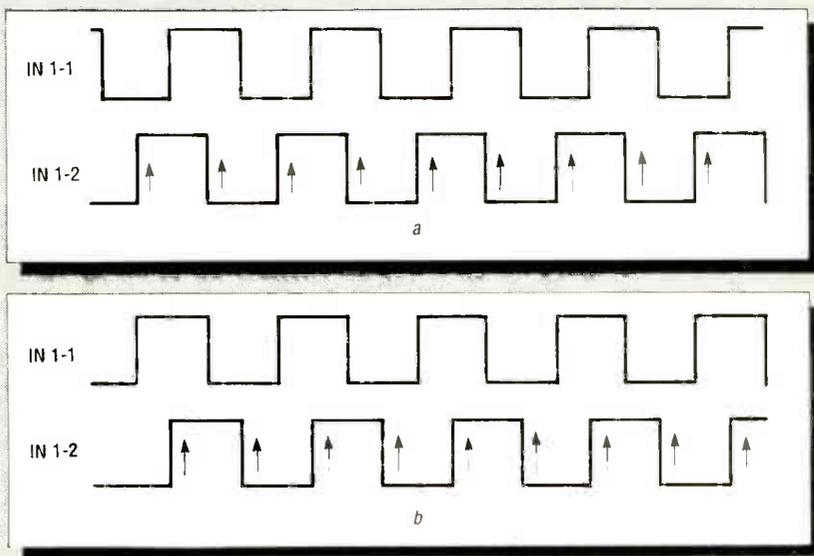


FIG. 8—WHEN THE LEFT WHEEL GOES FORWARD (a), pin 5 of IC2 is at 0 volts, and when the left wheel goes in reverse (b), pin 5 is at 5 volts.

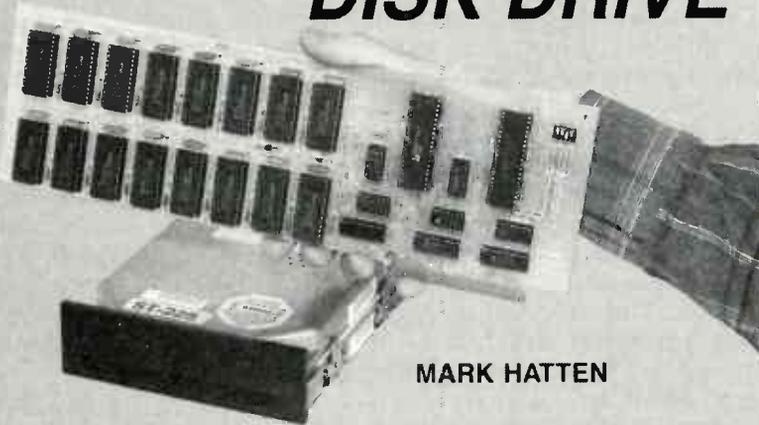
sents wheel velocity from the square-wave frequency. The analog switch IC8, which is controlled by IC2-a, is used to select the forward and reverse velocity-feedback signals. When the motor spins in reverse, the velocity-feedback loop requires an inverted

11 are the input to the PWM IC's, pin 4 is the "forward" output signal, and pin 7 is the "reverse" output signal. When the left wheel is moving forward, the analog input voltage to pins 9 and 11 will vary between +0.7 volts

*continued on page 88*

# COMPUTER DIGEST

## BUILD A SOLID-STATE DISK DRIVE



Retain important PC data with  
this inexpensive battery-backed RAM disk.

**W**ouldn't it be nice if you didn't lose memory contents every time you turned off your PC? And wouldn't it be nice to have a RAM disk that didn't tap into your regular memory, whether conventional (0–640K), extended (above 1 MB), or expanded (bank-switched beneath 1 MB)?

If you think that either would be nice, then you'll be interested in our static RAM disk. It's a full-length card for any 8- or 16-bit expansion slot; you can install 32K–512K of static CMOS RAM's on the board. The board has provision for an optional battery backup system so the card will retain its contents even after the main system loses power. That capability could be useful in remote data logging or industrial use.

You can build the board for well under \$100, not counting the cost of the RAM. A double-sided

PC board is available, as are complete kits and assembled units. The complete assembly-language source code for the RAM disk is also available, allowing custom modifications.

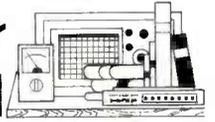
### Hardware overview

The circuit consists of three main sections: the RAM array, the bus interface circuit, and the battery backup circuit. Figure 1 shows a block diagram.

The static RAM portion consists of a maximum of sixteen 32K × 8 CMOS static RAM's (SRAM's), divided into two banks. The address and data lines of all SRAM's in both banks are driven by IC1, an 8255 configured as a triple parallel port. Port A drives the low-order address lines (A0–A7). Port B drives the high-order address lines (A8–A14), and Port C drives the data lines (D0–D7).

*continued on page 79*

## EDITOR'S WORK- BENCH



### Letters

**S**everal items in recent columns have provoked questions from readers. Following are my responses.

M. Delez of Juneau, AL asked for clarification on what I meant by stating that the number of jobs in hardware servicing would shrink (see Editor's Workbench, April 1990, p. 70). Mr. Delez is seriously considering a career in computer and audio/video servicing, and wonders what he should do. As stated in the article, I was talking about *component-level* servicing (and R&D work). Perhaps I should have made it clearer that higher-level servicing—board swapping and the like—will continue to be a high-activity sector of the job market.

A. Kusnevick of Paxton, IL asked for clarification on the ROM-scan routine that a PC BIOS executes when booting (discussed in conjunction with Annabooks' PromKit, in the March 1990 Editor's Workbench, p. 72). In particular, he wondered where the byte that specifies the number of 512K blocks of memory is located. In a ROM that is to become a BIOS extension, the first byte contains 55h, the second byte contains AAh, and the third contains the length specifier, which specifies the number of 512-byte blocks in the ROM. The fourth and fifth bytes contain the address in the ROM where the initialization routine is stored. If the checksum of all

bytes in the ROM equals zero, the BIOS saves its current location on the stack and calls the init routine, which should end with a FAR RET to continue the boot process and turn control over to COMMAND.COM.

Another reader took me to task for my statement in the April 1990 column (p. 70), that few of the modern generation of word processors allow you to type and format equations in a quality manner. He included a sample printout of the same equation shown in the magazine as rendered by WordPerfect 5.1. My excuse is simply the fast-changing character of this business; I wrote that column shortly before WordPerfect 5.1 was released. You may also be interested to know that Ventura Publisher with the Professional Extension has an equation editor. So does Word for Windows, which also has a BASIC-like language that allows you to solve equations as well as display and print them.

On a related note, I just received an advertisement for a program called Exact that loads as a TSR and pops up within your word processor. The program allows you to see expressions as you type them, and apparently to use your word processor to print them as well. More than twenty word processors are supported. Contact Technical Support Software, Inc., 72 Kent Street, Brookline, MA 02146 (617) 734-4130 for more information. If there is sufficient reader interest, I'll get a copy of the program and check it out.

Of course, displaying and printing equations is only icing the cake. The real work consists of deriving the equation, making the calculations, and plotting the results. And that leads us to a really neat software package called Derive.

## Fun with Math

**D**erive is simply amazing. In the company's words, "Derive is a menu-driven symbolic math system for personal computers. Derive does numerical and symbolic equation solving, exact and approximate arithmetic, calculus, trigonometry, and matrices. Derive Plots expressions in 2D and 3D on monochrome and color graphics monitors."

One might add that it does all that without requiring a 386, or a math coprocessor, or lots of memory. A PC compatible, 512K of RAM, and a single floppy are all you need; a graphics display is also nice for viewing plots. Hercules, CGA, EGA, VGA, and several other formats are supported. Derive also runs on the NEC PC-9801. The program will run faster on faster machines, of course, but it won't use more than 640K of memory or a coprocessor, even if either or both happen to be present.

The following are several examples of what Derive can do. (Solutions will be presented below.)

- Compute  $\pi$  to 70 decimal places.
- Simplify algebraic expressions  $(X+1)/(1-X^2)$ .
- Factor large numbers (987654321)
- Perform complex-number arithmetic manipulation
- Find symbolic limits, do differentiation, find Taylor series, manipulate vectors and matrices, etc.
- Solve just about any computable equation to just about any desired degree of precision.
- Plot just about any equation of one or two variables.
- Generate an expression in a form suitable for inclusion in any BASIC, FORTRAN, or Pascal program.
- And that just scratches the surface.

### Features

Derive comes on a single floppy disk; the executable file is about 227K. The disk also includes several sample files containing various expressions useful for vari-

ous types of calculation. Installation consists simply of copying the files to your working disk.

The program works using an amalgamation of Microsoft Word style menus and WordStar keystroke commands. Command menus appear near the bottom of the screen; you execute a command by highlighting it and pressing the Enter key, or by pressing the capitalized letter in the command.

You use the Author command to type in and edit expressions. Each expression is numbered; expressions scroll up the screen each time you add a new one. You can't edit an expression after pressing Enter, but various editing commands allow you to copy parts of previously entered expressions into the current one. And the Build command allows you to build up a complex expression from previously entered ones.

After entering an expression, you can simplify it, factor it, expand it, solve it, plot it, or save it. Of course, you can also load previously saved expressions.

Derive includes several features that simplify expression entry. For example, you don't have to enter an asterisk to indicate multiplication. Variables are normally a single letter, but you can configure the program to use multi-character names. Variables and constants can be designated by the Greek letters in the IBM PC character set by pressing an Alt-key combination (e.g., Alt-P for  $\pi$ ).

Derive includes all common operators and functions (+, -, \*,  $\div$ , exponentiation, log, ln, sqrt, abs, sin, cos, tan, cot, sec, csc, max, min, RMS, VAR, STDEV), and numerous others. You can also write your own functions, and declare constants to be used in calculations.

Internally, Derive stores every rational number as an integer or a ratio of integers. Irrational numbers (e.g., SQRT(2)) are stored in symbolic form. You can force Derive to compute results in exact, approximate, and mixed modes. In exact mode, all computations are done using integ-



ers and symbols, so there are no round-off errors.

In approximate mode, irrational numbers and fractional results of rational operations are rounded. You can set the number of decimal places after which rounding occurs. So if you really want to know what  $\pi$  to 500 decimal places is...

In mixed mode, rational numbers are computed exactly, while irrational numbers are accurately approximated.

Exact mode provides the most precision, but requires the most memory; approximate mode computes fastest and uses the least memory.

You can also specify separately the display mode (rational, decimal, scientific, or mixed; and number of display digits), and number base. For the latter you can specify different values for input and output, thus allowing Derive to function as a number base converter. Derive accepts number base values between two and thirty-six.

You can plot any one- or two-variable equation. A single variable gives a 2D plot; two variables give a 3D plot, as shown in Fig. 1. In either case you can alter several parameters to vary the appearance of the plot, including scale, number of "tick" marks on the axes, and viewing angle of a 3D plot. It's particularly fascinating to view a 3D plot from different angles. Unfortunately, Derive includes no print module, so to print a plot, you'll have to rely on a third-party screen-print utility.

Derive's initial screen is where you enter expressions and where Derive displays results. If you choose to plot an expression, Derive switches to another screen. However, you can split the screen into several windows, each of which may be either an expression window or a plot window. Figure 2, for example, shows a three-window screen at VGA resolution. Window 1 contains several expressions; note that expression 27 ( $y/x$ ) is highlighted; that is the current expression. Window 3 shows a 3D plot of that expression, and Window 2 shows a 3D plot of expression 26 ( $x/y$ ).

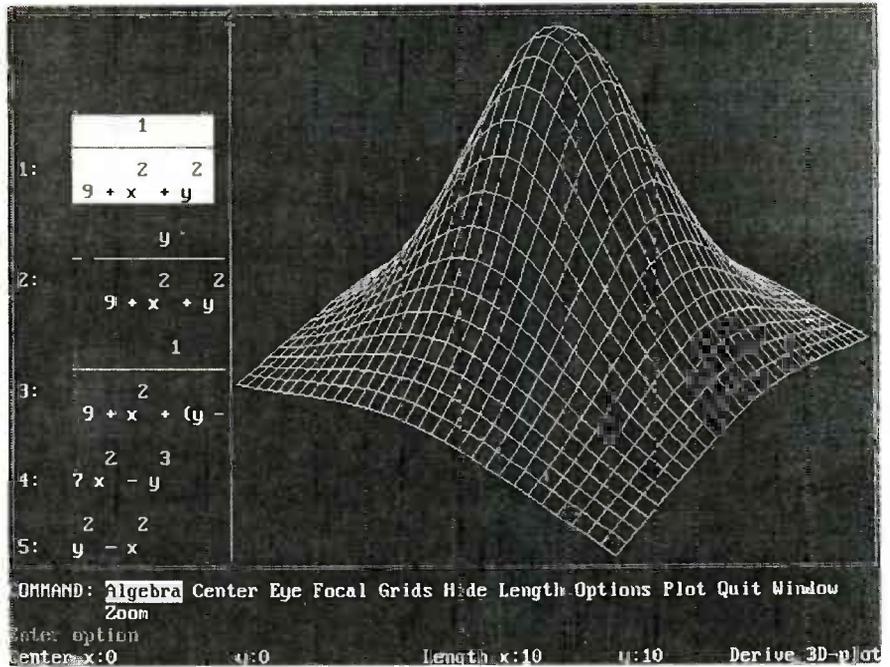


FIG. 1

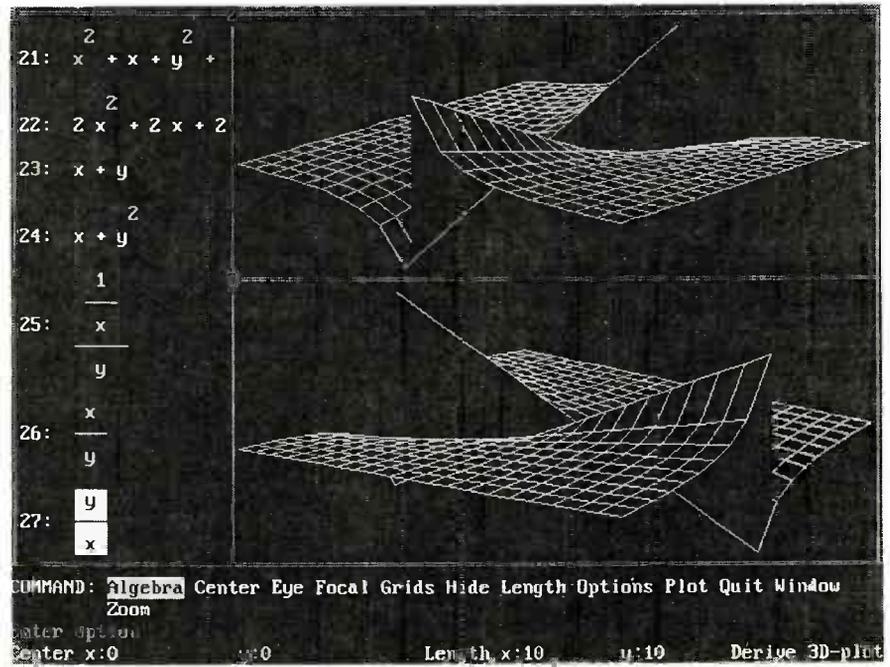


FIG. 2

### Using Derive

To say that Derive can do all of those things does not in the least say how much fun it is to use the program. And it's obvious that you can have fun with Derive, regardless of your prior mathematical training. You might also learn something in the process.

In playing with Derive, I followed the basic sequence of my mathematical education. To start learning how to use the program, first I tried some basic arith-

metical expressions. Confidence grew quickly, so I tried some algebra. I remembered plotting various equations ( $y=x^2$ ,  $y=x^3$ , etc.) by hand in high-school algebra. So I typed in a simple equation and issued the plot command. Instant gratification. Since it was so easy, next I tried variations on basic themes ( $y=x^2+1$ , etc.). In that way I could see instantly how changing different constants and variables affected a given type of equation.

# R-E Computer Admart

Rates: Ads are 2 1/4" x 2 7/8". One insertion \$950. Six insertions \$925 each. Twelve insertions \$895 each. Closing date same as regular rate card. Send order with remittance to **Computer Admart**, Radio Electronics Magazine, 500-B Bi-County Blvd., Farmingdale, NY 11735. Direct telephone inquiries to Arline Fishman, area code-516-293-3000. *Only 100% Computer ads are accepted for this Admart.*

**ICs PROMPT DELIVERY!!!**  
 SAME DAY SHIPPING (USUALLY)  
 QUANTITY ONE PRICES SHOWN FOR APRIL 29, 1990

OUTSIDE OKLAHOMA: NO SALES TAX

**DYNAMIC RAM**

1MB COMP DeskPro 386 20	\$295.00
SIMM AST Prem386 33Mhz	225.00
SIMM 1Mx9 80 ns	90.00
SIMM 256Kx9 100 ns	35.00
1Mbit 1Mx1 80 ns	8.75
41256 256Kx1 60 ns	4.50
41256 256Kx1 80 ns	3.50
41256 256Kx1 100 ns	3.10
41256 256Kx1 120 ns	2.40
4464 64Kx4 100 ns	3.50
41264* 64Kx4 100 ns	7.50

**EPROM**

27C1000 128Kx8 200 ns	\$18.00
27512 64Kx8 200 ns	7.80
27256 32Kx8 150 ns	6.50
27128 16Kx8 250 ns	3.75

**STATIC RAM**

62256P-10 32Kx8 100 ns	\$9.00
6264P-12 8Kx8 120 ns	4.50
6116AP-12 2Kx8 120 ns	4.25

OPEN 6 DAYS, 7:30 AM-10 PM: SHIP VIA FED-EX ON SAT.

SAT DELIVERY INCLUDED ON FED-EX ORDERS RECEIVED BY: Th: 82 \$625.00 Fr: P1 \$16.50 1 lb

MasterCard VISA or UPS CASH COD. MICROPROCESSORS UNLIMITED, INC. 24 000 S. Peoria Ave. (918) 267-4961 BEGGS, OK 74421 No minimum order. Please note: prices subject to change. Shipping insurance (over \$1 for packing material)

## SECRETS OF THE COMMODORE 64

**BP135**—A beginners guide to the Commodore 64 presents masses of useful data and programming tips, as well as describing how to get the best from the powerful sound and graphics facilities. We look at how the memory is organized, random numbers and ways of generating them, graphics-color-and simple animation, and even a chapter on machine code. Get your copy today. **Send \$5.00 plus \$1.25 for shipping in the U.S. to Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.**



## GETTING THE MOST FROM YOUR PRINTER

Getting The Most From Your Printer



**BP181**—It is probable that 80% of dot-matrix printer users only ever use 20% of the features offered by their printers. This book will help you unlock the special features and capabilities that you probably don't even know exist. To order your copy send **\$6.95 plus \$1.50 for shipping in the U.S. to Electronic Technology Today Inc., P.O. Box 240, Massapequa Park, NY 11762-0240.**

CIRCLE 61 ON FREE INFORMATION CARD

Then I was off into trigonometry. First it was sin (x). Next was 2 sin (x). Then sin x<sup>2</sup>. You get the idea.

With 3D plots, you could easily spend hours trying different equations, different viewpoints, etc. Even my wife, a decidedly non-mathematical person, got involved. "Let's try just one more..." The point is that Derive is a superb educational tool. It's also a serious and powerful tool for scientists, mathematicians, and engineers. It's therefore highly recommended.

Here are solutions to the questions posed above.

3. 141592653 589793238  
462643383 279502884  
197169399 375105820  
974944592 307816
- 1/(X-1)
- 3<sup>2</sup> × 17<sup>2</sup> × 379721 **CD**

## Exploring Math With Derive

Derive comes with a user's manual that is really a reference guide for those who already know what they are doing. If you're interested in Derive from an educational point of view—either for yourself or for someone else—you'll want to check out *Exploring Math from Algebra to Calculus with Derive. A Mathematical Assistant*. The author is a professor of mathematics, and it is obvious that he sincerely wants to find ways of teaching people about math, not just the wizards, but the rest of us as well, and that he thinks Derive can assist the process. The book is extremely friendly in both the way it is written and in the way it is laid out.

Chapter 15 of the book describes how the author has used Derive to teach math to students at various levels, including first-year calculus students, first-year algebra students, fifth graders, and first and second graders. Seriously. How many pieces of software have you seen that could be used by graduate engineers and first graders? If you're still in school, know someone who is, or need a brush-up. Derive and a

copy of this book should be high-priority items. **CD**

## ITEMS DISCUSSED

• Derive (\$200), Soft Warehouse, Inc., 3615 Harding Avenue, Suite 505, Honolulu, HI 96816. (808) 734-5801. CIRCLE 246 ON FREE INFORMATION CARD

• *Exploring Math from Algebra to Calculus with Derive, A Mathematical Assistant*, by Jerry Glynn, published by MathWare, 604 E. Mumford, Urbana, IL 61801.

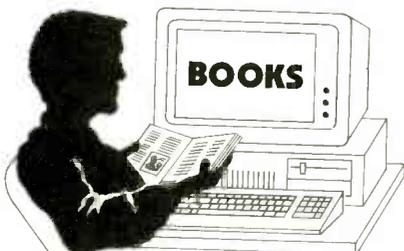
**If there's a pain in your chest, be a pain in the neck. Complain to a doctor.**



Chest pain could be a sign of heart disease. The sooner you see a doctor, the better your chances for life.



American Heart Association



## RAM DISK

continued from page 75

A second 8255, IC2, drives the chip select ( $\overline{CS}$ ) inputs of all SRAM's. Port A drives IC11-IC18, Port B drives IC19-IC26, and Port C is not used.

The bus interface consists of a group of buffers and gates that isolate the circuit from the PC expansion bus, and they're also used to decode a set of I/O port addresses for passing data and control information.

The battery-backup circuit consists mostly of several diodes that isolate the optional battery from the PC's power source. We'll discuss the hardware in more detail next time.

### Software success

Success for the PC has come about in part because of the expandability of the system. A good part of that versatile expandability is due to the concept of the *device driver*.

A device driver provides a means of adding special features to DOS in such a way that those features appear to be an integral part of DOS. In fact, DOS itself comes with several built-in device drivers.

- ANSI.SYS is a device driver that provides a standard way of dealing with the display system,
- DRIVER.SYS is a device driver that lets you add high-density floppy disks to older machines, and to refer to the same physical disk drive by several different drive letters.
- VDISK.SYS is a device driver that emulates a disk drive using either conventional or extended memory.

Manufacturers of special equipment often supply their own device drivers. For example, network interface cards, CD-ROM drives, and some types of hard disks require device drivers.

What all device drivers share is the fact that, if a driver is to be used, it must be loaded from disk every time a PC boots. How does DOS know which device driver or drivers to load? Via the CONFIG.SYS file.

CONFIG.SYS is simply an AS-

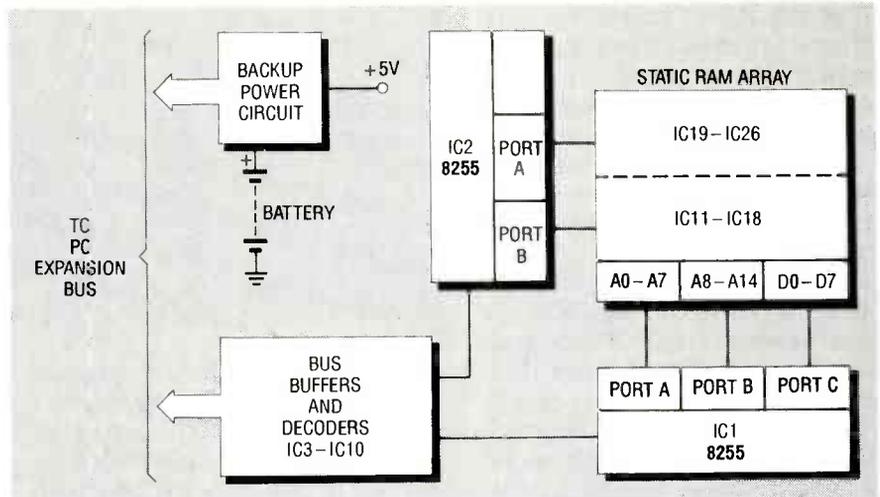


FIG. 1. THE STATIC RAM DISK consists of three major subsystems: an array of as many as sixteen 32K CMOS static RAM's, a bus-interface circuit, and a battery-backup circuit.

CII text file; each driver that DOS is supposed to load must be specified on a separate line in the file. (CONFIG.SYS also specifies several operational parameters particular to your machine; see your DOS manual for details.)

The structure of a device driver line in CONFIG.SYS is as follows. Spaces are shown for clarity, but must not be included, except between the name of the driver and the optional parameters.

```
DEVICE = [drive:][\PATH]
          [DRVNAM][PARMS]
```

First comes the phrase DEVICE = . Then comes an optional drive and an optional path and subdirectory where the driver is stored. If no drive is specified, the boot drive is assumed. If no path is specified, the root of the boot drive is assumed.

Next is the name of the driver itself. The name must follow normal DOS file-naming conventions: a name with a maximum of eight characters, plus a three-character extension. Common extensions include SYS and BIN, but neither is required. Last come any optional parameters the driver might require.

As you've probably guessed by now, the SRAM disk uses a device driver to talk to DOS.

### Types of device drivers.

There are two types of device drivers: character and block. As the names suggest, a character driver deals with information character by character, and a

block driver deals with information in larger chunks called blocks. The size of the block can vary within certain limits set by DOS.

Examples of devices that use character drivers include the serial and parallel ports. Examples of devices that use block drivers include the floppy and hard disk drives.

Generally speaking, a block driver can operate more efficiently than a character driver, because there is less overhead involved in each transfer of information to or from the device controlled by the driver. With some physical devices (disk drives, for example) you know that each time you request some information, you'll get, say, 512 bytes.

However, you can't always use a block driver. With a serial port, for example, you can obtain only a byte at a time. The SRAM disk could have been implemented as either a character or a block driver but, for the sake of efficiency, has been implemented as a block driver.

### Driver components

A driver consists of three main components: an initialization routine, a strategy routine, and an interrupt routine.

The initialization routine is generally called once, when DOS loads the device driver. Its job is to set up pointers to the BIOS parameter block (BPB) and to the

end of the driver in memory. In addition, it must initialize the hardware as required. The initialization routine is usually located last in the device driver file, so that after it does its job, the system can reclaim the memory that was formerly occupied by that driver.

The task of the strategy routine is to get a pointer to the DOS request header. The DOS request header is an array of bytes that communicates what type of activity DOS is trying to request from the driver. The address of the byte array is passed to the driver using register pair ES:BX.

The interrupt routine is what does the actual work. It can perform various types of operations, some of which are mandatory for block drivers, and others for character drivers. We'll discuss some of the more important operations now.

MediaCheck detects whether the storage media was removed or tampered with. BuildBPB (Build BIOS Parameter Block) deals with that occurrence. For example, DOS calls BuildBPB whenever it detects that a floppy disk has been changed. In our driver, MediaCheck always returns an OK sign to DOS. Because of that, BuildBPB will be called only once, when the drive is initialized.

The input and output routines pass sectors of data to and from the disk. They use a buffer area specified by DOS in the request header. The number of bytes per transfer can not exceed 64K (the maximum size of a memory segment). If a file is larger than 64K, DOS will read or write the file in 64K chunks until the entire file has been transferred.

### Structure of a driver

Every device driver has a device header that occupies the first few bytes of the file. Our device header is shown in Table 1. The first entry (Nexdev) is there to provide a means of letting DOS link each device driver to the next. DOS fills in the links as it loads each driver; the last driver in the chain has -1 (FFFFh) in the Nexdev field.

The next entry is the attribute

TABLE 1—DEVICE HEADER

nexdev	DD	-1	
attribute	DW	02000h	
	DW	STRATEGY	
	DW	INTERRUPT	
	DB	1	; number of devices
	DB	(7) DUP ?	; used for char name ; if char driver

variable, whose value depends on the type of device. Our driver uses a value of 2000h, which is the setting for a non-IBM block device. If you run CHKDSK on the RAM drive, it returns a *Probable non-IBM disk* warning because of that value, but otherwise functions normally.

The next two entries are the addresses of the strategy and interrupt routines.

The last entry is an eight-byte field that is used differently for block and character devices. For a character device, you would assign a name like CON, PRN, LPT1, etc. For a block device, the first byte contains the number of physical devices that are being controlled by the driver, and the remaining seven bytes are undefined.

### The BPB

Another important data structure in a device driver is the BIOS parameter block, or BPB. The BPB is a data structure that tells DOS everything it needs to know about the format in which information is stored on the specified device. The BPB is located in the first sector of a disk, and it includes several items, as shown in Table 2.

The first item in the BPB contains the number of bytes per sector. The next item specifies the number of sectors per cluster. If you're unfamiliar with the term *cluster* (also known as the allocation unit), it specifies the smallest number of sectors that can be allocated to store a file. For example, if ten clusters were allocated to a file, and if the BPB defined four clusters per sector, then the file would consist of forty sectors. Even if a file is only a single byte in length, it requires a full cluster on the disk.

Different versions of DOS use different cluster sizes. DOS 3.3 generally allocates four sectors per cluster (depending on overall disk size); DOS 2.x allocated 8 sectors per cluster.

The default allocation unit in the static RAM disk is one sector/cluster, but you could alter that value to be any power of two (2<sup>0</sup>, 2<sup>1</sup>, 2<sup>3</sup>, etc.).

The next item in the BPB is the

### Parts List

#### Resistors

All resistors are 1/4-watt, 5%, unless otherwise noted.

R1-R5.....	4700 ohms
R6-R21.....	22,000 ohms

#### Capacitors

C1-C16.....	0.01 μF polyester
C17.....	10 μF, 10 volts, electrolytic

#### Semiconductors

D1, D2.....	1N914 switching diode
IC1, IC2.....	8255 programmable peripheral interface
IC3.....	74LS245 bidirectional bus buffer
IC4, IC5.....	74LS244 octal bus driver
IC6.....	74LS138 three-to-eight line decoder
IC7.....	74LS85 four-bit comparator
IC8.....	74LS04 hex inverter
IC9.....	74LS00 quad NAND gate
IC10.....	74LS08 quad AND gate
IC11-IC26.....	43256-10 Static RAM

#### Other Components

SW1.....	four-position DIP switch
B1.....	four AA cells, with holder (optional)

TABLE 2—BIOS PARAMETER BLOCK

BPB	EQU	\$	
BPB_SS	DW	512	; sector size in bytes
BPB_AU	DB	1	; sectors per cluster
BPB_RS	DW	1	; sectors for boot sector
BPB_NF	DB	1	; # of FAT tables
BPB_DS	DW	16	; # of Directory entries
BPB_TS	DW	1024	; # of total sector
BPB_MD	DB	0FEH	; media descriptor
BPB_FS	DW	4	; # of sectors/FAT(S)
;BPB_ST	DW	00	; These variables would be
;BPB_NH	DW	00	; drive.
;BPB-H5	DW	00	; used for a real disk
BPB_PRT	DW	BPB	; Pointer to this table

number of sectors reserved for the boot sector. The boot sector of the BPB contains a short program that starts the process of loading DOS from disk. DOS itself contains the remainder of the loader program.

The next entry specifies the number of File Allocation Tables (FAT's). DOS uses the file allocation table to keep track of which sectors have been used, which are free, and which are physically damaged. DOS normally maintains two copies of the FAT: to conserve space, our driver maintains one.

Next in the BPB comes the number of directory entries. This value specifies the number of files that can be present in the root directory of a disk. (Subdirectories are actually files, so the number of subdirectories is limited only by the available disk space.) DOS 3.3 typically allows 512 directory entries; again, to conserve space, our driver allows 16.

The next BPB entry contains the total number of sectors contained on the disk. This value represents the total size of the disk, including space occupied by boot sectors, FAT's, etc. In our case, the total number of sectors (TS) can be determined from this formula:

$$TS = (32768/512) * (\text{number of SRAM's})$$

The next entry is called the media descriptor: it specifies the type of media being used, the number of sides, etc. Our driver uses the code for a single-sided floppy-disk drive.

Following the media descriptor

**Ordering Information**

**Note: The following are available from**

**Hatronics**  
**145 Lincoln Street**  
**Montclair, NJ 07042**  
**(201) 783-7264**

**(201) 245-6614 (BBS, join the Hatronics conference)**

- Bare PC board ..... \$50
  - Kit with OK RAM ..... \$90
  - Kit with 128K RAM ..... \$155
  - Kit with 256K RAM ..... \$220
  - Kit with 512K RAM ..... \$322
  - Assembled and tested unit, OK ... \$135
  - Assembled and tested unit, 256K ..... \$255
  - Assembled and tested unit, 512K ..... \$395
- All orders add \$10 for shipping and handling. ... New Jersey orders add 6% sales tax.

is a field that specifies the number of sectors that must be allocated to each copy of the FAT.

Several other fields in the BPB are defined for use with physical disk drives, including the number of sectors per track, the number of disk heads, and the number of hidden sectors. Our driver does not need to use any of those fields.

Obviously, the subject of device drivers is complex; for detailed information, the best work that was found by the author is called *Writing MS-DOS Device Drivers* by Robert S. Lai.

Next time, we'll discuss hardware operation in detail, and then show how to build and initialize the drive. **CD**

**HARDWARE HACKER**

*continued from page 68*

be Jerryco's stock #79106 copy-machine chassis. This is a wide dual-bin input feeder and registration assembly for \$10.50. As is, its a great electromechanical treasurer trove. With some stupendous hacking effort, you might convert it into a fake Kroy Kolor machine, an automatic dual bin laser feeder, or find some unique robotics applications for it.

Arlin Shepard of Lazer Products tells me he has at long last found a few more Canon fusing units. We looked at these several columns ago for Kroy Kolor, lamination, and for dry-film printed-circuit bonding.

Adobe Systems has released their new black book, otherwise known as the *Adobe Type 1 Font Format*. This has all of the previously secret insider stuff on their encrypting, compacting, and the hinting of high-quality typography. I do have a few copies on hand here if you need one.

Turning to my own products, I've put together a special new Lancaster Classics package of six of my finest hardware books plus that complete *Hardware Hacker II* reprint set which covers everything that has appeared in these **Radio-Electronics** columns.

Finally, I've got a new and free mailer for you which includes dozens of insider hardware hacking secret sources. Write or call for info.

As always, this is your column and you can get technical help and off-the-wall networking per that "Need Help?" box. The best calling times are weekdays 8-5 in *Mountain Standard Time* Let's hear from you. **R-E**

**"Make a promise to the earth"**

When you plant a tree you make life better for your children and for the future. Join me and plant a tree.

For your free brochure, write:  
 Trees for America, The  
 National Arbor Day  
 Foundation, Nebraska  
 City, NE 68410.



John Denver for  
**The National Arbor Day Foundation**

# MARKET CENTER

## FOR SALE

**GREAT buys!** Surplus prices, ICs, linears, transformers, PS, stepping motors, vacuum pump, phototransistor, meters, LSASE, FERTIK'S, 5400 Ella, Phila., PA 19120.

**DESCRAMBLERS.** All brands. Special: Combo Jerrold 400 and SB3 \$165.00. Complete cable descrambler kit \$39.00. Complete satellite descrambler kit \$45.00. Free catalog. **MJM INDUSTRY**, Box 531, Bronx, NY 10461-0531.

T.V. notch filters, surveillance equipment, brochure \$1.00. **D.K. VIDEO**, Box 63/6025, Margate, FL 33063. (305) 752-9202.

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

**ENGINEERING** software, PC/MSDOS. Hobbyists — students — engineers. Circuit design \$49.00, PCB layout \$99.00, Logic simulation \$29.00, FFT analysis \$69.00, Mathematics \$39.00, Circuit analysis \$29.00. Call or write for free catalog. (614) 491-0832. **BSOFT SOFTWARE**, 444 Colton Rd., Columbus, OH 43207.

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

**RENTAL** movie stabilizer. Connect between VCRs or to monitor. Satisfaction guaranteed. \$69.95, \$4.00 handling. 1 (800) 367-7909.

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

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

**CABLE TV converters and descramblers.** We sell only the best. Low prices. **\$B-3 \$79.00.** We ship C.O.D. Free catalog. **ACE PRODUCTS**, PO Box 582, Dept. E, Saco, ME 04072. 1 (800) 234-0726.

## CABLE TV DESCRAMBLERS!



## BARGAIN HEADQUARTERS!

JERROLD • TOCOM • HAMLIN  
SCIENTIFIC ATLANTA • ZENITH

Oak M35B ONLY \$60  
6 month warranty! We ship C.O.D.!  
Lowest retail/wholesale prices!

FREE CATALOG:  
Global Cable Network  
1032 Irving St. Suite 109  
S.F., CA 94122

**ORDER TODAY! 800-327-8544**

**Quality Microwave TV Antennas**

WIRELESS CABLE—1.9 to 2.7 Ghz. 40db Gain (+)  
36-Channel System Complete \$149.95  
12-Channel System Complete \$114.95  
Call or Write for "FREE" Catalog

**Phillips-Tech Electronics**  
P.O. Box 8533 • Scottsdale, AZ 85252  
(602) 947-7700 (\$3.00 Credit all phone orders!)

LIFETIME WARRANTY MasterCard • Visa • C.O.D.'s Quantity Pricing

**SAMS** closeout sale. #2 to #2600 \$6.00 each postpaid. MC/Visa. Call 1 (800) 274-2081. 9-5 CST.

**PRINTHEAD** repairs — Okidata, Epson, NEC, Toshiba, Digital, Texas Inst., also do board repair — **DATAFIX**, (201) 322-7666.

**TUBES** Sylvania 6LQ6, 6L6GC, 20L6 etc. Huge discounts. **ARLEN SUPPLY**, 7409 West Chester Pike, Upper Darby, PA 19082. 1 (800) 458-1301.

**TJ SERVICES** is here to serve you! Our quality products, quick courteous service, knowledgeable sales people and rock bottom prices prove it! Not sure what you need? Call (313) 979-8356 we'll help! We specialize in Jerrold, Hamlin, interference filters and most SA equipment.

**PROGRAMMABLE** stepper motor drive & control for under \$100, IBM PC/XT compatible, **Commodore 64**, or other with 25 pin parallel port. PCB, interface, & software. Send for detailed literature to: **MASE**, R.D. #2 Box 166, Mohrsville, PA 19541.

**DIGITIZER** for IBM compatible PCs 640 by 480 resolution from VCR video camera \$85.00, demonstration disk \$3.00. **CODEWARE**, Box 3091, Nashua, NH 03061.



**EMINENCE**



**MOTOROLA**

**Polydax**

**1-800-338-0531**

**PIONEER**

### 3-WAY 100W CROSSOVER

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



**\$12.50 \$9.95**  
#260-210 (1-9) (10-up)

### SPEAKER CONTROL PANEL

Panel with 50 watt L-pads  
for tweeter and midrange  
and built-in LED power  
meter. 5" x 2 1/2" 100  
watt version available



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

### 12" POLY WOOFER

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



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

### 15" WOOFER

Original Sanyo  
woofer. Paper  
cone with vented  
dust cap and  
treated cloth  
surround. 12 oz.  
magnet. 60 watts  
RMS, 85 watts  
max. 8 ohm.  
Resonance: 26 Hz.  
Response: 25-  
2,500 Hz.



**\$23.90 \$21.90**  
#291-155 (1-5) (6-up)

### PIONEER HORN TWEETER

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



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

### 12" SUB WOOFER

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



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

### 15" THRUSTER WOOFER

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



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

### GRILL FRAME KIT

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



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

### 18" EMINENCE WOOFER

MADE IN USA

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



**\$98.90 \$89.50**  
#290-200 (1-3) (4-up)

### TITANIUM COMPOSITE TWEETER

Titanium is deposited on a polymer  
dome to combine the advantages of  
both hard and soft dome  
technologies. 8 ohm. Ferro fluid  
cooled voice coil. fs = 1200 Hz.  
SPL = 90 dB 1W/1M. 50 watts RMS.  
70 watts max. 4" round. Polydax  
part #DTW100T125.



**\$27.50 \$24.80**  
#270-047 (1-9) (10-up)

Parts Express International Inc. 1989 CATALOG  
CALL TOLL FREE 1-800-338-0531  
FREE CATALOG



# AMAZING SCIENTIFIC & ELECTRONIC PRODUCTS

GRA1	ANTI GRAVITY GENERATOR	\$10.00
LC7	40 WATT BURNING CUTTING LASER	\$20.00
RUB4	HI POWER PULSED DRILLING LASER	\$20.00
BTC5	1 MILLION VOLT TESLA COIL	\$20.00
MCP1	HI VELOCITY COIL GUN	\$15.00
LLS1	LASER LIGHT SHOW 3 METHODS	\$20.00
EH1	ELECTRONIC HYPNOTISM TECHNIQUES	\$8.00
EML1	LOWER POWERED COIL GUN LAUNCHER	\$8.00
JL3	JACOB LADDER 3 MODELS	\$10.00
SD5	SEE IN THE DARK	\$10.00
LEV1	LEVITATION DEVICE	\$10.00

FMV1K	3 MILE FM VOICE TRANSMITTER	\$34.50
PFS1K	HAND CONTROLLED PLASMA FIRE SABER	\$49.50
NIG7K	HI FLUX NEGATIVE ION GENERATOR	\$34.50
PG5K	PLASMA LIGHTNING GLOBE	\$49.50
LHC2K	VISIBLE SIMULATED 3 COLOR LASER	\$44.50
HOD1K	HOMING/TRACKING BEEPER TRANSMITTER	\$44.50
LGU6K	2.5 MW HAND-HELD VISIBLE LASER GUN	\$249.50
BTC3K	250,000 VOLT TABLE TOP TESLA COIL	\$249.50
IOG2K	ION RAY GUN, project energy without wires	\$129.95
TKE1K	TELEKINETIC ENHANCER/ELECTRIC MAN	\$79.50
VWPM7K	3 MILE AUTO TELEPHONE TRANSMITTER	\$49.50

ASSEMBLED		
ASSEMBLED IN OUR LABS		
LIST10	INFINITY XMTR Listen in via phone lines	\$199.50
IPG70	INVISIBLE PAIN FIELD BLAST WAVE GENERATOR	\$74.50
ITM10	100,000 VOLT INTIMIDATOR UP TO 20'	\$99.50
JAT30	AUTOMATIC TELEPHONE RECORDING DEVICE	\$24.50
PSP40	PHASOR SONIC BLAST WAVE PISTOL	\$89.50
DNE10	ALL NEW 26" VIVID COLORED NEON STICK	\$74.50
LGU20	5 TO 1MW VISIBLE RED HeNe LASER GUN	\$199.50
BLS10	100,000 WATT BLASTER DEFENSE WAND	\$89.50

EASY ORDERING PROCEDURE - TOLL FREE 1-800-221-1705 or 24 HRS ON 1-603-673-4730 or FAX IT TO 1-603-672-5406  
 VISA, MC, CHECK, MO IN US FUNDS. INCLUDE 10% SHIPPING. ORDERS \$100.00 & UP ONLY ADD \$10.00. CATALOG \$1.00 OR FREE WITH ORDER.

**INFORMATION UNLIMITED**  
 P.O. BOX 716, DEPT. R2, AMHERST, NH 03031

### WIRELESS CABLE RECEIVERS 1.9 TO 2.7 GHz



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

SUN MICROWAVE INT'L. INC. SEND \$1.00 FOR P.O. BOX #34522 CATALOG ON THESE PHOENIX, AZ 85067 AND OTHER FINE (602) 230-0640 VIDEO PRODUCTS QUANTITY DISCOUNTS LIFETIME WARRANTY

VISA-MCAMEX MEMBER OF THE BETTER BUSINESS BUREAU

**SCREEN** print your circuit boards fast and easy. For information write to **FRED AYRES**, 4423 W. 69th, Brooklyn, OH 44144.

**DESCRAMBLERS:** dealers! We have new Z-Tac descramblers, only \$185.00 in 10 lots, with other systems available. 1 (800) 695-CABL.

**OVER 100 CPUs and microcontrollers** compared! Great for engineers and hobbyists. Includes design worksheets. \$4.00, satisfaction guaranteed, details free, **TRAVCO**, 107 E. Vallette, Suite 1301K, Elmhurst, IL 60126.

**MOTOROLA** Marti system (telephone interconnect) base station, power supply, hand-held, like new, \$1,495.00, (317) 843-2212.

3 1/2" HD 1.44MB disks \$1.89 each! Formatted, postpaid! 100% certified with labels. Made in USA. Or send \$2.00 refundable for huge catalog on electronics and rental disks. **BEACH RADIO**, 271 Shirley Street, Boston, MA 02152. (617) 846-0822.

**ZENITH** descrambler test device. Authorizes all channels for full service. Sold as test aid only! \$69.95 each for info call (407) 768-0278.

## PLANS AND KITS

**SURVEILLANCE transmitter kits!** Four models of each; telephone, room, combination telephone/room transmitters tune from 65 to 305 MHz. Catalog with **Popular Communications** book review of "Electronics Eavesdropping Equipment Design," \$1.00. **SHEFFIELD ELECTRONICS**, 7223 Stony Island Ave., Chicago, IL 60649-2806.

**BUILD** this five-digit panel meter and square-wave generator including an ohms, capacitance and frequency meter. Detailed instructions \$2.50. **BAG-NALL ELECTRONICS**, 179 May, Fairfield, CT 06430.

**MINIATURE FM transmitters!** Tracking transmitters! Voice disguisers! Bug detectors! Phone Devices! More! Available in kits or assembled! Catalog \$2.00: **XANDI ELECTRONICS**, Box 25647, Dept. 60F, Tempe, AZ 85285-5647.

**CATALOG: hobby/broadcasting/HAM/CB: Cable TV, transmitters, amplifiers, surveillance devices, computers, more!** **PANAXIS**, Box 130-F7, Paradise, CA 95967.

## REMOTE CONTROL KEYCHAIN



Complete w/mini-transmitter and 45 vdc RF receiver Fully assembled including plans to build your own auto alarm Quantity discounts available

**\$24.95** Check, Visa or M/C Add \$ 3 shipping

VISITECT INC./Dept. R (415) 872-0128 PO BOX 5442, SO. SAN FRAN., CA 94080

**INVESTIGATORS**, experimenters — Quality plans. Micro and restricted devices. Free catalog. Self-addressed stamped envelope required **KELLEY SECURITY INC.**, Suite 90, 2531 Sawtelle Blvd., Los Angeles, CA 90064.

**CB Tricks II** book. Power amplifier design and theory, UHF CB tune ups. Send \$19.95 **MEDICINE MAN CB**, PO Box 37, Clarksville, AR 72830.

**DETECTION** — Surveillance, debugging, plans, kits, assembled devices. Latest high-tech catalog \$5. **DETECTION SYSTEMS**, 2515 E. Thomas, #16-864F, Phoenix, AZ 85016.

**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) \$8.95, \$2.00 postage. **CABLETRONICS**, Box 30502R, Bethesda, MD 20824.

# CABLE TV

TB-3 (Tri-Bi) or SA-3  
 Quantity Prices

10	20
<b>\$48.</b>	<b>\$43.</b>
Each	Each
50	100
<b>\$39.</b>	<b>\$35.</b>
Each	Each

Hours open 10:00 am to 4:00 pm Eastern time  
 Minimum order 5 units 55.00 ea.  
 Dealers wanted. We ship COD.

King Wholesale  
 1-800-729-0036  
 Fax number 6173400053

"No one beats the King's prices!"

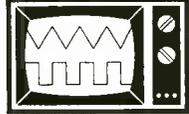
# DESCRAMBLERS



One tree can make 3,000,000 matches.



One match can burn 3,000,000 trees.

**FINALLY!**  
 An interesting and worthwhile project. This **EASY-TO-BUILD** circuit lets you use any regular TV set as a simple **OSCILLOSCOPE**. No modifications to TV! Tiny, 9v battery powered. Goes anywhere! Order now! Ask for our **FREE CATALOG** of other plans and kits!

DETAILED PLANS: \$7.95  
**TV-SCOPE**  
 PENN RESEARCH, Box 3543  
 Williamsport, PA 17701

**SURVEILLANCE.** Audio/video equipment — Debugging, industrial or private. 500 item catalog \$7.00. **SECURITY SYSTEMS**, 3017G Hudson, New Orleans, LA 70131.

**FM wireless microphone, 3 mile range, plans \$4.00.** **FM**, PO Box 4383, Bloomington, IL 61702-4383.

**DAZER** defense device kit! \$44.95. Exciting unique kits catalog \$1.00. **QUANTUM RESEARCH**, 1919-77 Avenue, Edmonton, Alberta T5T 2S1.

**ELECTRICITY** from the sun! Learn to make homemade solar cells. Pennies each. \$5.95, W.C.N., 3283 Belvedere, Riverside, CA 92507.

**MUSICIANS**, 0-999 beats per minute digital metronome; plans \$15.00 check to: **NEUTRONICS**, 107 Elmdorf, Rochester, NY 14619.

**BUILD robot** from outer space! Plans \$11.95, details free. **ROBOT WORKS**, Box 1979, Colorado Springs, CO 80901.

**DIGITAL V.O.M./D.P.M. SALES—SERVICE—PARTS**

**FLUKE-BECKMAN-SIMPSON-ETC.**  
 U.S. MADE ONLY QUOTATION PRIOR TO WORK FAST SERVICE, 90 DAY WARRANTY, STANDARDS TRACEABLE TO NBS SINCE 1948. CALIBRATION CERTIFICATE AVAILABLE.

INDUSTRIAL INSTRUMENT WKS. INC.  
 5745 SALMEN, HARAHAN, LA 70123 504/733-8355



## NEW HE NE LASER TUBES \$35

Dealer Inquiries Invited.  
Free Catalog!

MEREDITH INSTRUMENTS: 6403 N. 59th Ave.  
Glendale, AZ 85301 • (602) 934-9387  
"The Source for Laser Surplus"

**LASERS** Build gunsights, pointers, liteshow, nitelite, lab. Blueprints and instructions \$9.00 each, 3 for \$20.00. Free list. **NIGHTWRITER**, POB 4418, Phoenix, AZ 85016.

**FM transmitter 88-108 MHZ kit \$12.95:** Flyback tester assembled \$95.99; S & H 4%, **SIERRA ELECTRONICS**, Box 709, Elfers, FL 34680-0709.

**INFRARED detector.** Build our penlight style pocket tester. Test and verify infrared signals on V.C.R.'s, T.V.'s, alarm systems, remote controls, etc. Plans \$5.00, kit \$15.00 to **K-TRONICS**, 3004 South Turner, Springdale, AR 72764.

## BUG ROOM THRU PHONE

Circuit added to your phone always silences 1st ring. When you send secret sequence of "silent rings" - your phone answers itself allowing you to listen in on room while still on the hook! You are not detected! Works like a normal phone all other times. Free hard to find TCM 1506 ring detector chip included with step by step instructions. Send \$13.95 to:

**LASER BOUNCE, INC.**  
2020 Pennsylvania Ave. NW Suite 802  
Washington, D.C. 20006

**STRANGE stuff.** Get the advantage! Laser listener, surveillance, descrambling, underground information. Plans, kits, complete items. Informational package \$3.00 refundable. **DIRIJO/BOND**, Box 212, Lowell, N.C. 28098.

**RECEIVE** all cordless telephones on your police scanner. \$5.00 and SASE gets frequencies. **FRE-QUENCIES**, PO Box 550, Tiverton, RI 02878.

**LASER** lighting entertainment systems. Create your own 3-dimensional laser light shows. Detailed mechanical and electrical schematics, scanning and control operations. \$20.00. **MILLENNIUM**, 877 Saint Charles #5, Thousand Oaks, CA 91360.

## GET IN NOW ON THE \$12 BILLION A YEAR COMPUTER SERVICE INDUSTRY

**EARN UP TO 45/HR!**  
**LEARN HOW TO CLEAN/ MAINTAIN/REPAIR PRINTERS...**  
VIEJO'S AWARD-WINNING TRAINING VIDEO AND COMPANION TRAINING MANUAL (OVER 300 ACTION-PACKED PAGES) REVEALS SECRETS OF PRINTER REPAIR WITH YOUR AVERAGE MECHANICAL ABILITY WE CAN SHOW YOU HOW TO REPAIR UP TO 95% OF ALL PRINTERS - START EARNING EXTRA CASH IN DAYS!

**HUGE UNTAPPED MARKET!**  
SERIOUS LACK OF TRAINED TECHNICIANS  
OVER 37 MILLION P.C.'S IN USE - APPROXIMATELY 85% HAVE A PRINTER ATTACHED - VAST MAJORITY OF PRINTER BREAKDOWNS ARE DUE TO SIMPLE MECHANICAL OR ELECTRO-MECHANICAL FAILURE.

**FREE INFO**  
CALL 1-800-537-0589

OR WRITE TO: **VIEJO PUBLICATIONS**  
3540 WILSHIRE BL. # 310  
DEPT RE 2 L A CA 90010

## EDUCATION & INSTRUCTION

**MAGIC!** Four illustrated lessons plus inside information shows you how. We provide almost 50 tricks including equipment for four professional effects. You get a binder to keep the materials in, and a one-year membership in the International Performing Magicians with a plastic membership card that has your name gold-embossed. You get a one-year subscription to our quarterly newsletter "IT'S MAGIC!" Order now! \$29.95 for each course + \$3.50 postage and handling. (New York residents add applicable state and local sales tax). **THE MAGIC COURSE**, 500-B BiCounty Boulevard, Farmingdale, NY 11735.



New solid-state and digital TV sets, stereos, and videocorders are tougher to repair than old-fashioned tube type sets and require special training for the service technician who works on them.

Only a few states have laws requiring competency tests for licensing technicians who repair consumer electronics, but fifteen years ago the International Society of Certified Electronic Technicians (CET) began its own certification program to qualify these technicians and those in industry. To carry the CET designation, technicians must have four years experience and pass a rigid examination on general electronics and a specific area of expertise such as audio or radio-TV.

Many consumers look for a Certified Electronic Technician in the shop when they need any electronic item repaired.

### Free Consumer Checklist

A consumer checklist for selecting a service shop is available free by sending a stamped, self-addressed envelope to: Checklist, ISCEET, 2708 West Berry, Fort Worth, TX 76109. The list reminds consumers to check such items as "Does the business have the parts for your particular brand?", "Did you get an estimated price?" and "Did you check this company with the Better Business Bureau?"



Modern electronic equipment such as digital TVs or stereos should be repaired by specially trained people.

available free by sending a stamped, self-addressed envelope to: Checklist, ISCEET, 2708 West Berry, Fort Worth, TX 76109. The list reminds consumers to check such items as "Does the business have the parts for your particular brand?", "Did you get an estimated price?" and "Did you check this company with the Better Business Bureau?"

# Take Note Of MCM Electronics

You'll Be Glad You Did

## SELECTION



Our huge inventory of over 15,000 different items is constantly monitored and re-stocked to virtually eliminate backorders and get your parts and components to you FAST!

## NAME BRANDS



RCA/GE, Pioneer, Pyramid, Weller, Switchcraft, Excelite, Leviton, Audio-Technica, B&K, Rawl, GC, Pyle, Sams, Mueller and MORE! You'll find the most respected brands in the industry at MCM!

## SERVICE

Our friendly, knowledgeable Sales Reps are just a quick, TOLL-FREE call away to take your order or provide production technical assistance when you need it. We also offer FAX ordering, convenient hours and multiple payment options.

## FREE CATALOG



For A FREE, ONE-YEAR SUBSCRIPTION to the MCM Electronics Catalogs, Call TOLL-FREE,

**1-800-543-4330**



**MCM ELECTRONICS**

650 CONGRESS PARK DR.  
CENTERVILLE, OH 45459-4072

A PREMIER Company

SOURCE NO. RE-65

CIRCLE 87 ON FREE INFORMATION CARD

# UNICORN YOUR I.C. SOURCE

## COLLIMATOR PEN (INFRA-RED)

A low power collimator pen containing a MOVPE grown gain guided GaAlAs laser. This collimator pen delivers a maximum CW output power of 2.5 mW at 25°.

These collimated laser sources are designed for industrial applications such as data retrieval, telemetry, alignment, etc.

The non-hermetic stainless steel encapsulation of the pen is specifically designed for easy alignment in an optical read or write system, and consists of a lens and a laser device. The lens system collimates the diverging laser light. The wavefront quality is diffraction limited.

The housing is circular and precision manufactured with a diameter of 11.0 mm and an accuracy between + and - 11 μm.

LIST PRICE: ~~\$180.00~~ OUR PRICE: **\$39.99**

• QUALITY COMPONENTS...LOW PRICES SINCE 1983 •



## LASER DIODE (INFRA-RED)

Designed for general industrial low power applications such as reading optical discs, optical memories, barcode scanners, security systems, alignment, etc.

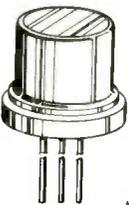
The gain guided laser is constructed on an n-type gallium arsenide substrate with a Metal Organic Vapor Phase Epitaxial process (MOVPE).

The device is mounted in a hermetic SOT1148D encapsulation, (diameter 9.0 mm)

The SB1053 is standard equipped with a monitor diode, isolated from the case and optically coupled to the rear-emitting facet of the laser. This fast-responding monitor diode can be used as a sensor to control the laser optical output level.

LIST PRICE: ~~\$38.00~~ OUR PRICE: **\$9.99**

• WE CARRY A FULL LINE OF COMPONENTS! •



## EPROMS

STOCK#	PINS	DESCRIPTION	1-24	25-99	100+
1702	24	256 x 4 1μs	3.99	3.79	3.41
2706	24	1024 x 8 450ns	6.49	6.17	5.55
2758	24	1024 x 8 450ns	3.99	3.79	3.41
2716	24	2048 x 8 450ns (25v)	3.29	3.13	2.82
2716-1	24	2048 x 8 350ns (25v)	3.79	3.60	3.24
TMS2716	24	2048 x 8 450ns	6.29	5.98	5.38
2716	24	2048 x 8 450ns (25v CMOS)	3.99	3.79	3.41
2732	24	4096 x 8 450ns (25v)	3.79	3.60	3.24
2732A-2	24	4096 x 8 200ns (21v)	3.79	3.60	3.24
2732A	24	4096 x 8 250ns (21v)	3.69	3.51	3.16
2732A-4	24	4096 x 8 450ns (21v)	3.19	3.03	2.73
TMS2532	24	4096 x 8 450ns (25v)	5.79	5.50	4.95
TMS2532	24	4096 x 8 450ns (25v CMOS)	1.99	1.89	1.70
27532	24	4096 x 8 450ns (25v CMOS)	4.19	3.98	3.58
2764-20	28	8192 x 8 200ns (21v)	3.99	3.79	3.41
2764	28	8192 x 8 250ns (21v)	3.79	3.60	3.24
2764A-20	28	8192 x 8 200ns (12.5v)	3.99	3.79	3.41
2764A	28	8192 x 8 250ns (12.5v)	3.29	3.13	2.82
TMS2564	28	8192 x 8 250ns (25v)	6.79	6.45	5.81
2764C	28	8192 x 8 250ns (21v CMOS)	4.19	3.98	3.58
27128-20	28	16,384 x 8 200ns (21v)	5.79	5.50	4.95
27128	28	16,384 x 8 250ns (21v)	5.09	4.84	4.35
27128A	28	16,384 x 8 250ns (12.5v)	5.79	5.50	4.95
27C128	28	16,384 x 8 250ns (21v)	5.79	5.50	4.95
27256-20	28	32,768 x 8 200ns (12.5v)	5.29	5.03	4.53
27256	28	32,768 x 8 250ns (12.5v)	4.79	4.55	4.09
27256B	28	32,768 x 8 250ns (12.5v CMOS)	5.29	5.03	4.53
27512-20	28	65,536 x 8 200ns (12.5v)	7.49	7.12	6.41
27512	28	65,536 x 8 250ns (12.5v)	6.99	6.64	5.98
27512B	28	65,536 x 8 250ns (12.5v CMOS)	6.99	6.64	5.98
27C1024	32	131,072 x 8 200ns (12.5v CMOS)	17.99	17.09	15.38
86764	24	8192 x 8 450ns	13.99	13.29	11.96
86766	24	8192 x 8 450ns	14.99	14.24	12.82

• CALL FOR A FREE CATALOG! •



10010 Canoga Ave., Unit B-8 • Chatsworth, CA 91311

OUTSIDE CALIFORNIA: (800) 824-3432  
IN CALIFORNIA: (818) 341-8833  
ORDER BY FAX: (818) 998-7975

CIRCLE 190 ON FREE INFORMATION CARD

## THE ELECTRONIC GOLDMINE



The Electronic Goldmine has one of the greatest selections of unique electronic kits available in the World! We have over 130 Kits and almost 1,000 unique, bargain priced, components in our new 1990 Catalog #211. Request your copy today, or better yet, order and be placed on our Preferred Customer mailing list to be the first to receive new catalogs when they are printed.

### ☆ MINI GEGGER COUNTER KIT ☆

Everyone knows how fascinating and useful Geiger Counters are, but their price is usually \$100 or more! We've made a tremendous price breakthrough! Not only is our Geiger Counter Kit one of the smallest, it's the most reasonable priced Geiger Counter available anywhere!

This ultra-sensitive kit detects Alpha, Beta, Gamma and X-ray radiation and emits clicks in proportion to the intensity of the radiation. Features sensitive alpha window GM tube and IC circuit that operates from standard 9V battery (not included). Detects radiation from radium dials on old watches, lantern mantles, radioactive minerals, background radiation, etc. Note: not for detecting Radon Gas. Size of Board: 3" x 19". Complete with all parts, PC board and instructions.



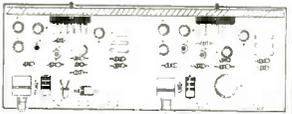
C6430 \$59.95

**SPECIAL ITEM!**

### 20W + 20W STEREO AMP KIT

Two separate high power amps on one PC board. Each amp has its own level control and puts out 20 watts.

20 Watts RMS. Features red LED "on" indicator and low distortion circuitry. Great stereo booster amp for your car sound system. Use with any speakers capable of handling at least 20 Watts. Operates on 12VDC. Size of board 6" x 22". Complete with all parts, PC board and instructions.



C6442 \$19.95

MINIMUM ORDER: \$10.00 plus \$3.00 shipping and handling

We accept MC, Visa and Money Orders

SEND ORDERS TO: The Electronic Goldmine

P.O. Box 5408 Scottsdale, AZ 85261

PHONE ORDERS: (602) 451-7454

CIRCLE 177 ON FREE INFORMATION CARD

BE a recording engineer; Train at home for high-paying — Exciting careers. Free information. **AUDIO INSTITUTE**, 2174 Union St. Suite 22K, San Francisco, CA 94123

BASIC video cleaning and maintenance. TV one half hour, VCR one hour. \$38.00 each. **JAMES BRADFORD**, PO Box 38359, Detroit, MI 48238.

EARN \$32,000 to \$58,000 working 6-8 months annually. 6-7 months part time studying required. U.S. or foreign merchant marine radio officer's licenses. Booklet tells how and where to obtain study materials, meet government requirements, exams. Also address list of 100+ government agencies, universities, US, foreign shipping companies, all potential employers. Send \$7.50 to **KNOWLTECH INC.**, POB 1070, St. Pete, FL 33731.

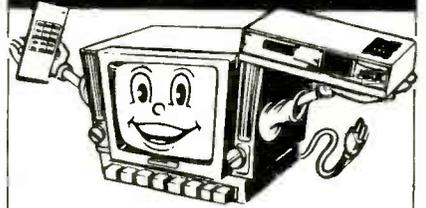
COMPLETE digital training course. Comprehensive overview of digital electronics. Super handy desktop reference! Hundreds of pages/illustrations. Free newsletter with order. Send \$10.00 to **VIEJO PUBLICATIONS**, 3540 Wilshire Blvd. #310, Dept. DG100, LA, CA 90010 or call 1 (800) 537-0589.

## CABLE TV DESCRAMBLER LIQUIDATION!

- Major Makes & Models!
- Will match or beat anyone's prices!
- Dealer discounts at 5 units!
- Examples:
  - HAMLIN COMBOS \$44 ea. (Min. 5)
  - OAK ADD/ON \$40 ea. (Min. 5)
  - OAK M35B \$60 ea. (Min. 5)

**WEST COAST ELECTRONICS**  
For Information: 818-709-1758  
Catalogs & Orders: 800-628-9656

## CABLE T.V. CONVERTERS WHY PAY A HIGH MONTHLY FEE?



All Jerrold, Oak, Hamlin, Zenith, Scientific Atlanta, Magnavox and all specialized cable equipment available for shipment within 24 hours. For fast service MC / VISA or C.O.D. telephone orders accepted (800) 648-3030 60 Day Guarantee (Quantity Discounts) 8 A.M. to 5 P.M. C.S.T. **CLOSED WEEK-ENDS.** Send self-addressed Stamped envelope (60¢ postage) for Catalog.

**MIDWEST ELECTRONICS INC.**  
P.O. Box 5000  
Suite 311 (R)  
Carpentersville, IL 60110

No Illinois Orders Accepted.

ELECTRONIC camera repair: Five day residency and 18 home study lessons. Video aided and 800-number supported. Free brochure. **C & C ASSOCIATES**, 300 Highail, Greencastle, IN 46135. (317) 653-3405. Regulated by Commission on Proprietary Education.

BECOME a TV satellite news technician. Home training. Free info. **SPACELINK**, PO Box 8497, Bridgeport, CT 06606.

ELECTRONIC review Detailed electronics reviewing for bettering grades, interviews, and promotions. Over 300 pages \$39.95 include \$4.25 shipping. **USER-GRAPHICS**, Education Department, 7136 Everett, Boise, ID 83704-7415.

## TEST EQUIPMENT ACCESSORIES

LOW cost oscilloscope probes, multimeter test leads. Save over 50%. 1 (800) 772-1519 free catalog. **PROBEMASTER INC.**, 4898 Ronson Court, San Diego, CA 92111-5000.

**NUTS & VOLTS** P.O. Box 1111-E  
MAGAZINE Placentia, CA 92670  
714-532-7271

GIVE YOURSELF A BREAK — A PRICE BREAK!  
NUTS & VOLTS WILL **SAVE** YOU MONEY  
ON ELECTRONIC PARTS & EQUIPMENT  
PLUS SHOW YOU WHERE TO FIND UNIQUE,  
UNUSUAL AND HARD-TO-FIND ITEMS.  
SUBSCRIBE TODAY!  
Orders Only 800-789-6624

Subscription Rates	
U.S. FUNDS REQUIRED	
3rd Class Mail - USA	
ONE YEAR \$10.00	
TWO YEARS \$21.00	
LIFETIME \$60.00	
1st Class Mail	
ONE YEAR USA \$20.00	
CANADA-MEXICO \$22.00	
Air Mail	
FOREIGN 1 Yr. \$55.00	

A National Publication For The Buying And Selling Of Electronic Equipment

## SATELLITE TV

FREE catalog — Lowest prices worldwide, save 40 — 60%. Systems, upgrades, parts, all major brands factory fresh and warranted. **SKYVISION, INC.**, 2009 Collegeway, Fergus Falls, MN 56537. 1 (800) 334-6455. MN & International (218) 739-5231.

VIDEOCIPHER II manuals. **Volume 1** — hardware, **Volume 2** — software. Either \$34.95. **Volume 3** — projects/software, **Volume 5** Documentation or **Volume 6** — Experimentation \$44.95 each. **Volume 4** — Repair \$99.95. **Cable Hacker's Bible** — \$34.95. **Clone Hacker's Bible** — \$34.95. Catalog — \$3.00. CODs: (602) 782-2316. **TELECODE**, PO Box 6426-RE, Yuma, AZ 85366-6426.

## ANTIQUE RADIO CLASSIFIED

Free Sample!  
Antique Radio's  
Largest Circulation Monthly.  
Articles, Ads & Classifieds.  
6-Month Trial: \$11. 1-Yr: \$20 (\$30-1st Class).  
A.R.C., P.O. Box 802-L4, Carlisle, MA 01741

# CABLE TV "BOXES"

Converters — Descramblers  
Remote Controls — Accessories

- ★ Guaranteed Best Prices ★
- ★ 1 Year Warranty — C.O.D.'s ★
- ★ Immediate Shipping ★
- ★ FREE CATALOG ★

Call or Write

**TRANS-WORLD CABLE CO.**

12062 Southwest 117th Court, Suite 126  
Miami, Florida 33186  
1-800-442-9333



## BUSINESS OPPORTUNITIES

**EASY** work! Excellent pay! Assemble products at home. Call for information: (504) 641-8003 Ext. 5192.

**MAKE** \$50/hr working evenings or weekends in your own electronics business. Send for free facts. **INDUSTRY**, Box 531, Bronx, NY 10461.

**YOUR own radio station!** AM, FM, TV, cable. Licensed/unlicensed. **BROADCASTING**, Box 130-F7, Paradise, CA 95967.

**INVENTORS:** We submit ideas to industry. Find out what we can do for you. Call 1 (800) 288-IDEA.

## K.D. VIDEO

FOR ALL YOUR CABLE TV NEEDS  
WE SPECIALIZE IN DEALER PRICING

QTY	1	10	20
Jerrold (Type) SB-3	89.00	56.00	48.00
Jerrold (Type) Tri-Bi	119.00	69.00	65.00
Scientific Atlanta SA-3	129.00	80.00	75.00
Hamlin MLD-1200	99.00	59.00	45.00
Oak N-12 Vari-Sync	99.00	59.00	58.00
Jerrold 550 Converter	99.00	75.00	68.00
Jerrold 400 DRX-3DIC (With Built in SB-3)	169.00	109.00	100.00

1-800-327-3407

Call us for prices on large quantities

K.D. Video PO Box 29538, Mpls., MN 55429

**EASY! Moneymaking** one man CRT rebuilding machinery. \$6,500.00 — \$11,900.00. **CRT**, 1909 Louise, Crystalake, IL 60014. (815) 459-0666.

**LEARN** to clean/repair fax machines. Huge new market! Earn \$85/hour. No experience necessary. Free details call 1 (800) 537-0589 or write to: **VIEJO PUBLICATIONS**, 3540 Wilshire Blvd. #310, Dept. FX200, LA, CA 90010.

## COMPUTERS FOR LESS

10 MHz 8088 System..... \$369

- 4.77/10 MHz 8088 Motherboard
- 256 KB RAM (640KB max)
- 150 Watt Power Supply
- Floppy Disk Controller
- One 5.25" 360 KB Floppy Drive
- MonoGraphics Card w/ Parallel Port
- 101 Key Enhanced Keyboard
- Case (3 LEDs ,2 Buttons ,Key-Lock)
- 12" Amber Monochrome Monitor

12 MHz 80286 System..... \$669

- 12 MHz 80286 Motherboard
- 0 Wait State
- 512 KB RAM (4 MB max)
- 200 Watt Power Supply
- Floppy Disk Controller
- One 5.25" 1.2 MB Floppy Drive
- MonoGraphics Card w/ Parallel Port
- 101 Key Enhanced Keyboard
- Case (3 LEDs ,2 Buttons ,Key-Lock)
- 12" Amber Monochrome Monitor

One Year Parts & Labor Warranty

30 Day Satisfaction Guarantee

Shipping & Handling Extra

VISA & M/C add 3% Amex add 4%

Price & Availability subject to change without prior notice

## JINCO COMPUTERS INC.

5122 Walnut Grove Avenue

San Gabriel, CA 91776

Tel: (818) 309-1108

CIRCLE 178 ON FREE INFORMATION CARD

**CABLE TV secrets** — the outlaw publication the cable companies tried to ban. HBO, Movie Channel, Showtime, descramblers, converters, etc. Suppliers list included. \$9.95. **CABLE FACTS**, Box 711-R, Pataskala, OH 43062.

**VIDEOCYpher II descrambling manual.** Schematics, video and audio. Explains DES, EPROM, CloneMaster, 3Musketeer, pay-per-view (HBO, Cinemax, Showtime, adult, etc.) \$13.95, \$2.00 postage. Collection of software to copy and alter EPROM codes, \$25. **CABLETRONICS**, Box 30502R, Bethesda, MD 20824.



## TUBES - 2000 TYPES DISCOUNT PRICES!

Early, hard-to-find, and modern tubes. Also transformers, capacitors and parts for tube equipment. Send \$2.00 for 24 page wholesale catalog.

## ANTIQUE ELECTRONIC SUPPLY

688 W. First St. • Tempe, AZ 85281 • 602/894-9503

# If You Are Buying Any of The Following Panasonic® Products Elsewhere, You Are Paying Too Much! Period.

- ★ Series ECQ-E Metallized Polyester Capacitors
- ★ Series ECQ-P(F) Precision Polypropylene Capacitors
- ★ Series X-Y Interference Suppressor AC Capacitors
- ★ Series ECE-Z Low Impedance Aluminum Electrolytic Caps.
- ★ Series TSW Large Aluminum Electrolytic Capacitors
- ★ Series EVN-K0 & EVN-K4 Carbon Trim-Pots.
- ★ Series EVM-31G & EVN-36C Dust-Proof Cermet Trim-Pots
- ★ Series EVM-Q0 & EVM-Q1 Hermetically Sealed Trim Pots
- ★ Series EXBF 2% SIP Resistor Networks
- ★ Series ECQ-M Polyester & Foil Capacitors
- ★ Series ECQ-V Metallized Stacked Film Capacitors
- ★ Series ECE-K Sub-Miniature Aluminum Electrolytic Capacitors
- ★ Series ECE-LS Miniature Aluminum Electrolytic Capacitors
- ★ Series ECS-EF Dipped Solid Tantalum Capacitors
- ★ Series EVM-M0F & EVM-M1F Industrial Cermet Trim-Pots
- ★ Series EVM-S0G Hermetically Sealed Trimmer Potentiometers
- ★ Series EVM-C7G Rectangular 15-Turn Trimmer Potentiometers

### 12 Months Saving Guarantee

We will refund the first year Membership Fee of any member who has purchased \$300 or more worth of products from Electronic Buyers Club and has not saved an amount greater than the first year Membership Fee, if buying the same items elsewhere.

And these are only 1603 of the more than 10,000 items that we stock and offer to our Members at super low prices. In fact after buying just a few hundred of the above items from Electronic Buyers Club, you will recover the \$35.00 Annual Membership Fee while your saving continues on for the rest of the year. Become a Member today and start paying Less.

### 30 Days Money Back Guarantee

We will refund the full Membership Fee of any new member of Electronic Buyers Club who within 30 Days after receiving the Membership Binder, returns the Binder to EBC and asks for the cancellation of Membership.

**Electronic  
Buyers  
Club**

A Division of International Components Corporation

1803 N.W. Lincoln Way • Toledo, OR 97391  
PHONE (All 50 States & Canada): 1-800-325-0101  
FAX: (503) 336-4400 • Hours: 6:00 AM - 6:00 PM PST



CIRCLE 186 ON FREE INFORMATION CARD

# CABLE TV DESCRAMBLERS

JERROLD™ Tri-Bi Mode.....	\$105.00	10 Lot \$85.00
JERROLD™ SB-3 OR 2.....	\$89.00	\$65.00
Hamlin M.I.D-1200.....	\$99.95	\$62.00
Oak N-12 W/V.S.....	\$99.95	\$62.00
Oak-M-35-B W/V.S.....	\$99.00	\$78.00
OAK E-13.....	\$99.95	\$58.00
Zenith SSAVI.....	\$185.00	\$145.00
Eagle PD-3.....	\$120.00	\$85.00
Scientific Atlanta.....	\$129.95	\$105.00
SA-Combo's.....	CALL	\$Call
Tocom.....	\$350.00	\$295.00
Oak N-12 W/ Auto.....	\$140.00	\$105.00
Jerrold Starcom CSV.....	\$139.95	Call

M.D. ELECTRONICS  
WILL MATCH ANY  
ADVERTISED PRICE  
IN THIS MAGAZINE

## \*NEW STARGATE 2000 CABLE CONVERTER



1-\$89.00 10-\$69.00 100-Call

Last channel recall-Favorite channel select-  
75 channel-Channel scan-Manual fine tune-  
One year warranty-surge protection-HRC & Stand-  
ard switchable- and much more. **Call Today!**

INFORMATION(402)554-0417

Orders Call Toll Free

**1-800-624-1150**

**M.D. ELECTRONICS**  
**115 NEW YORK MALL**  
**SUITE 133E**  
**OMAHA, NE. 68114**

M.C.  
VISA  
C.O.D.

CIRCLE 53 ON FREE INFORMATION CARD

# CABLE TV EQUIPMENT

Converters, Remote Controls,  
Descramblers, CD Players.



**JERROLD-OAK-SCIENTIFIC ATLANTA-HAMLIN  
ZENITH MANY MORE CALL TODAY!**

- √ Only quality products sold
- √ Easy to use
- √ Satisfaction guaranteed
- √ Knowledgeable sales staff
- √ Most orders shipped within 24 hours

**CALL FOR YOUR FREE CATALOG**

**MC 1-800-228-7404 VISA**

**MAKE THE CONNECTION**

**WITH**

**NU-TEK ELECTRONICS**

5114 Balcones Wood Dr.#307 Dept.298

Austin, TX. 78759

**LET the government finance your small business.**  
Grants/loans to \$500,000. Free recorded message:  
(707) 449-8600. (KS1).

**EARN \$1000's extra as a part-time computer dealer.** Where to buy products at big discounts. Who to sell to. Financing without cash. Obtaining free software. Exclusive dealer trade shows. Step-by-step check list. Industry inside knowledge. Written by industry pioneer. Order now, only \$24.95 plus \$4.00 shipping/handling, CA residents add \$1.81 sales tax. **CORNERSTONE PUBLICATIONS**, Dept BC, PO Box 5151, San Jose, CA 95150. Allow 2-4 weeks.

**MAKE \$75,000 to \$250,000 yearly or more** fixing IBM color monitors (and most brands). No investment. Start doing it from your home. (A telephone required.) Information, USA, Canada \$1.00 cash. US funds, other countries \$8.00 **RANDALL DISPLAY**, Box 2168-R, Van Nuys, CA 91404 USA.

## INVENTORS

**INVENTORS!** Can you patent and profit from your idea? Call **AMERICAN INVENTORS CORPORATION** for free information. Over a decade of service 1 (800) 338-5656. In Massachusetts or Canada call (413) 568-3753.

## SPEAKER BOX

**BUILDERS program** for the IBM PC XT/AT and Commodore 64 computers. Very easy to use, even for beginners. Calculates ported boxes, closed boxes, port sizes, unknown speaker tester. Includes manuals and books. Only \$25.00. **JORDAN CENTURY**, PO Box 1347, Odessa, TX 79762.

## COMPUTER BOOKS

**DISCOUNT computer books.** All titles available, including recent releases. Please call or write for our latest catalog. **BOOKWARE**, 147 Campville Road, Northfield, CT 06778. 1 (800) 288-5662.

## Computer Kits

80286-12mhz, 1.2 or 1.44 Floppy,  
101 Keyboard, 5.25" Mono Monitor,  
Parallel Port, 5 Drive Case, 200 Watt  
Power Supply, Year Warranty, 100%  
IBM Compatible, Free Software

**Free Catalog**

General Technics  
Quality Computer Systems  
Post Office Box 2676  
Lake Ronkonkoma, NY 11779  
(516) 981-9473



## LAWN MOWER

*continued from page 74*

(minimum speed) to +8.0 volts (maximum speed). Pin 4 will have an active PWM output and pin 7 will remain at -10 volts. Conversely, when the left wheel moves in reverse, the input voltage will vary between -0.7 volts (minimum speed) to -8.0 volts (maximum speed), and the voltage at pin 4 will remain at -10 volts. Therefore, each drive wheel can be made to move in the forward or reverse direction by simply changing the polarity of the input signal at pins 9 and 11.

### Driver transistors

Transistors Q1-Q12 are used as drivers at the output of the PWM IC's (IC9 and IC10). Those transistors are required to convert the ±10-volt drive signal from the UC3637's into a 0- to +30-volt drive signal required by the power MOSFET's (contained on power board) to turn the drive wheels. As the forward output signal (IC9 pin 4) rises to +10 volts, Q2 will turn on

and ground the R73-R72 junction. That causes Q1 to turn on and +30 volts to be applied to the power MOSFET inputs (J22 pin 25). When the forward output signal drops to 0 volts, Q2 will turn off and Q3 will be turned on. That causes the voltage at J22 pin 25 to quickly return to 0 volts. The resultant output is an amplified PWM signal that varies between 0 and +30 volts. The process is identical for the outputs at pin 7 of IC9 and pins 4 and 7 of IC10.

### Sensor amplifiers

There are 15 identical grass-sensor amplifiers contained on the motor-controller board (see Fig. 4). The outputs are identified as BD1-BD15. Since all the amplifier circuits are identical, we will describe only the operation of the BD1 amplifier.

The input to the amplifier is AC coupled by capacitor C27. SIP-resistors R95 and R96 provide transistor-array IC16's bias voltage. (In order to conserve as much space as possible, transistor arrays IC16 and IC17 were used for most of the amplifier circuits instead of discrete tran-

sistors.) Transistor IC14-a provides an amplified output at its collector with the help of pull-up resistor R97-a. The output is coupled to inverter IC14-a for buffering and signal inversion. The TTL output of IC14-a (pin 2) is sent to the CPU board through J22 pin 2 for processing.

### Motherboard

The motherboard provides the interconnections between the CPU board, the motor-controller board, and the power board. The motherboard is a simple two-sided PC board that contains three edge connectors. The schematic diagram of the motherboard will be shown next month.

### Next month

Unfortunately, you'll have to wait until next month for details on how to build the motor-controller board and also the motherboard. We'll also provide foil patterns for the main and motor-controller board if you wish to etch your own PC boards. We will show you how to assemble all of the mechanical components and wind up with the completed working unit. **R-E**

**WANTED**

**INVENTORS!** Confused? Need help? Call **IMPAC** for free information package. In US and Canada: 1 (800) 225-5800.

**INVENTIONS/new products/ideas wanted:** Call **TLCI** for free information 1 (800) 468-7200 24 hours/day - USA/Canada.

**TEST equipment** Only Hewlett-Packard, Fluke, Tektronix, Wavetek, Boonton and other top American manufactures wanted. Send your list or catalog to: **HTB ELECTRONICS, Alter Apeler Weg 5 2858 Schiffford West Germany.**

**ATTENTION — Hiring!** Government jobs — your area. \$17,840 — \$69,485. Call (602) 838-8885. Ext R 16329.

**WANTED** Tektronix 549 oscilloscope working/not working. **MICHAEL PAGE**, 100 McCaul Street, Toronto, Ontario, Canada M5T 1W1. (416) 977-5311.

**TOCOM DESCRABLERS**

**TOCOM** descramblers complete units with remote \$150.00 each. Quantity discounts. Scientific Atlanta 8500's \$200.00. Call (213) 478-2506.

**BEST BY MAIL**

Rates: Write National, Box 5, Sarasota, FL 34230

**AUTOMOTIVE**

**GOVERNMENT SEIZED VEHICLES** Low as \$100! Amazing recorded message reveals details! (708)705-2324.

**BOOKS · CATALOGS · MAGAZINES**

**FREE CATALOG · DESIGNER** Clothing. OMEGA, 101(RE) Clematis, Pensacola, FL 32503-2834.

**BUSINESS OPPORTUNITIES**

**MINI STUM GUNS.** 5" long, 65,000 volts. Distributors needed. 803-627-1739.

**OF INTEREST TO ALL**

**BE A PROFESSIONAL.** Learn how! Send \$1.00 to: Pro-7(RE), Box 620190, San Diego, CA 92162.

**VACATIONS NATIONWIDE 50% SAVINGS!** 1-900-988-3636. Ext. 44. \$3 per call.

**3 FOR 1 SPECIAL**

**ON SUB-MINIATURE VOICE FM TRANSMITTERS. KITS CONTAIN PC BOARDS**



**\*FMX-1 LONG RANGE (3 MI) ULTRA SENSITIVE FM VOICE XMTR** with fine tune, range control plus..... \$34.50



**\*TELX-1 TELEPHONE FM XMTR (3 MI)** automatically operates when phone is used. Crystal clear clarity with fine tune and range control. Non detectable..... \$34.50



**\*ATR-1 AUTOMATIC TELEPHONE RECORDING DEVICE** tapes telephone conversation all automatically..... \$19.50

**ALL THREE OF ABOVE FOR..... \$69.50**

**CALL OR SEND VISA, MASTER CHARGE, MONEY ORDER, ETC. TO AMAZING CONCEPTS, BOX 716, AMHERST, NH 03031. (603) 673-4730.**

**FREE CATALOG!**  
**1-800-648-7938**  
 For all information 1-702-362-9026  
**JERROLD HAMLIN OAK ETC.**  
**CABLE TV**  
**DESCRAMBLERS**  
 • Compare our low Low Retail Prices!  
 • Guaranteed Prices & Warranties!  
 • Orders Shipped Immediately!  
**REPUBLIC CABLE PRODUCTS INC.**  
 4080 Paradise Rd. #15 Dept. RE-90  
 Las Vegas, NV 89109

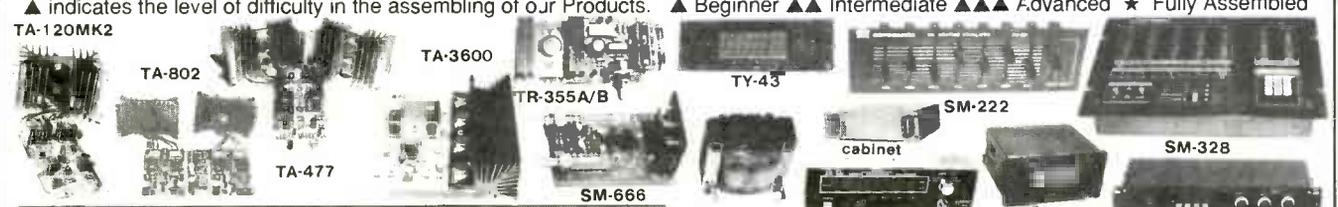
\*\*\*\*\*PRESENTING\*\*\*\*\*  
**CABLE TV**  
**DESCRAMBLERS**  
 \*\*\*\*\*STARRING\*\*\*\*\*  
**JERROLD, HAMLIN, OAK**  
 AND OTHER FAMOUS MANUFACTURERS

- FINEST WARRANTY PROGRAM AVAILABLE
- LOWEST RETAIL/WHOLESALE PRICES IN U.S.
- ORDERS SHIPPED FROM STOCK WITHIN 24 HOURS

FOR FREE CATALOG ONLY **1-800-345-8927**  
 FOR ALL INFORMATION 1-818-716-5914

**PACIFIC CABLE CO. INC.**  
 7325 RESEDA BLVD., DEPT. 1000  
 RESEDA, CA 91335

**MARK V ELECTRONICS, INC.**  
**QUALITY COMPONENTS \* COMPETITIVE PRICES**  
 ▲ indicates the level of difficulty in the assembling of our Products. ▲ Beginner ▲▲ Intermediate ▲▲▲ Advanced ★ Fully Assembled



AMPLIFIERS		KIT	ASSMB.
MODEL	DESCRIPTION		
TA-28MK2	Digital Voice Recorder ▲▲	\$ 33.00	
TA-50A/B	Multi-Purpose Melody Generator ▲	11.84	\$ 16.58
TA-50C	Multi-Purpose Melody Generator ▲	12.65	17.71
TA-120MK2	35W Class "A" Main Power Mono Amp ▲▲	27.16	38.81
TA-300	30W Multi-Purpose Single Channel Amp ▲▲	23.00	29.00
TA-302	60W Stereo Power Booster (w/case) ▲▲	53.00	70.00
TA-323A	30Wx2 Stereo Pre-main Amp ▲	23.50	38.35
TA-377A	Hi-Quality FET Stereo Pre-Amp ▲▲▲	59.95	75.00
TA-400	40W Solid State Mono Amp ▲	23.00	34.93
TA-477	120W Mostel Power Mono Amp ▲▲	63.00	85.00
TA-800	80W+80W DC Pre-Main & Power Amp ▲▲▲	63.92	79.20
TA-802	80W+80W DC Stereo Main Power Amp ▲▲▲	43.94	59.72
TA-820A	60W+60W OCL DC Pre-Main Stereo Amp ▲▲	41.39	49.37
TA-1000A	100W Dynamic Class "A" Main Power Mono Amp ▲▲	53.69	80.58
TA-1500	100Wx2 Class "A" DC Stereo Pre-Main Amp ▲▲▲	73.70	95.81
TA-2200	FET Super class "A" DC Pre-Amp ▲▲▲	47.70	58.24
TA-2400A	Electronic Echo & Reverberation Amp ▲▲▲★		116.80
TA-2500	HQ Pre-Amp. w/10 band graphic equalizer ★		90.80
TA-2800	Hi-FET IC Pre-Amp. w/3 way tone control ▲▲	48.90	63.57
TA-3000	Stereo Simulator (mono TV / any mono source) ▲▲	30.20	41.38
TA-3600	300W HQ Hi-Fi Power Mono Amp ▲▲▲	79.00	103.00

MISCELLANEOUS		KIT	ASSMB.
MODEL	DESCRIPTION		
TY-23B	3 Channel Color Light Controller ▲▲▲▲	\$ 56.04	\$ 74.50
TY-25	Stereo Loudspeaker Protector ▲	12.65	18.88
TY-35	FM Wireless Microphone ▲	9.22	
TY-36	AC/DC Quartz Digital Clock ▲	18.00	25.20
TY-38	Sound/Touch Control Switch ▲	12.00	
TY-41MKV	Infrared Remote Control Unit w/case ▲▲	20.00	35.00
TY-42	Bar/Dot Level Meter ▲▲	24.15	
TY-43	3 1/2 Digital Panel Meter ▲	29.00	38.00
TY-45	20 Steps Bar/Dot Audio Level Display ▲▲	38.45	46.14
TY-47	Superior Electronic Roulette ▲▲	19.46	27.24
SM-222	7 Band Hi-Fi Graphic Equalizer ▲▲▲	26.80	38.80
SM-328	4 Channel Professional Color Light Controller★		150.00
SM-333	Audio/Video Surround Sound Processor ▲▲▲★	62.00	83.00
SM-666	Dynamic Noise Reduction ▲	26.00	34.00

METAL CABINETS WITH ALUMINUM PANEL			
MODEL	H" x W" x D"	MATCHING	PRICE
LG-1273	3" 12" 7"	TA-2800, TA-377A	\$ 20.16
LG-1684	4" 16" 8"	TA-3221, TA-323A, TA-377A	24.64
LG-1924	4" 19" 11 1/2"	TA-802, TA-820A, TA-1500, TA-120MK2, TA-800,	30.00
LG-1925	5" 19" 11 1/2"	TA-477, TA-800, TA-1500, TA-1000A	33.00
LG-1983	2 3/4" 19" 8"	TA-377A, TA-2800, TA-2200, TA-120MK2	26.50

POWER TRANSFORMERS			
MODEL	DESCRIPTION	MATCHING	PRICE
001	56VCT, 60VCT 6A	TA-800, TA-802, TA-820A, TA-1000A, TA-1500	\$ 26.00
002	72VCT 3A	TA-3221, TR-503, TA-323A, TA-400	21.00
003	80VCT 6A	TA-477	27.00
004	48VCT 6A	TR-120 MK2	21.00
005	52VCT 3A	TR-355B	15.00
006	36VCT 5A	TR-355A	14.50
007	112VCT 6A	TA-3600	42.00

WE ACCEPT MAJOR CREDIT CARDS MONEY ORDERS AND CHECKS - BUSINESS & SHOWROOMS. (PACIFIC TIME) MON-FRI 9:30 A.M. - 5:00 P.M. SAT 10:00 A.M. - 5:00 P.M. TERMS: 5% 10.00 MIN ORDER \$20.00 CHARGE CARD ORDER 10% 5% P.P.S. GROUND. FOR SHIPPING INSIDE USA. MIN \$3.00. FOR SHIPPING OUTSIDE USA. ADD 20% MIN \$5.00. TRANSIT INSURANCE ADD 5% OF TOTAL. OUTSIDE USA ONLY. CA RESIDENTS ADD SALES TAX @ 7.5%. ALL MERCHANDISE ARE SUBJECT TO PRIOR SALE. PRICES ARE SUBJECT TO CHANGE WITHOUT PRIOR NOTICE. WE ARE NOT RESPONSIBLE FOR TYPOGRAPHICAL ERRORS.

**MARK V ELECTRONICS, INC. - 8019 E. Slauson Ave, Montebello, CA 90640**

CIRCLE 93 ON FREE INFORMATION CARD

www.americanradiohistory.com

JULY 1990

89

**Intel Math Coprocessors**

**8088 or 8086 Systems**

8087	5MHz	\$89.95
8087-2	8MHz	\$129.95
3087-1	10MHz	\$169.95

**80286 Systems**

80287	6MHz	\$139.95
80287-8	8MHz	\$209.95
80287-10	10MHz	\$239.95

**80386 Systems**

80387-16	16MHz	\$349.95
80387-20	20MHz	\$399.95
80387-25	25MHz	\$499.95
80387-33	33MHz	\$649.95

**SIP Modules**

41256A9A-80	80ns, 256Kx9	\$54.95
41256A9A-10	100ns, 256Kx9	\$44.95
421000A9A-70	70ns, 1 Megx9	\$169.95
421000A9A-80	80ns, 1 Megx9	\$124.95
421000A9A-10	100ns, 1 Megx9	\$116.95
94000L-80	80ns, 4 Megx9	\$499.95
94000L-10	100ns, 4 Megx9	\$499.95

**SIMM Modules**

41256A9B-80	80ns, 256Kx9	\$49.95
41256A9B-10	100ns, 256Kx9	\$39.95
421000A8B-10	100ns, 1 Megx8	\$109.95
421000A9B-70	70ns, 1 Megx9	\$169.95
421000A9B-80	80ns, 1 Megx9	\$119.95
421000A9B-10	100ns, 1 Megx9	\$113.95
94000S-80	80ns, 4 Megx9	\$499.95
94000S-10	100ns, 4 Megx9	\$499.95

**NEC V20 & V30 Chips**

UPD70108-5	5MHz, V20 Chip	\$5.25
UPD70108-8	8MHz, V20 Chip	\$6.95
UPD70108-10	10MHz, V20 Chip	\$10.95
UPD70116-8	8MHz, V30 Chip	\$7.95
UPD70116-10	10MHz, V30 Chip	\$13.49

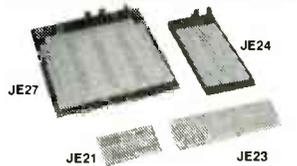
**Dynamic RAMs**

TMS4416-12	120ns, 16Kx4	\$2.75
TMS4416-15	150ns, 16Kx4	\$2.49
4116-12	120ns, 16Kx1	\$1.49
4116-15	150ns, 16Kx1	\$1.09
4116-20	200ns, 16Kx1	\$.89
4164-100	100ns, 64Kx1	\$2.75
4164-120	120ns, 64Kx1	\$2.39
4164-150	150ns, 64Kx1	\$2.15
4164-200	200ns, 64Kx1	\$1.75
41256-60	60ns, 256Kx1	\$5.25
41256-80	80ns, 256Kx1	\$3.75
41256-100	100ns, 256Kx1	\$3.15
41256-120	120ns, 256Kx1	\$2.95
41256-150	150ns, 256Kx1	\$2.59
41464-80	80ns, 64Kx4	\$5.95
41464-10	100ns, 64Kx4	\$4.95
41464-12	120ns, 64Kx4	\$3.95
41464-15	150ns, 64Kx4	\$3.59
511000P-70	70ns, 1 Megx1	\$13.95
511000P-80	80ns, 1 Megx1	\$12.95
511000P-10	100ns, 1 Megx1	\$12.35
514256P-80	80ns, 256Kx4	\$13.45
514256P-10	100ns, 256Kx4	\$12.95

**Static RAMs**

6116P-3	150ns, 16K (CMOS)	\$2.79
6264LP-10	100ns, 64K (CMOS)	\$6.95
6264LP-15	150ns, 64K (CMOS)	\$4.95
43256-10L	100ns, 256K	\$10.95
43256-15L	150ns, 256K	\$9.95
62256LP-15	150ns, 256K (CMOS)	\$10.95

**PROTOTYPING PRODUCTS**  
**Jameco Solderless Breadboards**



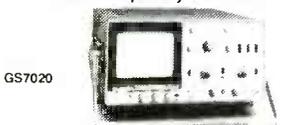
Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price
JE21	3.25 x 2.125	400	0	\$4.95
JE23	6.5 x 2.125	830	0	\$6.95
JE24	6.5 x 3.125	1,360	2	\$12.95
JE25	6.5 x 4.25	1,660	3	\$17.95
JE26	6.875 x 5.75	2,390	4	\$22.95
JE27	7.25 x 7.5	3,220	4	\$32.95

**Oscilloscope Probes**

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

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

**GoldStar 20MHz Oscilloscope and 1GHz Frequency Counter**



- Large 6" rectangular display
- High sensitivity: 1 mV/div
- Wide measuring range
- Measured value hold function

GS7020	Oscilloscope	\$399.95
FC7102	Frequency Counter	\$299.95

**Metex Digital Multimeters**

**General Specs:**

- Handheld, high accuracy
- AC/DC voltage, AC/DC current, resistance, diodes, continuity, transistor hFE
- Manual ranging w/ overload protection

M3650, 3650B & M4650 only:		
Also measure frequency and capacitance		
M4650 only:		Data hold switch • 4.5 digit

M3610	3.5 Digit Multimeter	\$49.95
M3650	3.5 Digit Multimeter w/Frequency & Capacitance	\$69.95
M3650B	Same as M3650 w/Bargraph	\$74.95
M4650	4.5 Digit w/Frequency, Capacitance and Data Hold Switch	\$99.95

**Multimeter Specials**

M80:		
AC/DC voltage, AC/DC current, resistance, diodes, continuity & frequency • Full auto-ranging on DC voltage • High/low semi-automating for AC/DC current and ohms • Data hold switch • Extra-large display		
M80	3.75 Digit Multimeter	\$59.95
M3900:		
AC/DC voltage, AC/DC current, resistance, diodes, continuity, dwell angle and engine RPM • High surge voltage protection		
M3900	3.5 Digit Multimeter	\$59.95

**Prototype Design Stations**

**WM1 & WM2 Features:**

- Removable solderless breadboard
- Variable and fixed DC power supply
- Multi-frequency signal generator
- Analog multimeter
- 8 bicolor LEDs (red & green)
- 8 logic switches
- Logic probe
- Lighted power switch
- Fuse overload protected
- Sturdy ruggedized case

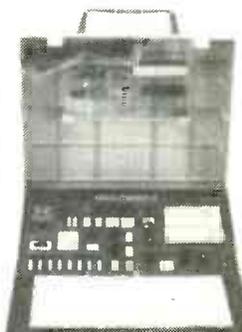
**WM1 Special Features:**

- 4 potentiometers
- Built-in speaker

**WM2 Special Features:**

- Pulse Generator
- Binary coded decimal (BCD) to 7-segment decoder/driver
- DB25 connector
- Frequency counter (1Hz to 1MHz)

WM1	Analog Prototype Station	\$199.95
WM2	Digital Prototype Station	\$249.95



**A.R.T. EPROM Programmer**



Programs all current EPROMs in the 2716 to 27512 range plus the X2864 EEPROM

**UVP EPROM Eraser**



Erases all EPROM's • Erases 1 chip in 15 Min. and 8 chips in 21 min. • UV intensity: 6800 UW/CM<sup>2</sup>

EPP	\$179.95
DE4	\$69.95

**Soldering and Desoldering Stations**

60 Watt Analog Display Soldering Station • Electronic temperature control from 200° to 878°F • Cartridge heating element for a longer life of the soldering tip

XY1683	\$59.95
--------	---------

60 Watt Analog Display Soldering Station • Electronic temperature control from 200° to 878°F • Ceramic heating element for a steady temperature and long life

XY2660	\$89.95
--------	---------

60 Watt Digital Display Soldering Station • Electronic temperature control from 200° to 878°F • Temperature displayed on easy to read .560"H 3 digit LED readout • Nichrome heating element

XY960	\$99.95
-------	---------

30 Watt Electronic Temperature Controlled Desoldering Station • Electronic temperature control from 212° to 842°F • Self-contained high rotary vacuum pump

XY999	\$279.95
-------	----------



**51-Piece Electronic Tool Kit**

The MS305 provides the tools needed for building, repairing and general maintenance of most electronic equipment. A convenient and durable carry-along combination lock case safely protects and secures this 51-piece tool kit. From the digital multimeter to the desoldering pump this kit is the perfect item for technicians and electronic enthusiasts.



**Tools Included in Kit**

- 10' measuring tape
- Electric tape
- 6" long tweezers
- 7" brush and scraper
- 7" fine point probe
- 7" slotted probe
- Rosin core solder
- 30 watt soldering iron
- Desoldering pump
- Soldering stand
- Stainless steel scissors
- Utility components box
- 8 pcs. hex key wrench
- Digital Multimeter
- Round needle file
- Flat needle file
- 6" adjustable wrench
- Utility knife with extra blade
- Bent needle nose pliers
- Diagonal cutting pliers
- 5.25" needle nose pliers
- 6 piece precision screwdriver set
- Brush
- 10 piece screwdriver set: 5 Slotted & 5 Phillips
- Flat nose pliers
- Carrying case: 17.63"W x 12.5"D x 3.5"H

MS305	\$119.95
-------	----------

**Partial Listing • Over 4000 Components and Accessories in Stock! • Call for Quantity Discounts**

**CIRCLE 114 ON FREE INFORMATION CARD**

Request Jameco's 1990 Catalog for a Complete Listing of Components, Test/Measurement Equipment and Computer Products

**Jameco 20MHz 80386 Desktop Computer Kit**

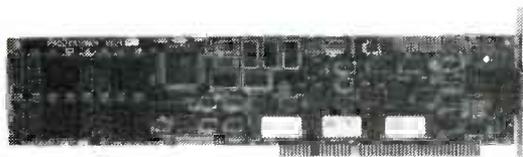
- Fully IBM Compatible
- Free! Concurrent 386 (Disk Operating System) Software Included
- Free! QAPLUS Diagnostic Software Included!
- Free! WORDSTAR EASY Word Processing Software Included!
- 1MB RAM Included, Expandable to 8MB onboard, 16MB with optional expansion board
- 8/16/20MHz Keyboard Switchable Operation
- AMI BIOS ROMs Included
- Floptop Case w/200 Watt Power Supply
- MiniScribe 3.5" 40MB RLL Hard Disk Drive
- Teac 1.2MB Floppy DSHD Disk Drive
- Fujitsu 101-Key (Enhanced) Keyboard



Shown with VGA Option (not included)  
 JE2059 Multiscan Monitor and VGA Card...\$669.90 (See Below)

**JE3550** 20MHz 80386 Compatible Kit.....**\$1599.95**

**Jameco IBM PC/XT/AT Compatible Cards**



- JE1043** 360KB/720KB/1.2MB/1.44MB Floppy Disk Controller Card (PC/XT/AT) .. **\$49.95**
- JE1050** Monochrome Graphics Card w/Parallel Printer Port (PC/XT/AT) ..... **\$49.95**
- JE1052** Color Graphics Card w/ Parallel Printer Port (PC/XT/AT) ..... **\$49.95**
- JE1055** EGA Card w/ 256K Video RAM (PC/XT/AT) ..... **\$139.95**
- JE1057** 8/16-Bit VGA Card w/256K Video RAM (PC/XT/AT) ..... **\$199.95**
- JE1060** I/O Card w/ Serial, Game, Printer Port & Real Time Clock (PC/XT) ... **\$59.95**
- JE1062** RS232 Serial Half Card (PC/XT/AT) ..... **\$29.95**
- JE1065** I/O Card w/ Serial, Game and Parallel Printer Port (AT)..... **\$59.95**
- JE1077** Multi I/O Card w/ 360KB/720KB/1.2MB/1.44MB Floppy Controller (AT) .. **\$99.95**

**EGA, VGA & Multiscan Monitor Packages**

Relisys 14" EGA monitor and EGA card package (720 x 350 max. resolution)

**JE1059** EGA Monitor & EGA Card..... **\$459.95**

Relisys 14" Multiscan monitor and 16-Bit VGA card package (800 x 600 max. resolution)

**JE2059** Multiscan Monitor & VGA Card ..... **\$669.90**

Relisys 14" VGA monitor and 16-Bit VGA card package (720 x 480 max. resolution)

**JE2061** VGA Monitor & VGA Card..... **\$599.90**



JE2061

**IBM PC/XT/AT Compatible Keyboards**



FKB4700

**JE2015** 84-Key Standard AT Style Layout ..... **\$59.95**

**FKB4700** 101-Key Enhanced Layout with 12 Function Keys ..... **\$69.95**

**MEI 100-Key Microtype Keyboard**



- IBM PC/XT/AT/386 Compatible
- Saves an amazing 60% of the desk space used by equivalent standard keyboards

**MIRU**.....**\$129.95**

**Jameco Digitizer Tablet**



- AutoCAD 10 template and four-button puck • Resolution: up to 1016 lines per inch • Accuracy: ±.025" • Emulates three of the worlds most popular formats: Summagraphics MM, Summagraphics Bit Pad One, Calcomp 2000 • EEPROM allows custom configuration

**JCAD** Digitizer Tablet **\$199.95**  
 Stylus Two Button Stylus .... **\$39.95**

**Logitech ScanMan Plus Scanner**

- IBM PC/XT/AT Compatible
- 4" Scanning Window
- 400 dpi



**SCANP**.....**\$219.95**

**Logitech Mice**



- MSER** Serial Mouse & MouseWare Software ..... **\$89.95**
- MBUS** Mouse w/Bus Board & MouseWare Software ..... **\$99.95**
- MPS2** PS/2 Mouse & MouseWare Software ..... **\$79.95**

**Modems**



9600E iPictured

**External Modems**

- 1200C** Datatronics 1200 Baud ..... **\$89.95**
- 2400C** Datatronics 2400 Baud ..... **\$149.95**
- 9600E** Prometheus 9600 Baud ..... **\$699.95**

**Internal Modems**

- 1200B** Jameco 1200 Baud ..... **\$49.95**
- 2400B** Jameco 2400 Baud ..... **\$99.95**

**IBM Compatible Cases and Power Supplies**



JE1030



JE2012

- JE1010** Flip Top Standard PC/XT Case ..... **\$39.95**
- JE1011** Slide Standard PC/XT Case ..... **\$39.95**
- JE1030** 150 watt PC/XT Power Supply ..... **\$59.95**
- JE1032** 200 watt Baby AT Power Supply ..... **\$89.95**
- JE1035** 300 watt AT Power Supply ..... **\$139.95**
- JE2011** Vertical Case w/300W Pwr. Supply ..... **\$249.95**
- JE2012** Mini Vertical Case w/200W Pwr. Supply ..... **\$149.95**
- JE2019** Flip Top Baby AT Case ..... **\$69.95**

**Floppy Disk Drives**



- Mitsubishi MF353B** 3.5" 720KB Internal Drive ..... **\$99.95**
- Toshiba 356KU** 3.5" 1.44MB Internal Drive .. **\$109.95**
- Teac FD55B** 5.25" 360KB Half Ht. .... **\$89.95**
- FD55G** 5.25" 1.2MB Half Ht. .... **\$99.95**

**MiniScribe Hard Drives**



- MFM M8425** 20MB (68ms) 3.5"HH ..... **\$224.95**
- M8425XT** 20MB (68ms) 3.5"HH (Kit) ..... **\$269.95**
- M8425AT** 20MB (68ms) 3.5"HH (Kit) ..... **\$339.95**

**RLL**

- M8438** 30MB (68ms) 3.5"HH ..... **\$249.95**
- M8438XT** 30MB (68ms) 3.5"HH (Kit) ..... **\$299.95**
- M8438AT** 30MB (68ms) 3.5"HH (Kit) ..... **\$389.95**
- M8450** 40MB (46ms) 3.5"HH ..... **\$329.95**
- M8450XT** 40MB (46ms) 3.5"HH (Kit) ..... **\$369.95**
- M8450AT** 40MB (46ms) 3.5"HH (Kit) ..... **\$429.95**

(Kit) includes Hard Disk Drive, Controller & Cables

**Colorado Memory Systems 40MB Tape Back-Up**



- IBM PC/XT/AT/386 Compatible • Back-up 40MB in 40 minutes • Back-up 60 to 120MB with extended tapes and data compression software • Includes 40MB tape cartridge

- DJ10** 40MB Tape Back-Up..... **\$299.95**
- KE10** External Enclosure Kit ..... **\$149.95**
- TB40** 40MB Tape Cartridge ..... **\$24.95**
- TB60** 60MB Tape Cartridge ..... **\$32.95**

1355 Shoreway Road, Belmont, CA 94002

**24 Hour Order Hotline**

**(415) 592-8097**

**\$50.00 Minimum Order**

FAX's (415) 592-2503 or (415) 595-2664  
 Telex 176043 - Ans. Back: Jameco Blmt  
 Data Sheets - 50¢ each

For a **FREE 48-Page Flier** send **\$2.00** to cover **First Class Postage and Handling**  
 © 1990 Jameco Electronics 790

**CA Residents Add**  
 6.25%, 6.75% or 7.25% Sales Tax  
 Shipping - Add 5% plus \$1.50 Insurance  
 (May vary according to weight and shipping method)  
 Terms: Prices subject to change without notice.  
 Items subject to availability and prior sale.  
 Complete list of terms/warranties is available upon request.  
 IBM is a registered trademark of International Business Machines



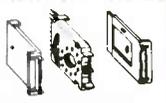
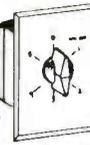
Please refer to **Mail Key 2** when ordering



QUALITY PARTS • DISCOUNT PRICES • FAST SHIPPING

# ALL ELECTRONICS CORP.

P.O. Box 567 • Van Nuys, CA • 91408

<p><b>THUMBWHEEL SWITCH</b></p> <p>1 pole 10 position decimal encoded switches which interlock to make up desired number or digits. Terminates to 11 pc pins (1 common and 10 poles). Each section measures .31" wide X .20" high X .78" deep. End plates can be added to form a .94" high bezel.</p> <p>CAT# SWTH-9 \$1.25 each 10 for \$10.00</p> <p>END PLATES - CAT# SW-9EC \$1.00 per set</p> 	<p><b>RG 11/U 75 OHM VIDEO CABLE</b></p> <p>100 ft. or 200 ft. rolls of RG 11/U terminated to heavy duty F connectors. Includes 75 ohm terminator and F-61 splicer on one end. New cables manufactured for IBM PC networks. IBM P/N 1501908 COM/SCOPE.</p> <p>CAT# RG-11-1 100 ft. roll \$15.00 CAT# RG-11-2 200 ft. roll \$27.50</p> 	<p><b>INSTRUMENT ENCLOSURES</b></p> <p>High quality molded ABS Instrument enclosures. Integrated PC board standoffs and two sets of vertical mounting slots for front and rear sub panels. All enclosures are 6" wide X 6 1/4" deep. Choice of three heights. Includes non-skid rubber feet and hardware. Available in beige, ivory, black, and blue.</p> <p>Panel ht. CAT# 2 1/4" CAT# MB-A \$7.50 each 10 for \$65.00 2 5/8" CAT# MB-B \$7.75 each 10 for \$67.50 3" CAT# MB-C \$8.00 each 10 for \$70.00</p> <p>Please specify color.</p> 	<p><b>SOUND ACTIVATED SWITCH</b></p> <p>PC board with electret mike responds to sounds in immediate vicinity. Originally part of sound activated light organ. Shuts off when sound is not present. Includes hook-up diagram.</p> <p>CAT# SAB-2 \$2.50 each</p> 	
<p><b>SWITCHES</b></p> <p><b>ITT PUSH BUTTON</b> ITT MDPL series. 3/4" X 1 1/2" grey rectangular key cap. S.P.S.T. N.O. Push to close. RATED: 0.1 amp switching. 0.25 amp carry current. P.C. mount.</p> <p>CAT# PB-8 65¢ each • 10 for \$6.00 100 for \$50.00</p> <p><b>SPDT PUSHBUTTON</b> Marquardt# 1843 Rated 6 amps @ 125/250 Vac. Black plastic pushbutton. Switch body: .92" X .94" X .65".</p> <p>CAT# PB-18 \$1.65 ea. • 10 for \$15.00</p> <p><b>PUSHBUTTON SWITCH</b> GC/Thomson# 35-420 S.P.S.T. normally open momentary pushbutton switch. Red plastic actuator 0.57" diameter. Chrome bezel 0.68" diameter. Threaded bushing mounts in .50" diameter hole. Rated 3 amp @ 250Vac. Solder loop terminals.</p> <p>CAT# PB-20 \$1.00 each</p>   	<p><b>NICKEL-CAD BATTERIES (RECHARGEABLE)</b></p> <p>AAA SIZE \$1.50 each 1.2 volts 180 mAh CAT# NCB-AAA</p> <p>AA SIZE \$2.00 each 1.25 volts 500 mAh CAT# NCB-AA</p> <p>AA SIZE \$2.20 each WITH SOLDER TABS CAT# NCB-SAA</p> <p>C SIZE \$4.25 each 1.2 volts 1200 mAh CAT# NCB-C</p> <p>D SIZE \$4.50 each 1.2 volts 2000 mAh CAT# NCB-D</p> 	<p><b>0-6 HOUR AUTO SHUT-OFF TIMER</b></p> <p>M.H. Rhodes, Inc. Mark-Time# 90007 Timer fits standard 3" deep wallbox. Rated 20 amps @ 125 Vac. Turn knob to desired time. Includes hardware, beige wallplate, and knob. UL and CSA listed. CAT# TMC-6 \$5.75 each • 10 for \$50.00</p> <p><b>SPECIAL PURCHASE</b> 210 MFD 330 V PHOTOFLASH CAPACITOR</p> <p>Rubicon CE photoflash capacitor. 0.79" dia. X 1.1" high. These are new capacitors that have been prepped with 1.4" black and red wire leads soldered to the terminals.</p> <p>CAT# PPC-210 \$2.50 each 10 for \$22.50 • 100 for \$200.00 Large quantities available. Call for pricing.</p>  	<p><b>LED'S</b></p> <p><b>STANDARD JUMBO DIFFUSED T 1-3/4 size</b></p> <p>RED CAT# LED-1 10 for \$1.50 • 100 for \$13.00</p> <p>GREEN CAT# LED-2 10 for \$2.00 • 100 for \$17.00</p> <p>YELLOW CAT# LED-3 10 for \$2.00 • 100 for \$17.00</p> <p><b>FLASHING LED</b> with built in flashing circuit operates on 5 volts...</p> <p>RED \$1.00 each CAT# LED-4 10 for \$9.50</p> <p>GREEN \$1.00 each CAT# LED-4G 10 for \$9.50</p> <p><b>BI-POLAR LED</b> Lights RED one direction, GREEN the other. Two leads.</p> <p>CAT# LED-6 2 for \$1.70</p> <p><b>LED HOLDER</b> Two piece holder. CAT# HLED 10 for 65¢</p> <p><b>LED GRAB BAG</b> 50 assorted L.E.D.'s Many different shapes, colors, sizes. Round, rectangular, curved, etc. CAT# GRLED \$4.00 per assortment</p>   	<p><b>L.E.D. FLASHER KIT</b></p> <p>Two L.E.D.'s flash in unison when a 9 volt battery is attached. This kit includes a p.c. board, all the parts and instructions to make a simple flasher circuit. A quick and easy project for anyone with basic soldering skills.</p> <p>CAT# LEDKIT \$1.75 per kit</p>  <p><b>LED CHASER KIT</b></p> <p>Build this variable speed led chaser. 10 leds flash sequentially at whatever speed you set them for. Easy to build kit includes pc board, parts and instructions. Ideal for special lighting effects, costumes, etc. Operates on 3 to 9 volts. PC board is 5" X 2.25". A great one hour project. CAT# AEC \$6.50 ea.</p> 
<p><b>WALL TRANSFORMERS</b></p> <p>ALL PLUG DIRECTLY INTO 120 VAC OUTLET</p> <p>12 Vdc @ 500 ma. CAT# DCTX-125 \$4.50 9 Vdc @ 1 amp. CAT# DCKT-951 \$5.00 24 Vdc @ 625 ma. CAT# ACTX-2462 \$3.25</p> 	<p><b>XENON TUBE</b></p> <p>1" long flashtube with 3 1/2" red and black leads. Ideal for electronic flash or strobe projects.</p> <p>CAT# FLT-3 2 for \$1.00</p> <p><b>RELAYS</b></p> <p>5-6 VDC SIP REED RELAY Electrolux Relay Boy# BBS1A05A10 5-6 Vdc, 500 ohm coil. S.P.S.T. normally open reed relay. 0.5 amp contacts. SIP configuration. 1" X .375" X .3". CAT# RRLY-SIPS \$1.10 each • 10 for \$10.00</p> <p>5 VDC LATCHING RELAY Aromat# RS12D-5V Miniature SPDT, dual coil latching relay. 5 Vdc, 170 ohm coils. 1 amp. TTL compatible. UL and CSA recognized. 0.787" X 0.394" X 0.394" CAT# LRLY-5DC \$2.50 each</p> <p>12 VOLT D.C. COIL S.P.D.T. Orion# G2E-184P 4 amp contacts. 335 ohm coil. Sugar cube size. .61" X .42" X .44 high. P.C. mount with pins on DIP spacing. CAT# RLY-787 \$1.50 each</p>  	<p><b>22/44 PIN CONNECTOR</b></p> <p>.156" pin spacing, 0.200" between double rows, gold contacts, P.C. mounting.</p> <p><b>SPECIAL</b> Same as AMP# 2-530655-6. CAT# EBC-1G \$1.00 each • 10 for \$8.00</p> <p><b>ELECTRONIC GAME BOARD</b></p> <p>The inner workings of an electronic Scrabble game. Operates on 6 Vdc. 8 digit alphanumeric readout, 45 button keypad, 14 transistors, 2 I.C.'s, 1 piezo element and other goodies. Top and bottom row of keypad buttons are function keys, middle 3 rows are alphabetical. No Instructions available. 6" X 4.45". CAT# ST-4 \$1.75 each 10 for \$15.00</p>  	<p><b>OPTO SENSOR</b></p> <p>U shaped package with mounting ears. 1/8" opening. 3/4" mounting ears. CAT# OSU-6 50¢ each 10 for \$4.50 • 100 for \$40.00</p> <p><b>STEPPER MOTOR</b></p> <p>Airpax P/N C82711-M1 17 Vdc dual coil, permanent magnet stepper. 23.25 ohm coil. 7.5 degrees per step. CAT# SMT-6 \$6.00 each 10 for \$50.00</p>  	<p><b>STEPPING MOTOR CONTROLLER KIT</b></p> <p>Learn about stepping motors while building this simple circuit. Includes circuit board and all parts except 12 Vdc power supply.</p> <p>CAT# SMKIT \$18.00 each</p> 
<p><b>SERVO MOTOR</b></p> <p>3 Vdc servo with potentiometer. Ideal for robotics or remote control model experimentation. Rotates approx. 140 degrees. Pot connected to motor varies from 500 to 3000 ohms. 1.53" X 0.95" X 1.65". 0.87" diameter rubber wheel attached to motor shaft can be used as a capstan or can be easily removed. Prepped with capacitors, chokes and wire leads. CAT# SVQ-2 2 for \$1.00</p> <p><b>TIL-99 PHOTO TRANSISTOR</b></p> <p>TO-18 case with window. For wide-angle viewing applications. Spectrally and mechanically compatible with TIL-31B. CAT# TIL-99 \$1.00 each • 10 for \$9.00</p> <p><b>TIL-31B PHOTO DIODE</b></p> <p>TO-18 case with window. Infrared emitting photo diode. CAT# TIL-31B \$1.00 ea. • 10 for \$9.50</p>   	<p><b>RECHARGEABLE BATTERY PACK (USED)</b></p> <p>Four AA nickel cadmium batteries connected in series to make a 4.8 volt pack. Batteries are in a 2 X 2 configuration with a 2 pin connector attached. The four batteries can be separated into single AA size solder tab nickel cadmium batteries or resoldered into other configurations.</p> <p><b>SPECIAL SALE PRICE NOW</b> \$3.00 per pack • 10 packs for \$25.00 CAT# NCB-41AAU</p> 	<p><b>TELEPHONE COUPLING TRANSFORMER</b></p> <p>Multis Products International# A19N-HO-1D/1 Primary: 600 ohm Secondary: 600/600 ohm 0.77" X 0.61" X 0.63" high 6 p.c. pins on 0.187" centers. Primary inductance: 300 mH min., at 1kHz, 1 volt CAT# TCTX-1 \$1.25 ea. • 10 for \$11.00</p> 	<p><b>RECHARGEABLE BATTERY PACK (USED)</b></p> <p>Four AA nickel cadmium batteries connected in series to make a 4.8 volt pack. Batteries are in a 2 X 2 configuration with a 2 pin connector attached. The four batteries can be separated into single AA size solder tab nickel cadmium batteries or resoldered into other configurations.</p> <p><b>SPECIAL SALE PRICE NOW</b> \$3.00 per pack • 10 packs for \$25.00 CAT# NCB-41AAU</p> 	

ORDER TOLL FREE 1-800-826-5432

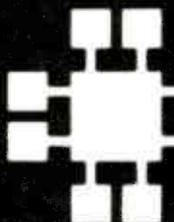


CALL OR WRITE FOR OUR  
**FREE**  
60 PAGE CATALOG  
WITH OVER 4000 PARTS!  
OUTSIDE THE U.S.A. PLEASE SEND  
\$2.00 POSTAGE FOR A CATALOG

MAIL ORDERS TO:  
**ALL ELECTRONICS**  
P.O. BOX 567  
VAN NUYS, CA 91408

INFO: (818)904-0524  
FAX: (818)781-2653  
MINIMUM ORDER \$10.00  
QUANTITIES LIMITED  
CALIF. ADD SALES TAX  
USA: \$3.50 SHIPPING  
FOREIGN ORDERS  
INCLUDE SUFFICIENT  
SHIPPING. NO C.O.D.





# JDR Microdevices

• 30 DAY MONEY BACK GUARANTEE • 1 YEAR WARRANTY ON ALL PRODUCTS • TOLL-FREE TECHNICAL SUPPORT

**MMC**  
MICROCOMPUTER  
MARKETING COUNCIL  
of the Direct Marketing Association, Inc.

## DEVELOPERS' WORLD

JDR caters to the developer with a full line of prototyping & programming products. Request our catalog for the complete line!

### MODULAR PROGRAMMING SYSTEM

MODULES USE A COMMON HOST ADAPTOR CARD-- 1 SLOT PROGRAMS EPROMS, PROMS, PALS, MORE!

#### HOST ADAPTOR CARD \$29.95

- UNIVERSAL INTERFACE FOR ALL PROGRAMMING MODULES!
- SELECTABLE ADDRESSES PREVENTS CONFLICTS
- MOLDED CABLE
- MOD-MAC



#### UNIVERSAL MODULE \$499.95

- PROGRAMS EPROMS, EEPROMS, PALS, BI-POLAR PROMS, 8748 & 8751 SERIES DEVICES; 16V8 AND 20V8 GALS (GENERIC ARRAY LOGIC) FROM LATTICE, NS, SGS • TESTS TTL, CMOS, DYNAMIC & STATIC RAMS • LOAD DISK, SAVE DISK, EDIT, BLANK CHECK, PROGRAM, AUTO, READ MASTER, VERIFY AND COMPARE • TEXTBOOK SOCKET FOR 3" 6-W. IC'S (8-40 PINS)

#### MOD-MUP

MOD-MPL-SOFT CUPL SOFTWARE ..... \$99.95

#### EPROM MODULE \$119.95

- PROGRAMS 24-32 PIN EPROMS, CMOS EPROMS & EEPROMS FROM 1K6 TO 1024K • HEX TO OBJ CONVERTER • AUTO, BLANK CHECK/PROGRAM/VERIFY • VPP 5, 12.5, 12.75, 13, 21 & 25 VOLTS • NORMAL, INTELLIGENT, INTERACTIVE & QUICK PULSE PROGRAMMING ALGORITHMS

#### MOD-MEP

OTHER MODULES: PAL PROGRAMMER, DIGITAL TESTER, BI-POLAR PROGRAMMER, MICROPROCESSOR PROGRAMMER FROM \$129.95 TO \$259.95-- CALL FOR INFORMATION

#### EPROM PROGRAMMER \$129.95

- PROGRAMS 27XX AND 27XXX EPROMS UP TO 27512
- SUPPORTS VARIOUS PROGRAMMING FORMATS & VOLTAGES
- SPLIT OR COMBINE CONTENTS OF SEVERAL EPROMS OF DIFFERENT SIZES
- READ, WRITE, COPY, BLANK CHECK & VERIFY
- SOFTWARE FOR HEX AND INTEL HEX FORMATS



#### MOD-EPROM

### EPROMS

27128	16384x8	250ns	12.5V	28	4.25
27128A-200	16384x8	200ns	12.5V	28	5.95

PARTIAL LISTINGS ONLY • MANY OTHERS AVAILABLE!

### EPROM ERASERS

#### DATASE II \$39.95

- SHIRT POCKET SIZE!
- ALL SIZES UP TO 4 AT A TIME
- ERASES MOST EPROMS IN 3 MINUTES

PE-140T SPECTRONICS 9 CHIP ERASER WITH TIMER .. \$139.95

### PROTOTYPE CARDS

FR-4 EPOXY GLASS LAMINATE WITH GOLD PLATED EDGE CARD FINGERS AND SILK SCREENED LEGENDS



#### FOR XT

JDR-PR1	WITH +5V AND GROUND PLANE	27.95
JDR-PR2	ABOVE WITH I/O DECODING LAYOUT	29.95
JDR-PR2-PK	PARTS KIT FOR JDR-PR2 ABOVE	8.95

#### FOR AT

JDR-PR10	16-BIT WITH I/O DECODING LAYOUT	34.95
JDR-PR10-PK	PARTS KIT FOR JDR-PR10 ABOVE	12.95

#### EXTENDER CARDS

SIMPLIFY PROTOTYPING AND TESTING

EXT-9086	8-BIT FOR 8088 MOTHERBOARDS	29.95
EXT-80286	16-BIT FOR 286/386 MOTHERBOARDS	39.95

UPGRADE YOUR OLD SYSTEM! REQUEST OUR NEW FLYER TO LEARN HOW!

## BUILD YOUR OWN 286 SYSTEM FOR UNDER \$650

IT'S A GREAT WAY TO LEARN AND A GREAT WAY TO SAVE! HERE'S JUST ONE OF OUR MOST POPULAR CONFIGURATIONS:

MCT-M286-12	8/12MHZ MINI 286 MOTHERBOARD	\$199.95
MCT-MGP	MONOCHROME GRAPHICS ADAPT	\$49.95
MCT-FDC-HD	360K-1.44MB FLOPPY CONTROLLER	\$49.95
CASE-JR	MINI FLIP-TOP CASE W/150W P.S.	\$149.95
FDD-360	360K 5-1/4" FLOPPY DISK DRIVE	\$69.95
JDR-MONO	MONOCHROME MONITOR (GREEN)	\$69.95
BTC-506C	STANDARD 84 KEY KEYBOARD	\$59.95
TOTAL SYSTEM (OK INSTALLED)		\$649.65

### OPTIONAL COMPONENTS

#### MOTHERBOARDS

MCT-TUF-BO-10	4.77/10MHZ SINGLE CHIP 8088	\$99.95
MCT-M286-16N	8/16MHZ 286 W/NEAT CHIPSET	\$289.95
MCT-M286-20N	10/20MHZ 286 W/NEAT CHIPSET	\$389.95

#### Littlefoot™ UPRIGHT CASE \$249.95

SPACE SAVING DESIGN HOLDS ALL SIZES OF MOTHERBOARDS AND INCLUDES A 250 WATT POWER SUPPLY

- MOUNTS FOR 3 FLOPPY AND 4 HARD DRIVES
- TURBO & RESET SWITCH
- LED SPEED DISPLAY



CASE-FLIP FLIP TOP CASE FOR 8088 MB'S ..... \$39.95

#### POWER SUPPLIES

PS-150	150 WATT SUPPLY FOR 8088'S	\$59.95
PS-200X	200 WATT SUPPLY FOR 8088'S	\$89.95
PS-200	200 WATT SUPPLY FOR 286/386'S	\$89.95

#### KEYBOARDS

BTC-5339	101 KEY ENHANCED KEYBOARD	\$69.95
MAX-5339	101 KEY W/TACTILE FEEDBACK (286)	\$69.95

#### DRIVE CONTROLLERS

MCT-FDC-HD4	4-FLOPPY DISK CONTROLLER	\$59.95
MCT-HDC	HARD DISK CONTROLLER	\$79.95
MCT-AFH	286 386 FLOPPY/HARD CONTROL	\$149.95

#### MEMORY/MULTIFUNCTION CARDS

MCT-RAM	576K RAM CARD (OK)	\$49.95
MCT-IO	MULTI I/O CARD	\$59.95

#### 1.44MB FLOPPY DRIVE \$99.95

- ULTRA HIGH DENSITY
  - READ/WRITE 720K DISKS TOO
  - BLACK OR BEIGE
- FDD-1.44X BLACK FDD-1.44A BEIGE  
FDD-1.2 5-1/4" DS/HD 1.2MB FLOPPY ..... \$95.95



#### SEAGATE HARD DRIVES

##### 21.4MB KIT \$249

##### 32.1MB KIT \$279

65MS AVG. ACCESSORY KIT INCLUDES INSTRUCTIONS, XT-COMPATIBLE CONTROLLER AND CABLES. CALL FOR PRICES ON OTHER SEAGATE DRIVES



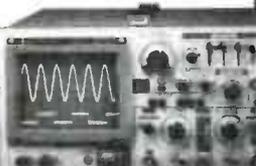
### 35MHZ DUAL TRACE OSCILLOSCOPE

## \$499.95

- WIDE BAND WIDTH
  - VARIABLE HOLDOFF
  - 1X/10X PROBES
  - FULL 2 YEAR WARRANTY
- MODEL-3500  
MODEL-2000  
20MHZ VERSION \$389.95

DMM-300	34 RANGES, ±0.25%, TEMP & TRANS TEST	\$79.95
DMM-200	3.5 DIGIT, 22 RANGES, ±0.25% ACCURACY	\$49.95
DMM-100	3.5 DIGIT, 14 RANGES, ±0.5% ACCURACY	\$29.95

ALL JDR INSTRUMENTS PRODUCTS WARRANTED 2 YEARS



### VGA COMPATIBLE PACKAGE \$499.95

- 720 X 540 MAX RESOLUTION, 640 X 480 IN 16 COLORS, 528 X 480 RESOLUTION IN 256 COLORS
- IBM STYLE MONITOR
- VGA, EGA, CGA, AND MGA COMPATIBLE



JDR-RGB 14" RGB MONITOR ..... \$239.95  
JDR-AMBER 12" TTL MONOCHROME-AMBER ..... \$69.95

### 16-BIT VGA DISPLAY ADAPTOR \$199.95

- 640 X 480 RESOLUTION
- 256K VIDEO RAM EXPANDABLE TO 512K
- 64 LEVELS OF GREY SCALE



MCT-VGA-16  
MCT-EGA ENHANCED GRAPHICS ADAPTOR ..... \$149.95  
MCT-MGMIO MONOGRAPHICS MULTI I/O ..... \$119.95

### 2400 BAUD MODEM \$89.95

- 2400/1200/300 BAUD HAYES COMPATIBLE
- CONFIGURE AS COM1, 2, 3 OR 4
- BUILT-IN SPEAKER • PROCOMM COMMUNICATIONS SOFTWARE



MCT-241  
MCT-121 1200 BAUD INTERNAL MODEM ..... \$59.95

### DYNAMIC RAMS

PART#	SIZE	SPEED	PINS	PRICE
4164-150	65536x1	150ns	16	2.49
41256-150	322144x1	150ns	16	2.59
41256-120	262144x1	120ns	16	2.95
41256-100	262144x1	100ns	16	3.19
41256-80	262144x1	80ns	16	3.75
1 MB-80	048576x1	80ns	18	12.95



### JIM'S BARGAIN HUNTERS CORNER

Jim Wharton  
JDR's VP Sales

### 112 WATT SWITCHING POWER SUPPLY

- OPEN-FRAME D POWER SUPPLY MADE BY DELTA
  - +5 @ 10A, +12V @ 3.5A, +12V @ 1.5A, -12 @ 200mA
  - MEASURES 5 X 8.5 X 1.97"; WEIGHS 2.3 LBS.
- PS-DPS-110AP EXPIRES 7/15/90

## \$19.95

# ORDER TOLL FREE 800-538-5000

KEY CODE 12

CUSTOMER SERVICE TOLL-FREE 800-538-5001 • TECHNICAL SUPPORT TOLL-FREE 800-538-5002

Terms: Minimum order \$10.00. For shipping & handling include \$4.00 for ground and \$5.00 for air. Orders over 1 lb and foreign orders may require additional shipping charges-- please contact the sales department for the amount. CA residents must include applicable sales tax. Prices subject to change without notice. We are not responsible for typographical errors. We reserve the right to limit quantities and to substitute manufacturer. All merchandise subject to prior sales. A full copy of our terms is available upon request. Items pictured may only be representative. JDR Microdevices and the JDR Microdevices logo are registered trademarks of JDR Microdevices. IBM, AT, PS/2 are trademarks of International Business Machines.

JDR MICRODEVICES, 2233 BRANHAM LANE, SAN JOSE 95124  
LOCAL (408) 559-1200 FAX (408) 559-0250 TELEX 171-110  
ALSO ORDER VIA OUR BBS (408) 559-0253



CIRCLE 113 ON FREE INFORMATION CARD

www.americanradiohistory.com



# It's no fluke.



Made in the U.S.A.

Feature	Fluke Model 77	Beckman Industrial RMS225
Digits	3-1/2 Digits	4 Digits
Resolution	3,200 Counts	10,000 Counts
Accuracy	0.3%	0.25%
Automatic Reading Hold	Touch Hold®	Probe Hold™
Analog Bar Graph	31 Segments	41 Segments
Battery Life	2,000 Hrs	500 Hrs
10A Range	✓ (Fused)	✓ (Unfused)
Protective Holster	✓	✓
3 Year Warranty	✓	✓
True RMS		✓
Auto Max Min™		✓
Relative Mode		✓
Self-Resetting Fuse		✓ (40mA Input)
Price	\$159*	\$149

® Touch Hold is a registered trademark of the John Fluke Mfg. Co., Inc. \* 1990 Fluke and Philips Catalog

Your best auto-ranging multimeter for the money. It doesn't happen by accident. It takes expertise, painstaking R&D, and a solid commitment to provide you with the features you've asked for at a price you can afford. When you add it all up, the new Beckman Industrial RMS225 simply outperforms any meter in its class. And like all the

other multimeters we've built over the years, it's designed for long lasting and trouble-free use. So, go visit your local distributor today and check out the new RMS225 digital multimeter. Once you compare it to the others, the choice will be obvious.



## **Beckman Industrial™**

An Affiliate of Emerson Electric Co.

Instrumentation Products Division  
 3883 Ruffin Road, San Diego, CA 92123-1898  
 (619) 495-3200 • FAX (619) 268-0172 • TLX 249031  
 Outside California 1-800-854-2708 Within California 1-800-227-9781

© 1990 Beckman Industrial Corporation. Specifications subject to change without notice. Fluke is a registered trademark of John Fluke Mfg. Co., Inc.

CIRCLE 98 ON FREE INFORMATION CARD

FULL FEATURES FOR JUST  
**\$129.95**

- 20MHz Frequency Counter
- Capacitance Meter
- Logic Probe
- Transistor Tester
- Continuity Tester
- LED Tester
- Diode Check
- 10A Ammeter
- Voltmeter
- Ohmmeter



# A Fistful Of Functions.

With more uses and features than most other hand-held multimeters, the DM27XL and DM25XL really pack a punch; especially when you've got to troubleshoot or analyze a variety of components and circuits.

Standard functions include capacitance measurement to 20 $\mu$ f, logic probe to 20MHz, transistor tester and resistance ranges to 2000M $\Omega$ . The DM27XL further adds 20MHz frequency counting capability with selectable

trigger sensitivity, plus an LED tester. Both meters feature an enhanced display, including a large, easy-to-read LCD, a full set of function annunciators and a battery-saving Auto Power Off.

Grab a DM25XL for just \$109.95, or a DM27XL for just \$129.95 (suggested retail price) at your local Beckman Industrial distributor. After using one, you won't be able to function without it.

**Beckman Industrial™**

An Affiliate of Emerson Electric Co.

Instrumentation Products Division  
3883 Ruffin Road, San Diego, CA 92123-1898  
(619) 495-3200 • FAX (619) 268-0172 • TLX 249031  
Outside California 1-800-854-2708 Within California 1-800-227-9781

© 1990 Beckman Industrial Corporation All specifications subject to change without notice.

CIRCLE 192 ON FREE INFORMATION CARD