Radio Electronics

MARCH 1992

TECHNOLOGY - VIDEO - STEREO - COMPUTERS - SERVICE

Bring the world of music to your computer with this easy-to-build **MIDI INTERFACE** for your PC

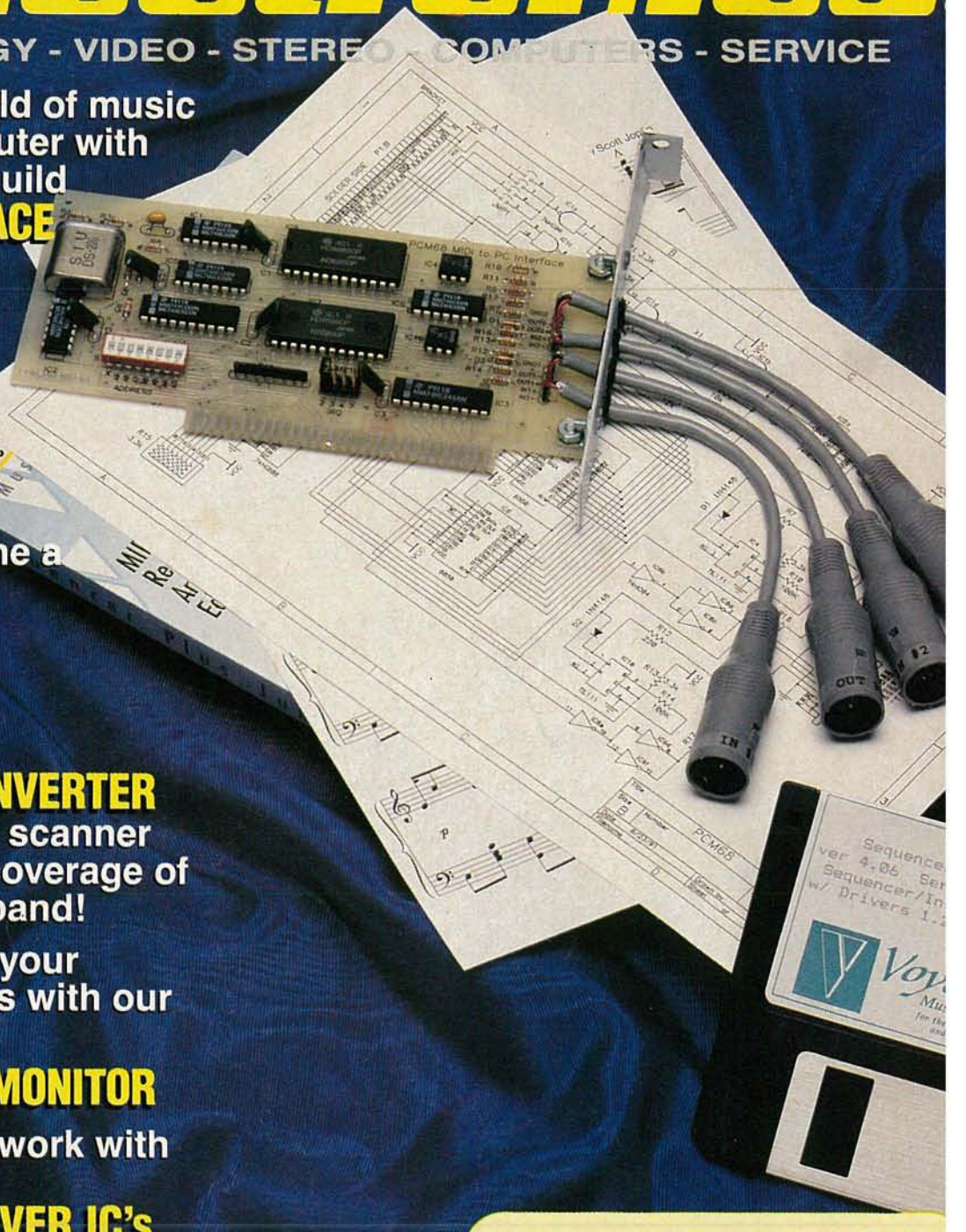
Build our single-chip **SOLID-STATE VOICE RECORDER**

How to become a **CERTIFIED ELECTRONIC TECHNICIAN**

Build our **SCANNER CONVERTER** and give your scanner unrestricted coverage of the 800-MHz band!

Keep tabs on your telephone bills with our **INTELLIGENT PHONE-LINE MONITOR**

Learn how to work with 7-segment **DECODER/DRIVER IC's**



0 09128 48783 0 03

$2.95 U.S.
$3.75 CAN

A GERNSBACK PUBLICATION

xxxxxxxx CAR-RT SORT xx CR03
750456HRR5165M093 03 97
NOV 93
RB

We Only Skimped On The Price

Introducing The Fluke Series 10—From $69.95

Fluke quality: Made in the USA by Fluke, with the same rugged reliability that's made us the world leader in digital multimeters. Count on hard-working high performance—and a two-year warranty to back it up.

Large, easy-to-read display: 4000 count digital readout.

Actual size: Easy to carry, easy to use.

***New!* Min/Max record with relative time stamp and Continuity Capture** Makes intermittent problems easie find. Records highs and lows—an "time stamps" when they occurred. continuity mode, opens or shorts a as 250 µs are captured and display

***New!* V Chek™:** For fast accurate checks on power sources and supplies, set your meter on V Chek—and let it do the rest. V Chek will determine continuity/ohms; if voltage is present, it will *automatically* change modes to measure AC or DC volts, whichever is detected. For most initial troubleshooting checks, here's the only setting you need to make.

Capacitance: Autoranging from .001 µF to 9999 µF. No need to carry a dedicated capacitance meter.

Autoranging with manual option: Your choice. depending on your situation.

Sleep Mode: Shuts itself off if you forget, extending long battery life even further.

***New!* Slide switch and a few pushbuttons control all functions:** Designed for true one-hand operation.

Fast, accurate tests and measurements: AC and DC voltage measurements to 600 volts, ohms to 40 MΩ; audible continuity test; and diode test.

For high performance at Fluke's lowest pric your hands on the new Series 10. Stop by local Fluke distributor and feel what a powe difference the right multimeter makes—at right price. For a free product brochure or the of your nearest distributor, call **1-800-87-FL**

Fluke 10	Fluke 11	Fluke 12
$69.95*	$79.95*	$89.95*
4000 count digital display	V Chek™	V Chek™
1.5% basic dc volts accuracy	Capacitance, .001 to 9999 µF	Min/Max rec with relati time stam
2.9% basic ac volts accuracy	4000 count digital display	Continuity Capture™
1.5% basic ohms accuracy	0.9% basic dc volts accuracy	Capacitance .001 to 99
Fast continuity beeper	1.9% basic ac volts accuracy	4000 count display
Diode Test	0.9% basic ohms accuracy	0.9% basic volts accu
Sleep Mode	Fast continuity beeper	1.9% basic accuracy
Two-year warranty	Diode Test	0.9% basic accuracy
	Sleep Mode	Fast continu beeper
	Two-year warranty	Diode Test
		Sleep Mode
		Two-year wa

*Suggested U.S. list price. *Optional holste tilt-stand ava*

The New Series 10. A Small Price For A Flu

FLUKE AND PHILIP
THE T&M ALLIANC

Safety—a Fluke standard: Designed to meet UL1244, IEC 1010, CSA and VDE safety requirements; extensive overload protection built in.

Audible Continuity: To perform fast continuity checks, just listen for the beep; no need to watch the display.

***New!* TL75 Hard Point™ Test Leads:** Comfort grip with extra strong tips for extended service life.

©1991 John Fluke Mfg. Co., Inc. Prices and specificati subject to change. Ad no. 00130.

FLUKE®

CIRCLE 121 ON FREE INFORMATION CARD

March 1992

Radio Electronics®

Vol. 63 No. 3

BUILD THIS

33 MIDI INTERFACE FOR YOUR PC
Bring the world of music to your PC.
John Simonton

41 SCANNER CONVERTER
Get unrestricted coverage of the 800-MHz band!
William Sheets and Rudolf F. Graf

53 INTELLIGENT PHONE-LINE MONITOR
The Digi-Call logs your phone/fax/modem usage automatically.
Thomas E. Black

59 SINGLE-CHIP MESSAGING SYSTEM
Add audio-storage capability to your next project!
Richard D. Tenney

TECHNOLOGY

16 MARCH 10: ELECTRONIC TECHNICIAN'S DAY
How you can become a Certified Electronic Technician.
Larry Steckler, EHF, CET

46 ELECTRONIC TEMPERATURE MEASUREMENT
A look at temperature and how it's measured electronically.
Harry L. Trietley

65 WORKING WITH LED DISPLAY DRIVERS
An in-depth look at LED display drivers.
Ray Marston

DEPARTMENTS

6 VIDEO NEWS
What's new in this fast-changing field.
David Lachenbruch

24 EQUIPMENT REPORTS
Dallas Semiconductor's Touch Memory Starter Kit

73 HARDWARE HACKER
Using the IC Master, and more.
Don Lancaster

80 AUDIO UPDATE
AES: Audio fact and fantasy.
Larry Klein

82 DRAWING BOARD
Our oscilloscope is shaping up nicely.
Robert Grossblatt

90 COMPUTER CONNECTIONS
Industry evolution.
Jeff Holtzman

PAGE 53

PAGE 59

AND MORE

102 Advertising and Sales Offices

102 Advertising Index

12 Ask R-E

14 Letters

93 Market Center

30 New Lit

26 New Products

4 What's News

ON THE COVER

The Musical Instrument Digital Interface, or MIDI, brings together music and computers, and allows a single musician to create the sounds of an entire orchestra. But you don't have to be a professional musician, or have a small fortune's worth of computer and musical hardware, to take advantage of MIDI. Instruments with MIDI interfaces have become common and affordable. Our MIDI interface is a low-cost solution for beginners, and serious users will find it easy to upgrade to meet their needs. For more information, turn to page 33.

COMING NEXT MONTH

THE APRIL ISSUE GOES ON SALE MARCH 5.

BUILD AN AUTO STEREO AMPLIFIER
This high-power, hi-fi car stereo amp is an excellent amplifier design course.

CABLE-TV SNOOPER STOPPER
Protect yourself against cable-TV snooping!

BUILD THE DIGI-CALL
Construction details for our intelligent phone-line monitor.

CIRCUIT COOKBOOK
More on 7-segment decoder/driver IC's.

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) March 1992. Published monthly by Gernsback Publications, Inc., 500-B Bi-County Boulevard, Farmingdale, NY 11735. Second-Class Postage paid at Farmingdale, NY and additional mailing offices. Second-Class mail registration No. R125166280, authorized at Toronto, Canada. One-year subscription rate U.S.A. and possessions $17.97, Canada $25.65 (includes G.S.T. Canadian Goods and Services Tax Registration No. R125166280), 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 $2.95. © 1992 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

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

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

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

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

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

Typography by Mates Graphics
Cover photo by Diversified Photo Services

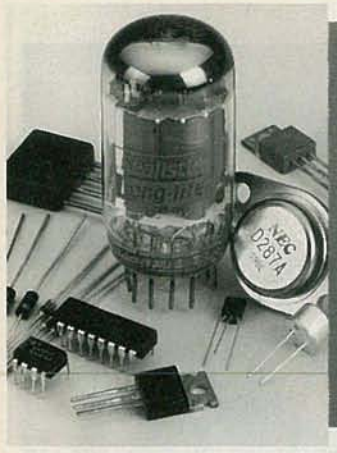
Radio-Electronics is indexed *Applied Science & Technology Index* and *Readers Guide to Periodical Literature.*
Microfilm & Microfiche editions are available. Contact circulation department for details.

Advertising Sales Offices listed on page 106.
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.**

The Audit Bureau of Circulation

RADIO SHACK

THE PARTS PLACE℠



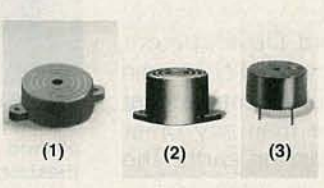
Super Selection! Try Our Special-Order Hotline

Your local Radio Shack stocks over 1000 popular electronic components. Plus, we can special-order over 10,000 items from our main warehouse—ICs, semiconductors, tubes, crystals, phono cartridges and styli, popular modules, even SAMS* manuals. There are no postage charges or minimum requirements for this service. Come in today for details!

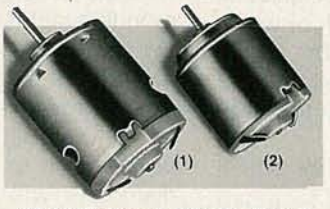
NEW! Micronta® LCD Digital Multimeter

With big display and protective rubber holster. Autoranging with manual override, high-speed sampling. Has data hold, 33-dot analog bargraph, 200 µA low-current range and continuity sounder. Fold-out stand/hanger. Measures to 1000 VDC, 700 VAC, 10A AC/DC, 30 megohms resistance. Batteries extra. #22-167 ..... **69.95**

Infrared Detector Module. A ready-to-use IR receiver for remote-control projects. Combines detector, limiter and demodulator in a compact 3-lead package. 5VDC. With data.
#276-137 ..... **3.49**

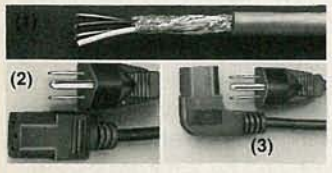


(1) Pulsing Buzzer. Extra-loud! 3 to 28 VDC. #273-066 ..... **4.29**
(2) "Ding-Dong" Chime. For doorbell, entry alert. Requires 6 to 18 VDC. #273-071 ..... **8.99**
(3) Mini Buzzer. Efficient! Draws 7 mA at 12VDC. #273-074 ... **2.99**



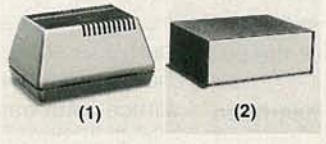
(1) High-Speed 12VDC Motor. Up to 15,200 RPM with no load. About 2″ long (including shaft).
#273-255 ..... **2.99**
(2) Low-Voltage Motor. For projects and solar power demos. 1½ to 3VDC. #273-223 ..... **99¢**

Mini Audio Amplifier. With built-in speaker. Use to boost computer audio, signal tracing and more. Has a high-gain IC circuit, ⅛″ headphone jack, ⅛″ input jack and volume control. Battery extra.
#277-1008 ..... **11.95**



(1) 4-Conductor Double Shielded Cable. 30 feet. For audio or data hookups. #278-777 ..... **7.95**
(2) 12-Foot "Business Machine" Power Cord. #278-1261 ... **5.99**
(3) 6-Ft. Version of Fig. 2. 90° connector. #278-1260 ..... **5.99**

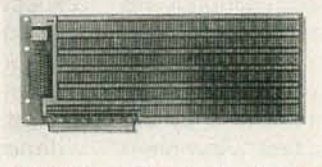
(1) Binding Posts/BNC Adapter. For dependable test instrument hookups. #274-715 ..... **8.95**
(2) Binding Post to Banana Plugs. Stackable. Includes one red and one black.
#274-716 ..... **Set 4.95**



(1) Power Supply Project Case. Vented 2½ × 4⅝ × 3¼″ molded box. #270-287 ..... **3.99**
(2) Deluxe Project Box. 3 1/16 × 8¼ × 6⅛″. All metal. With protective rubber feet. #270-274, **10.79**
20 different enclosures in stock!

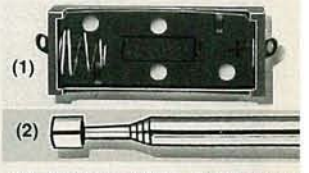
Infrared Detector Card. Detects normally invisible IR light. Fast way to confirm output from remote controls, infrared LEDs or laser in CD and video players. Great for science projects, too!
#276-099 ..... **5.95**

Portable Shortwave Antenna. Boosts reception on worldband portables! Clips to rod antenna. Wire extends up to 23 feet. Winds up on pocket-size reel for storage and travel. #278-1374 ..... **8.95**



PC/XT Experimenter's Circuit Card. Premium epoxy prototyping board fits computer's XT bus connector. Plated-through holes. 3⅞ × 10 1/16 × 1/16″. Accepts D-sub at right. #276-1598 ..... **29.95**

Right-Angle D-Sub 25 Female Connector. Ideal for use with card at left. Radio Shack has solder-type and IDC solderless connectors for computer and printer hookups. #276-1504 ..... **2.49**



(1) Holder for Type "N" Battery.
#270-405 ..... **59¢**
16 different holders in stock!
(2) Telescoping Antenna. 17¾″. Six sections. #270-1409 .... **2.59**
16 different antennas in stock!

Since 1921 Radio Shack has been the place to obtain up-to-date electronic parts as well as quality tools, test equipment and accessories at low prices. Our nearly 7000 locations are ready to serve you—NOBODY COMPARES

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

Radio Shack® SINCE 1921
AMERICA'S TECHNOLOGY STORE℠

CIRCLE 78 ON FREE INFORMATION CARD

WHAT'S NEWS

A review of the latest happenings in electronics.

Petal power?

Electrical engineers at the Georgia Institute of Technology (Atlanta, GA), with support from the U.S. Joint Services Electronics Program, have discovered that adding serrations shaped like flower petals to the outer edges of satellite dishes can significantly improve their performance by reducing unwanted "sidelobe" radiation—energy that is unintentionally scattered by the dishes. Reducing it minimizes the chance that antennas will interfere with each other or send signals in undesired directions, both of which could cause problems for future telecommunications satellites that will be placed much closer together in geosynchronous orbit.

The edge treatment, for which Georgia Tech has applied for a patent, allows designers to customize the serration design for specific applications, taking into account such factors as how much gain will be lost to reduce the sidelobe levels. The optimal length for the serrations seems to be about 10 times the wavelength the dish is designed to reflect. It isn't necessary for the petals to be of uniform size.

The petal-edge design has been incorporated in an outdoor compact range recently build for the U.S. Army's Electronic Proving Grounds at Fort Huachuca, AZ, and at least one manufacturer of compact antenna ranges has already adopted the technology. The edges will add little to the manufacturing costs of dishes, and could even be retrofitted onto existing dishes, although such modified dishes would require alterations to the feed systems.

DR. EDWARD B. JOY, PROFESSOR OF ELECTRICAL ENGINEERING at Georgia Tech, shows antenna dish with flower petal edges that improve the antenna's performance.

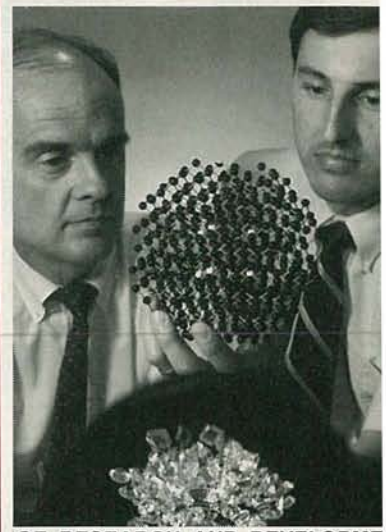
Harder than diamonds?

High-resolution x-ray measurements performed by scientists at Ford Motor Company (Dearborn, MI), show that gem-quality diamonds synthesized by scientists at GE Research and Development Center (Schenectady, NY) contain more atoms per cubic centimeter at room temperature than any other solid known to exist on earth. The diamonds, which are composed almost totally of the isotope Carbon-13, are of greater crystalline perfection than any found in nature, and range up to three carats.

Carbon exists as two stable isotopes: Carbon-12 and Carbon-13. Each Carbon-13 atom is slightly heavier than its Carbon-12 counterpart. Diamond is composed of carbon atoms arranged in a regular lattice, with each atom at the same small distance from its neighbors. The regular lattice, small distance between atoms, and very strong carbon-to-carbon bond, account for diamond's unsurpassed hardness. Natural diamonds contain 99% Carbon-12 and only 1% of Carbon-13, while the synthesized diamonds are made of 99% Carbon-13 and 1% Carbon-12.

A proprietary two-step process invented in the late 1980's by GE scientists involves, first, a low-pressure chemical vapor deposition technique to produce aggregates of small diamonds with the desired isotopic composition, and second, dissolving and recrystallizing the aggregate into gem-quality diamonds weighing a carat or more.

The Ford experiments showed



GE RESEARCH AND DEVELOPME Center scientists examine a model of atomic structure of a diamond s thesized from 99% Carbon-13. The d monds, shown in the foreground, co turn out to be harder than natural d mond, currently the world's hardest r terial.

that, as Carbon-13 interaction is creased, the interatomic distan or lattice constant, decreas slightly. Some scientists specul that the smaller lattice consta could make the GE diamond ev harder than natural diamonds.

Also revealed by the Ford expe ments is that the GE diamon crystal quality approaches that the best man-made semiconduc crystals. Because improved crys quality translates to improved el tronic properties, that discovery expected to stimulate the develo ment of electronic devices based diamonds. Laboratory studies ha shown that synthesized gem d monds can be electronica "doped" by the incorporation small amounts of boron, whi transforms it from an insulator int semiconductor.

GE manufactures diamond he sinks for the electronics industry well as diamond abrasives for n chining, grinding, sawing, and d ing applications.

WHAT YOUR TOOLS SAY ABOUT YOU.

"ULTIMATE PROFESSIONAL"

Here's the newest family member: the 60 MHz Tek 224. It's as rugged, reliable and easy to use as the rest of the 220 Series—and extended bandwidth makes it the logical choice for computer service professionals.

"ACE TROUBLESHOOTER"

The Tek 222 is everything a service scope ought to be. Lightweight. Rugged. Fully programmable. Floatable to ±400 V. Two channels, 10 MHz, Auto Setup and Auto Trigger make it easy finding trouble—fast.

"RUGGED SURVIVALIST"

Tek's 222PS Power Scout™ offers the field-proven performance of the 222, *plus* it's rated 600 VAC, 850 VDC and 6 kV peak surge. Perfect for circuit measurements requiring extra protection—and a few added guts.

They're just 4½ pounds. U.L. certified. And start at $2450. 220 Series handheld oscilloscopes—all with Tek's exclusive IsolatedChannel™ architecture—are the service tools the professionals use. There's one with you written all over it. To order, contact your Tek representative or distributor. Or just call Tek direct: 1-800-426-2200

Tektronix

Test and Measurement

Copyright © 1991, Tektronix, Inc.

CIRCLE 92 ON FREE INFORMATION CARD

VIDEO NEWS

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

DAVID LACHENBRUCH

• "Use it or lose it." Anticipating the arrival of HDTV, the FCC is preparing new allocation of TV channels to permit broadcasters to simulcast in standard NTSC and HDTV during a long transitional period. The FCC has found that there will probably be enough channels in most markets to allot those extra frequencies to broadcasters who are planning to transmit in HDTV. However, there is some fear that broadcasters, hesitant because of the expense of converting to HDTV, might merely sit on the extra channels. Thus, the Commission's chairman, Alfred Sikes, has warned that broadcasters won't be allowed to dally and that the UHF spectrum space that broadcasters don't use after a respectable period of time could well be turned over to land mobile services. The FCC is asking a number of questions to prepare for HDTV, including how long stations should continue broadcasting in NTSC after the arrival of high definition.

• Two-lens camcorder. One of the last holdouts against the 8mm video format—Sharp Electronics—has come into the fold in a big way. It has introduced two camcorders with dual-lens systems. Each of the compact, palm-sized models are virtually two cameras in one. One lens provides a fixed-focus, wide-angle picture, the other an 8:1 zoom system. The wide-angle lens gives a 62° filed of view, and switching from one lens to the other provides "instant 12:1 zoom," according to Sharp. The system provides a number of special effects. It can be used for picture-in-picture, with both lens and CCD operating systems operating at the same time, or the user can "wipe" from one lens to the other. The basic model has monophonic sound and a monochrome viewfinder, while the higher priced model has stereo audio and a color LCD viewer.

With Sharp's addition of 8mm (it will continue to offer VHS camcorders as well), only JVC—the inventor of VHS—has no involvement with 8mm, among all major camcorder makers. Even Matsushita Electric, which doesn't offer 8mm camcorders under its own brands (Panasonic, Quasar, and National), manufactures 8mm camcorders on a private-label basis of other brands.

• Home multimedia. Nobody has really defined the word "multimedia," which is largely used to describe CD-ROM computer products to which interactive video has been added. Those offering non-computer items with similar attributes have generally avoided the word. The question for the future is whether multimedia will enter the home as a computer or as an attachment for the common TV set. Although there are many approaches to multimedia via the computer, so far only two systems have been introduced that use the family TV. Those are Commodore's CDTV, which is based on the Amiga computer but has no keyboard, and Philips' CD-I, launched with great fanfare (**Radio-Electronics**, February 1992) reportedly is selling well. Philips recently announced agreement with Motion Picture Experts Group (MPEG), a standards-setting body, on a standard to add full-motion video to CD-I. All CD-I players have a port for the addition of a chip to provide full-motion, full-screen video. Philips promises the plug-in chip by mid-year.

While Philips is attempting to appeal to the entire family with its CD-I programming—including children's activities, adult games, and reference materials—Commodore says it will begin next year to offer special-interest interactive packages, including MIDI (musical instrument digital interface) selections for audio enthusiasts and titling and captioning software for videomakers. Commodore also plans to brid the gap between TV-based a computer-based multimedia by fering a CDTV drive to the 750,0 Amiga computer users in the U

• Full HDTV schedule. Hig definition broadcasting is now or regular schedule in Japan, the sat lite-delivered Hi-Vision signal bei transmitted for eight hours daily, though the broadcasts are still bill as "experimental." So-called "re ular" HDTV broadcasting is s three years off. Japan's anal HDTV system has been under d velopment for more than 20 yea TV sets to receive and display t broadcasts in full HDTV still co about $30,000, and HDTV VCR are around $115,000, althou costs will come down. Alrea some private broadcasters in Jap (as opposed to the public NHK n work, which developed Hi-Visic are calling the Japanese system "interim" measure until a truly d ital system is developed.

• Bigger S-VHS pus Although more than 20% of VCR's sold in Japan are in th Super-VHS format, the proporti in the U.S. continues to hov around 2%. Panasonic now plans major campaign around S-VH with lower prices—a strategy ready being followed by JVC, whi is now shipping an S-VHS deck c rying a "nationally advertised pri of $799," about $500 less than t cheapest model last year. Althou Panasonic's pricing hadn't been r vealed at our press time, it is e pected to be at least in line w JVC's. In addition, Panasonic v bring S-VHS into more comple VHS compatibility by making its e tire VHS line S-VHS "playba compatible"—meaning that i standard VHS decks will be able play S-VHS tapes as well as sta dard VHS (although with only sta dard VHS resolution). R

Afford. Ability.

In a dc power supply.

Now, put a dependable, 30-watt dc power supply on your bench for just **$300***. You'll get the low noise your work demands (200 μV rms). Constant-voltage or constant-current operation. And built-in reliability ensured by conservative design margins and rigorous environmental testing.

Outstanding value in a dc power supply. It's just one in a full line of basic instruments developed by HP to give you uncompromising performance at an affordable price.

To order, call HP DIRECT, 1-800-452-4844,† Ext.TW13.
We'll ship your order the day it's received. Instruments come with a sixty-day, money-back guarantee. All you need is a company purchase order or credit card.

VISA Mastercard

HP 30-watt power supplies		E3610A	E3611A	E3612A
Output	Range 1	8V, 3A	20V, 1.50A	60V, 0.50A
	Range 2	15V, 2A	35V, 0.85A	120V, 0.25A
Load or line regulation		0.01% + 2 mV		
Ripple and noise (10 Hz-10 MHz)		200 μV rms/2 mV p-p		

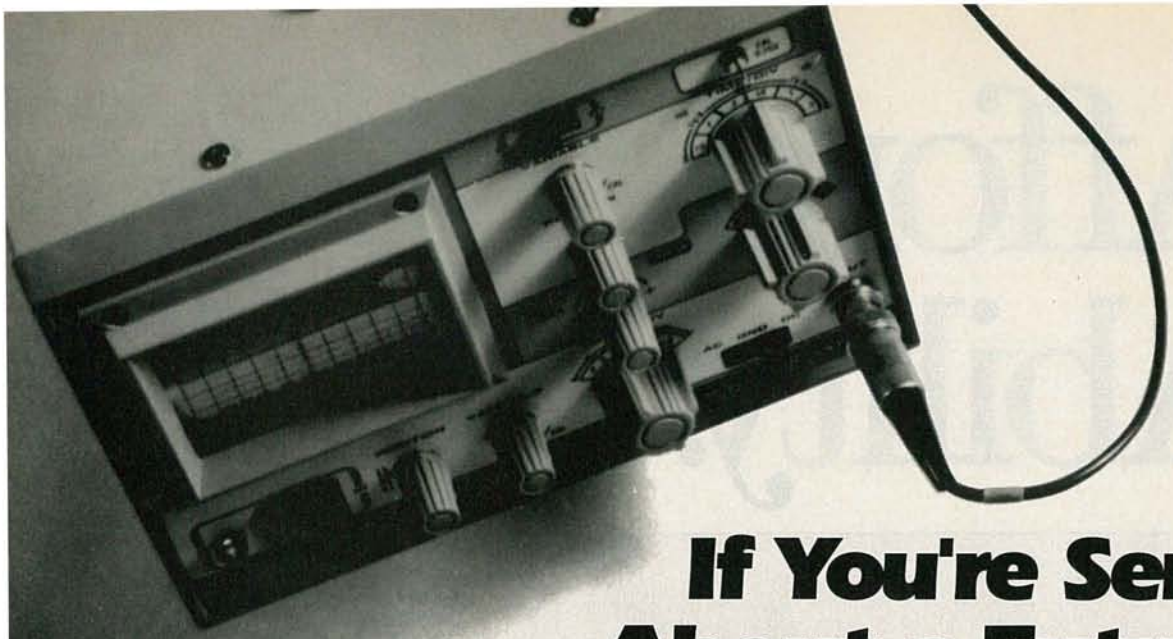
There is a better way.

HEWLETT PACKARD

* U.S. list price.
† In Canada call 1-800-387-3867, Dept. 442.

© 1992 Hewlett-Packard Co. TMNJD105B/RE

CIRCLE 192 ON FREE INFORMATION CARD

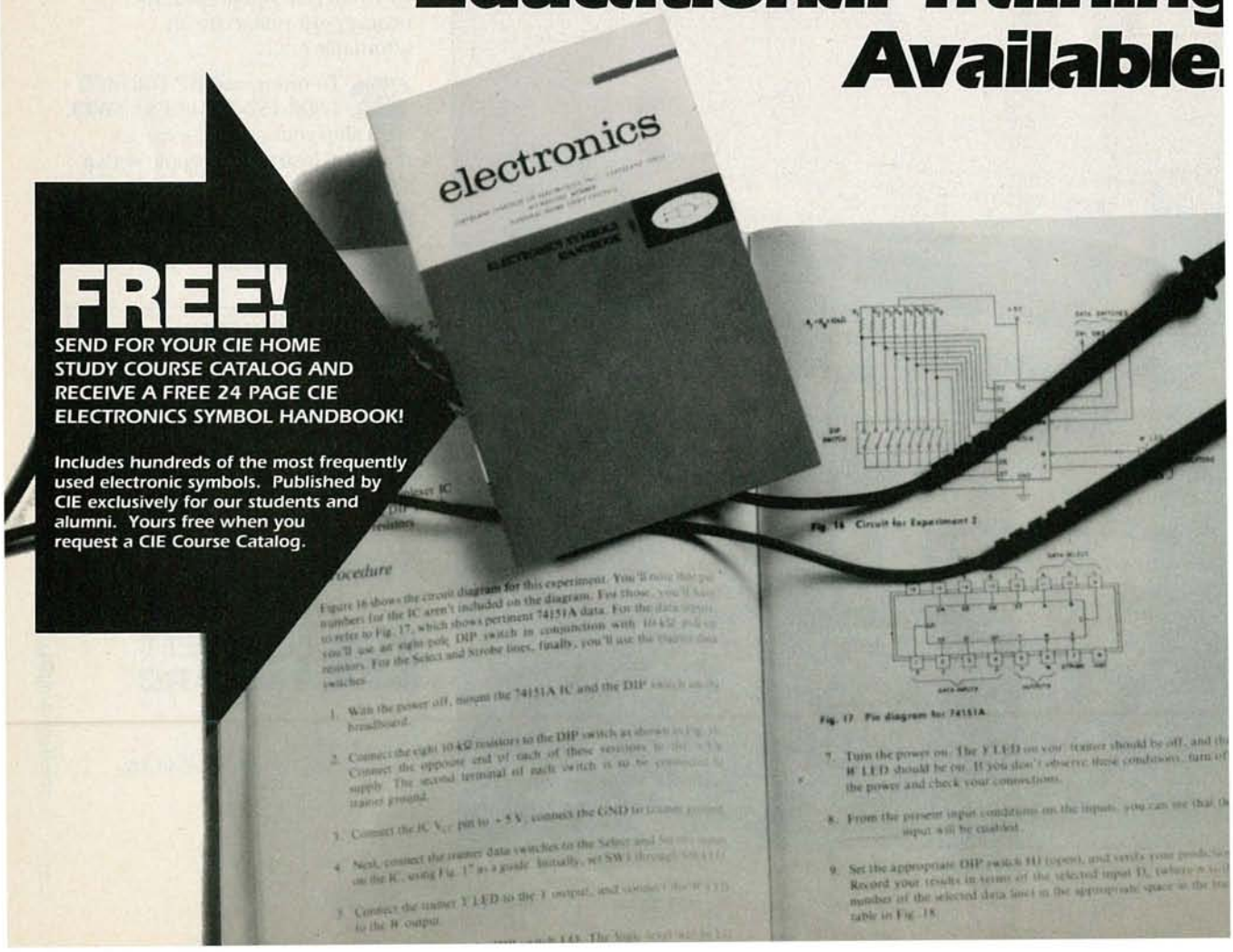


If You're Serious About a Future in Electronics, Ensure that Future with the Best Educational Training Available.

FREE!

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

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



If you want to learn about electron-
s, and earn a good income with that
nowledge then CIE is your best
ducational value.

CIE's reputation as the world
ader in home study electronics is
ased solely on the success of our
raduates. And we've earned that
eputation with an unconditional
ommitment to provide our students
ith the very best electronics
aining.

Just ask
ny of the
50,000-plus
raduates of
ne Cleveland
nstitute of
lectronics
ho are
orking in
igh-paying
ositions with
erospace,
omputer,
edical,
utomotive
nd communi-
ation firms
roughout the
orld.

They'll tell you success didn't
ome easy...but, it did come....thanks
CIE. And today, a career in elec-
onics offers more opportunities and
reater rewards than ever before.

IE's COMMITTED TO BEING HE BEST....IN ONE REA....ELECTRONICS.

IE isn't another be-everything-to-
verybody school. We teach only one
ubject and we believe we're the best
t what we do. Also, CIE is accredited
y the National Home Study Council.
nd with more than a 1,000 gradu-
tes each year, we're the largest
ome study school specializing
xclusively in electronics. CIE has
een training career-minded students
ke yourself for nearly 60 years and
e're the best at our subject .....
LECTRONICS ... BECAUSE IT'S THE
NLY SUBJECT WE TEACH!

CIE PROVIDES YOU WITH A LEARNING METHOD SO GOOD, IT'S PATENTED.

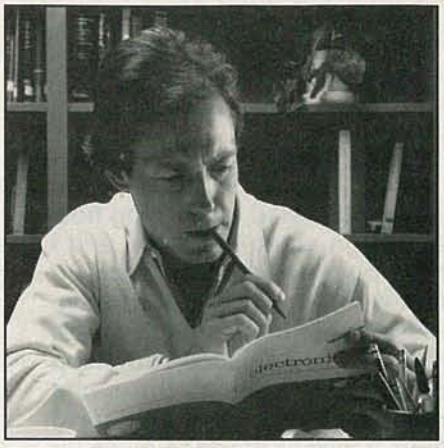
CIE's Auto-programmed lessons are a proven learning method for building valuable electronics career skills. Each lesson is designed to take you step-by-step and principle-by-principle. And while all CIE lessons are designed for independent study, CIE's instructors are personally available to assist you with just a toll-free call. The result is practical training... the kind of experience you can put to work in today's marketplace.

LEARN BY DOING...WITH STATE-OF-THE-ART FACILITIES AND EQUIPMENT.

In 1969, CIE pioneered the first Electronics Laboratory course and in 1984, the first Mircoprocessor Laboratory course. Today, no other home study school can match CIE's state-of-the-art equipment and training. And all your laboratory equipment, books, and lessons are included in your tuition. It's all yours to use while you study at home and for on -the -job after graduation.

PERSONALIZED TRAINING....TO MATCH YOUR BACKGROUND.

While some of our students have a working knowledge of electronics others are just starting out. That's why we've developed twelve career courses and an A.A.S. Degree program to choose from. So, even if your not sure which electronics career is best for you, CIE can get you started with



core lessons applicable to all areas of electronics. And every CIE course you take earns you credit towards completion of your Associate in Applied Science Degree. So you can work toward your degree in stages or as fast as you wish. In fact, CIE is the only school that actually rewards you for fast study, which can save you thousands of dollars.

SEND TODAY FOR YOUR CIE COURSE CATALOG AND WE'LL SEND YOU A FREE 24 PAGE CIE ELECTRONICS SYMBOL HANDBOOK!

WHY CHOOSE CIE FOR YOUR TRAINING?

150,000 successful graduates from every country around the world.

Only CIE rewards you for fast study. CIE offers an Associate Degree program based on actual study time used. The faster you complete your degree the less your overall tuition.

State-of-the-art laboratory equipment is yours to keep and it comes assembled, ready for hands-on experiments.

Approved for educational benefits under the G.I. Bill for veterans and other eligible persons.

Upon graduation, CIE offers free preparation to pass the Certified Electronics Technician Exams.

☐ **YES!** I want to get started. Send me my CIE school catalog including details about the Associate Degree Program. (For your convenience, CIE will have a representative contact you – there is no obligation.)

AE36

Name: _____

Address: _____

City: _____ State: _____

Zip: _____ Age: _____

Phone No. (____) _____

Check box for G.I. Bulletin Benefits
☐ Veteran ☐ Active Duty

CIE
CLEVELAND INSTITUTE OF ELECTRONICS
1776 East 17th Street
Cleveland, Ohio 44114
(216) 781-9400

ACCREDITED SCHOOL - NATIONAL HOME STUDY COUNCIL - NHSC

A school of thousands.
A class of one.
Since 1934.

ASK R-E

Write to Ask R-E, Radio-Electronics, 500-B Bi-County Blvd., Farmingdale, NY 11735

VIDEO FADER

I'm interested in learning how to design video hardware and I have been working on a circuit that would cause a video image to fade as I turn a potentiometer. I've tried several ideas but keep running up against the same problem. As I cause the signal to fade, it always starts to mess up horizontally and vertically before the image disappears completely. I'm not asking you to design the circuit for me, but I sure could use some advice. Do you have any idea what I'm doing wrong?—D. Koetting, St. Louis, MO

It's always a pleasure to answer a letter from someone who understands that the only way to learn is to make mistakes and work out the answers with a minimum of help and a maximum of brainwork.

I've studied your schematics and you've been making the same mistake each time. Each design you've done assumes that the video signal is similar to audio in that all the information contained in the signal is spread equally throughout the signal's entire voltage range. The video signal is extremely complex and different parts of it are reserved for different purposes. A typical line of video is shown in Fig. 1. Notice that the line is divided horizontally between the picture information (want to fade), and the control information (want to leave alone).

The only thing wrong with the designs you sent me is that they all treat the two parts of the video signal equally. By dropping the voltage level of the entire line of video, you're cutting the level of the control information in the horizontal interval as well. For your designs to work properly, your circuit must distinguish electronically between the picture and the control information in the horizontal interval.

This is the same problem that every television has and, as you would expect, there are one-chip solutions to the problem. National Semiconductor and other manufacturers have a range of chips available that can separate picture and sync. If you want to build something of your own to handle this proble the answer will become evid when you realize that in a stand NTSC signal (1 volt peak-to-pe the picture data lives above 300 livolts and the sync information li below that. You didn't ask for a s cific design, but remember that i volt TTL land, the picture infor tion will be seen as a high and s will be seen as a low.

Once you work out that par the problem, you have to use sync signal to gate your fade circ Reducing the picture to 300 m volts will make it disappear c pletely, and passing the wh signal during the sync interval steady the image as it fades a on the screen.

EGA-VGA ADAPTER

I have an AT clone and cently I upgraded my video c from EGA to VGA but I am s saving to buy myself an anal VGA monitor. The problem having at the moment is that old EGA monitor has a nine- connector and the VGA card h

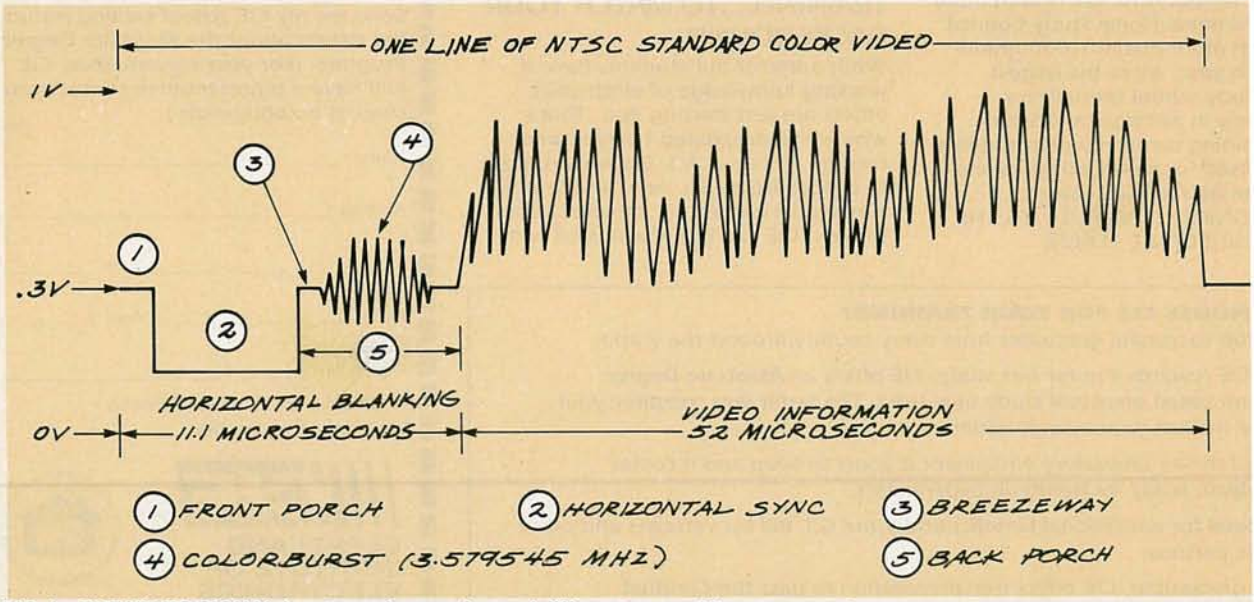


FIG. 1—THE VIDEO SIGNAL is extremely complex and different parts of it are reserved for different purposes. A typical line of video is divided horizontally between the picture information and the control information.

TABLE 1
IBM 15-PIN VGA CONNECTOR PINOUTS

Pin #	Function
1	Red Video
2	Green Video
3	Blue Video
4	Not Used
5	Ground
6	Red Ground
7	Green Ground
8	Blue Ground
9	No Pin
10	Sync Ground
11	Monitor ID (not used)
12	Monitor ID
13	Horizontal Sync
14	Vertical Sync
15	Not Used

Monochrome VGA monitors get their signal from Green Video on pin #2 and connect pin #12 to ground. Color VGA monitors leave pin #12 open. This allows the VGA card to detect the type of monitor it's driving when the computer is first turned on.

shown in Table 2. Making one of these adapters is easy but the fifteen-pin connectors are a pain in the neck to work with. If I were faced with your problem, I'd spring for a ready-made adapter.

While the adapter is standard, there's no guarantee that you can use it safely in your system. The EGA monitor you have is probably designed to handle only the standard EGA-level signals, and the VGA card you bought can probably drive only VGA-type analog monitors. Even if you were able to get past the problem with signal levels (and type), you'd still be left with the problem of the scan rate.

The standard EGA horizontal scan rate is about 21 kHz, while the regular VGA scan rate is considerably higher—about 31 kHz—and this is root of the problem. Trying to drive a monitor designed to scan at 21 kHz with a horizontal frequency 10 kHz higher will undoubtedly damage the horizontal deflection circuitry in the EGA monitor.

TABLE 2
PINOUTS OF THE NINE- TO FIFTEEN-PIN IBM VIDEO ADAPTER

Nine Pin Connector		Fifteen Pin Connector	
Pin #	Function	Pin #	Function
1	Red Video	1	Red Video
2	Green Video	2	Green Video
3	Blue Video	3	Blue Video
4	Horizontal Sync	13	Horizontal Sync
5	Vertical Sync	14	Vertical Sync
6	Red Ground	6	Red Ground
7	Green Ground	7	Green Ground
8	Blue Ground	8	Blue Ground
9	Sync Ground	10	Sync Ground
		5	Ground

a fifteen-pin connector. I know I can't see VGA-quality video on my monitor, but is there a standard for making an adapter to go from the fifteen pins on my card to the nine pins on my monitor?—F. Gisher, Benjamin, IN

At the risk of sounding completely mysterious, I have to tell you that the answer to your question is yes (maybe), and no (sort of). Even though VGA is an established standard, there are some important parts of it that aren't standardized.

Nine-to-fifteen pin adapters are sold by a lot of people. The pinout for the VGA's fifteen-pin connector is shown in Table 1, and the nine-to-fifteen pin adapter pinouts are

Some VGA cards—such as the ones from ATI—have hardware on them specifically designed to drive everything from monochrome to CGA to EGA monitors. In essence, while they look like a VGA card to both your computer and software, they can look like a variety of video cards to your monitor. Read your VGA card manual carefully and, if it doesn't specifically state that it can drive an EGA monitor, forget the idea and buy a VGA monitor.

By the way, the nine-to-fifteen-pin adapters are normally used for multisync monitors that can handle both analog (VGA) and TTL video signals. **R-E**

FREE
HEATH CATALOG

New and innovative electronics that make your life easier, safer and more secure, including:

- The world's largest and most varied selection of home lighting controls.
- Home security, safety and whole-house automation systems.
- The Heath Most Accurate Clock, accurate to +/-10 milliseconds.
- Heath's own Advanced Weather Computer for precision weather display and analysis.

And, the best electronics home study programs you'll find anywhere (the best value, too) including:

- ✔ New Computer-Aided Instruction (CAI) courses in basic electronics for accelerated, interactive learning.
- ✔ Video courses you can watch from the comfort of your easy chair.
- ✔ Courses that let you start at the level that's right for you and continue at your own pace.
- ✔ Courses from Heathkit Educational Systems, accredited and licensed as a premier electronics educator.
- ✔ Continuing Education Units (CEUs) awarded on successful completion of most Heath courses.

To receive your FREE Heath Catalog, fill in your name and address below and mail TODAY!

To: Heath Company
Dept. 020-150
Benton Harbor, MI 49022

Name _____

Address _____

City _____

State/Zip _____

CL-808

CIRCLE 86 ON FREE INFORMATION CARD

LETTERS

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

A REAL SOAP OPERA

Radio-Electronics readers might be interested to know that radio musical comedy is still alive and well in the 1990's. ZBS Foundation has produced "Dishpan Fantasy," a modern comic opera that is available to public radio stations as two half-hour programs. The format might be reminiscent of the past, but the plot and production methods are strictly contemporary. The story line blends bits of feminism with fantasy, comedy, love, and self-discovery. The music ranges from classical to rock'n'roll, from 50's cocktail lounge songs to African drums and whistles. The voices of two opera singers were used to create the seven characters in the opera. By running the singers' voices through a processor, the producer, Tim Clark, was able to create a cartoon-like quality. Using samplers and synthesizers, sound effects and environmental background noises were added. The "Finale" music-writing program was used for composing the opera, and the "Performer" program was used for the preliminary rough mix that allowed the singers to hear their parts with full orchestration. After the voices were recorded on a multitrack, Clark went back and added the music that was in the computer in the Performer program. Besides simplifying production, computer technology offered one big plus: Listeners can hear every word. Clark was able to rearrange the vocals and instrumentation so that the singers' words were always clearly understood. Check local public radio programming schedules for broadcast times of "Dishpan Fantasy."

KATHY GRONAU
ZBS Foundation

If "Dishpan Fantasy" isn't being broadcast in your listening area, you can order it on a 72-minute audio cassette for $12.95 directly from ZBS Foundation, RR#1 Box 1201, Ft. Edward, NY 12828-9713. Their phone number is 800-662-3345.—Editor

ONE READER'S OPINION

I'm writing to let you know that you're doing a great job. I work as an electrical engineer in the automotive field at a major R&D outfit during the day, and work towards my masters in E.E. at night. My job requires that I stay on the leading edge of technology and be informed on the latest techniques, applications, and discoveries. **Radio-Electronics** has been a great help in meeting those requirements. I can't emphasize enough that education is a priority for success and must be a lifetime commitment. I've always preached to other electronics students that **Radio-Electronics** is an excellent source of information. I love to study the "Build This" projects, admiring some of the designs—and catching some of the errors. The technology articles provide an excellent review. The various departments keep getting better, and I hate it when I don't have time to read them all.

One suggestion for impro ment: I'd like to see a sectior **Radio-Electronics** devoted testing your electronic skills. I haps it could be a one-page te covering a different topic ea month, that readers could take quiz themselves. Taking such te really keeps you on your toes.

Keep up the good work!

J. KEITH DAVIS
San Antonio, TX

ADC FOR YOUR PC IMPROVEMENTS

The surface temperature prob "Experimenting with ADC for y PC" (**Radio-Electronics**, Ja ary 1992) should not have its han filled with epoxy or silicone, as t will increase heat transfer betwe the sensor and the handle, thus creasing response time and creasing accuracy. The top of TO-92 case should also be filed to increase contact area and h transfer between the sensor a the measured surface.

At the low-temperature da gathering point, be sure not to r ord the voltage until the ice cub wet from its own melting. An cube just out of a freezer could h a temperature well below 0°C.

At the high-temperature da gathering point, the probe shc not be immersed if it's to be usec a surface probe. Place it against outer flat side of the container boiling water, just below the wa level. Bring the water to a rol boil, reduce the heat slowly, and r ord the voltage just as active bub production ceases.

A rolling boil can be more tl 1°C above the true boiling poin which is also greatly affected by barometric pressure. Pure water boil at less than 95°C in Denver der the influence of a low-press system, and at more than 101°C sea level under the influence c high-pressure system.

The current uncorrected ba

metric pressure can be obtained from your nearest airport or weather bureau. For every 0.1 inch of mercury above or below 29.92 inches, adding or subtracting 0.1°C from 100°C will be quite close.

For immersion probe construction, on the other hand, thermal isolation of the sensor from the handle is of little concern, but moisture proofing is important. For the low-temperature point, immerse the probe in a constantly stirred slurry of chipped ice and water using +0.3°C instead of 0.0°C as the temperature. At the boiling point, don't pour the water into another container. It will lose several degrees in the process. Immerse the probe to just above the bottom of the container, making temperature corrections and voltage recordings as outlined above.

DAN A. NIEMI
Gwinn, MI

SCRAMBLER/DESCRAMBLER REQUEST

It has been several years since my service training in electronics. As a matter of fact, my education was very complete—on tubes, that is. I've just recently regained my interest in electronics as a hobby for my golden (silicon?) years. After making a bunch of doo-dads directly from simple schematics, I would like to get back into designing my own circuitry as I did in days of yore.

In the meantime, while my knowledge is getting modernized, I would greatly appreciate plans for a simple solid-state scrambler/descrambler. The parameters could be very limited, since it only has to be variable to give four or five "channels" and an audio band (even just the frequencies of the human voice).

It's hard to believe the changes that have come to pass. Picking up my first subscription copy since dropping out years ago is like starting to learn a foreign language that your distant relative spoke in your youth. In any case, it is satisfying to see that the quality of **Radio-Electronics** has not suffered.

LEN BOULTER
Prince Rupert, B.C.
Canada

Keep reading—we're working on just such a project!—Editor **R-E**

Does Your Frequency Counter Give Honest Answers?

B+K PRECISION frequency counters are conservatively rated and designed for accuracy.

Before you buy a counter, compare specs and ask questions... Does high-input sensitivity come at the expense of false readings with no input? Is time base drift specified per *year*, or just per month? From 0° to 50° C, or only at room temperature?

B+K PRECISION's rugged, lab-grade counters have guaranteed specs. They'll perform as promised, every time. You can count on B+K!

1.3GHz 8-digit Multifunction Counter
- Frequency, period, period average, and totalize functions
- 1.0 PPM TCXO time base
- 10 mV rms max. sensitivity
- Optional accessory antenna
- 0.1 Hz max. resolution
- Remote start-stop

Model 1856 **$495.00**

175 MHz 8-digit Universal Counter
- Frequency, period, period average, totalize, frequency ratio, and time-interval function
- 10 PPM time base
- 20 mV rms max. sensitivity
- Optional accessory antenna
- 0.1 Hz max. resolution

Model 1823 **$395.00**

For detailed specifications on the complete line of B+K PRECISION frequency counters or immediate delivery, contact your local distributor or B+K PRECISION.

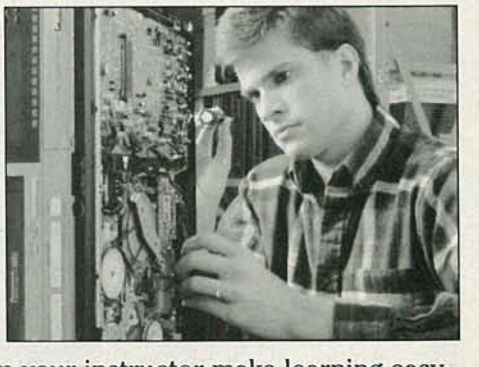
BK PRECISION® MAXTEC INTERNATIONAL CORP.

Domestic and International Sales
6470 W. Cortland St., Chicago, IL 60635
312-889-1448 • FAX: 312-794-9740

CIRCLE 77 ON FREE INFORMATION CARD

NO COMPLICATED ELECTRONICS, NO EXPENSIVE INSTRUMENTS:

Home study course shows you how to make good money in VCR repair.



An amazing fact: you can do more than four out of five VCR repairs with ordinary tools and basic fix-it procedures. Our home study program shows you how.

Learn all of the systems, mechanisms, and parts of almost all brands of VCRs. With *no* expensive instruments. *No* complicated electronics. *No* fancy workshop. The step-by-step texts and close personal attention from your instructor make learning easy.

Texts, course materials, and tool kit are sent to your home. Graduate ready to make up to $50.00 or more per hour in your own spare-time or full-time business.

Send today for your free career booklet. Or call 800-223-4542

Name _____
Address _____
City _____ State _____ Zip _____

The School of VCR Repair
2245 Perimeter Park, Dept. VC342 ,Atlanta, Georgia 30341

MARCI

LARRY STECKLER, EHF/CET, Editor-in-Chief

IF YOU MAINTAIN, REPAIR OR UPgrade electronic equipment you should become a Certified Electronics Technician (CET). Here's how you can become someone special.

On behalf of its more than 32,000 Certified Technicians, Ernie Curtis, CET, Chairman of the International Society of Certified Electronics Technicians, has declared Tuesday, March 10, 1992, "Electronics Technicians Day."

"The electronics technician," stated Curtis, "is responsible for keeping today's electronics-dependent society operating. Without this highly-skilled and specially-trained corps of electronics technicians, breakdowns in modern complex electronics would quickly bring our world to a sparking halt. Our intention," Curtis continues, "is to focus international recognition on the high standards of performance and excellence maintained by professional electronics technicians."

Over 100 ISCET Certification Test Administrators have volunteered to give tests during the week of March 8 through 14, 1992 to honor Electronics Technicians Day. The complete list of all of these test sites is published in the pages that follow this article. In 1991, the 30,000th CET, Robert Bruce Bottoms, CET was an ISCET member who used T-Day 1991 to upgrade from Associate to Journeyman. Bottoms, an employee of United Parcel Service, attended the 1991 ISCET convention in Reno, Nevada, and addressed an enthusiastic audience about his desire to represent a new generation of CET's.

What is ISCET?

As the proud electronics technicians division of the National Electronics Sales & Ser Dealers Association (NES ISCET was founded in 197(committee of Certified I tronics Technicians, wl main purpose was to foste spect and admiration for profession. By maintai rigorous standards in its tification program, ISCE able to separate the highly ed and knowledgeable tec cians from those with experience. ISCET's main f tions include direction an(ministration of the CET gram, the national appre and training program, the nical information training upgrading programs, an(serviceability programs.

The CET program wa signed to measure the deg theoretical knowledge and nical proficiency of practi technicians. A technician a CET certificate is thought the industry as one who sesses the training and e tise necessary to perform h with professional compete Since its inception, the program has continued to acceptance by technici manufacturers, and cons ers. Many organizations courage, and often req their technical employees certified by ISCET.

Technician skills

Just keeping up with changes that seem to occu ly in new equipment is a time task. To be able to se the latest electronics equip with its new circuitry, new ponents, and new principl a difficult challenge. To electronics technicians n constantly learn, constantl uire new theoretical and tical skills, and consta develop new techniques. must become familiar with

AT THE ISCET CONVENTION, the current ISCET chairman, Ernie Curtis, CET (left) accepts the gavel from outgoing chairman, Leonard Bowdre, CET.

10: ELECTRONICS TECHNICIANS DAY

kinds of test equipment and new servicing techniques to repair the latest electronics engineering marvels.

Perhaps this was best summed up by Leonard Bowdre, CET, ISCET's Immediate Past Chairman, when he said, "I marvel at the exponential changes in electronics since my introduction to it in 1946. The new techniques, devices, and technology that have appeared in the last two years alone are mind-boggling. With what today's technicans must know, I think they must be the most qualified, most underpaid, and the least recognized in the world's work force."

The CET exam

To become certified by ISCET, the electronics technician must pass both a 75-question Associate-level CET test, and a 75-question Journeyman-level test. To pass, the candidate must score a grade of 75% or better. An electronics technician or student with less than four years of experience may apply for the Associate-level exam only, which covers the following subjects:

- Basic Mathematics
- DC Circuits
- AC Circuits
- Transistors and Semiconductors
- Electronic Components
- Instruments
- Tests and Measurements
- Troubleshooting and Network Analysis

A fully certified technician must have four or more years of education or experience in electronics and must pass, in addition to the Associate-level test, one or more of the Journeyman options available in specialized fields of electronics. The Journeyman options that are available are:

- Consumer—Subjects covered include antennas and transmission lines, digital and linear circuits in consumer products, TV and VCR servicing problems, and the use of test equipment.
- Industrial—Subjects include transducers, switches, power factor, differential amplifiers, closed-loop feedback, basic logic circuits and functions, elements of numeric control, thyratrons, and SCR controls.
- Communications—This test covers two-way radio transceiver theory and servicing, receivers, transmitters, basic communications theory, deviation sensitivity, quieting, and troubleshooting.
- FCC Legal—This is a 25-question optional exam covering FCC regulations. Applicants who take the associate exam, the Communication option, and the FCC Legal exams will receive a general radio-telephone license.
- Computer—This test covers operation of computer systems with basic emphasis on hardware. Subjects covered include basic arithmetic and logic operations, computer organization, input and output equipment, and memory and storage. Some knowledge of software and programming is required, and the ability to explain troubleshooting procedure is also required.
- Audio—Products covered in this option include turntables, tape decks, compact discs, and

TRAINING NEVER STOPS for electronic technicians. Here Ernie Curtis, CET and other ISCET Members learn about the latest developments in digital electronics.

radios. The exam consists of both digital and analog sections, amplifiers and sound quality, system set-up, speaker installation, and troubleshooting audio systems.

- Medical—The priorities of this option are electrical safety and accuracy of calibration for electromedical instruments. The technician must be familiar with the basic vocabulary of medical instrumentation, telemetry, measurements, and differential and operational amplifier applications.
- Radar—A general knowledge of both pulsed and continuous-wave radar is necessary to take this Journeyman option. The test covers transmitters and receivers, CRT display systems and their power supplies, and antennas, transmission lines and their characteristics.
- Video—The rapidly growing field of video is covered by this exam. The technician needs to know NTSC standards, video basics, test signals, and the operation of both the electronic and mechanical systems in VCR's. Also covered are 8mm video, camcorders, cameras and monitors, and the microprocessors used in video products

Fees and difficulty

The fee for the CET exam is $25.00, which includes both the Associate exam and any one Journeyman option, if taken in one sitting. If the Journeyman option is taken separately from the Associate exam, each test is $25.00. Each additional Journeyman option is $25.00. If you fail any portion, the first retake is free, after a 60-day waiting period. The fee for any additional retake is $12.50. If you choose to take the FCC Legal exam after you have successfully completed the Communications option, there is an additional fee of $10.00. Don't underestimate the difficulty of the CET exam. Every year only 30% of those who take a CET test pass—it is not an easy test!

The best way to prepare for this exam is to study diligently. Tab Books publishes *The CET Study Guide* by Sam Wils which will help you prepare both tests. ISCET also has a tional study guides available a nominal fee.

If after reading this art you're interested in taking CET exam and joining the g ing ranks of Certified E tronics Technicians, con any one of ISCET's volun test administrators liste this article for details. exams are scheduled to be g during the week of Marc through 14, 1992. For any a tional information you m need, contact ISCET at 2 West Berry St., Fort Worth, 76109; phone 1-817-921-91

Join the professionals

You're already competen electronics or you wouldn' reading this magazine and article. You need to gain the ognition you deserve. To d take the CET challenge and 32,000 other electronics pr sionals. Become a CET. worth the effort and you des the recognition.

ISCET CERTIFIED ADMINISTRATORS FOR CET EXAM

David L. Bryan, CET
Alabama Aviat. & Tech. Coll.
PO Box 1209
Ozark, AL 36360
(205) 774-5113

David L. McCann, CET
64 Steele Lane
Loxley, AL 36551
(205) 343-8200

Delores Rasberry
Herzing Institute
1218 South 20th St.
Birmingham, AL 35205
(205) 933-8536

Ricky G. Reaves, CET
Shoals Comm. Coll.
PO Box 2545
Muscle Shoals, AL 35662
(205) 381-2813

R. T. Van Iderstine, CET
Southwest State Tech. College
925 Dauphin Island Pkwy.
Mobile, AL 36605
(205) 947-4441

Alison J. Fletcher, CET
Southern Tech. College
7601 Scott Hamilton
Little Rock, AR 72209
(501) 565-7000

Dennis P. Blum, CET
Phoenix Inst. of Tech.
2555 E. University Dr.
Phoenix, AZ 85034
(602) 244-8111

Frank Grabiec, CET
Dyna-tronics
1704 E. Claremont
Phoenix, AZ 85016
(602) 279-3791

H.J. Paine, CET
4631 E. 8th St.
Tucson, AZ 85711
(602) 881-6784

Russell Scarpelli, CET
10529 W. Dessert Forst. Cnle.
Sun City, AZ 85351
(602) 972-3854

Silvino Alonso
Calif. Business Inst.
3550 Johnson Ave.
El Monte, CA 91731
(818) 444-7779

Billy J. Edmonds, CET
1311-16th St.
Baywood, CA 93402
(805) 543-2700 Ext 7772

Howard Bardach, CET
The Audio Specialist
4381 Tujunga Ave.
Studio City. CA 91604
(818) 763-3009

John V. Craig, CET
531 W. Hueneme Rd.
Oxnard, CA 93033
(805) 982-5228

Max B. Free
California Med. Facility
2100 Peabody Rd.
Vacaville, CA 95696-4000
(707) 448-6841 Ext 3355

Robert A. Johnson, CET
Ameritech Colleges
4600 Ashe Rd., #313
Bakersfield, CA 93313
(805) 835-9225

Romualdo Malarayap, CET
ITT Technical Institute
1530 W Cameron Ave.
W. Covina, CA 91706
(818) 960-8681

David Marson, CET
California Youth Authority
PO Box 1245
Paso de Robles, CA 93447-1245
(805) 238-4040 Ext 428

Michael R. Miller, CET
California Mens Colony-West
PO Box 8103-Education Dept.
Slo, CA 93403-0006
(805) 543-2700 Ext 7143

Peter J. Moreno, CET
ITT Technical Institute
630 E. Brier Dr., #150
San Bernardino, CA 92408
(714) 889-3800

Kevin J. Price, CET
NEC
825 E. Hospitality Ln.
San Bernardino, CA 92408
(714) 885-3896

Parviz Shams
Southern Calif. Inst. of Tech.
10600 Katella Ave.
Anaheim, CA 92804
(714) 520-5552

Fredrick J. Smith, CET
Ed. Dept. Calif. Mens Cnty.
PO Box 8101
San Luis Obispo, CA 93409-0003
(805) 772-2009

Phillip G. Stephens
Matsushita Reg. Tech. Center
6550 Katella Ave.
Cypress, CA 90630
(714) 895-7435

Dr. Kenneth L. Wilson, CET
San Diego City College
1313-12th Ave.
San Diego, CA 92101
(619) 230-2601

Don Winchel, CET
M & D Electronics
PO Box 123
Smartville, CA 95977
(916) 639-2477

John F. McMullen, CET
Denver Inst. of Tech. Inc.
7350 N. Broadway
Denver, CO 80221
(303) 426-1808

Albert Moses, CET
PO Box 188
Cheswold, DE 19936
(302) 571-5402

George W. Shaiffer, CET
38 N Dartmouth
Widefield, CO 80911
(719) 392-1000

John F. Stackhouse, CET
ITT
2121 South Blackhawk
Aurora, CO 80014
(303) 695-1913

Anthony R. Valdez, CET
1919 Rolling Hills Rd.
Cortex, CO 81321
(303) 565-8457

John E. DePalma, CET
Conn. School of Electronics
586 Ella Grasso Blvd.
New Haven, CT 06519
(203) 624-2121

Daniel J. Shea, CET
Conn. School of Electronics
586 Ella Grasso Blvd.
New Haven, CT 06519
(203) 624-2121

William S. Brooks, CET
7112 N. Habana Ave.
Tampa, FL 33614-4365
(813) 933-1793

Edward Guary, CET
Eddy's Radio & TV Service
1110 NE 4th Ave.
Ft. Lauderdale, FL 33304
(305) 763-2964

Ronald A. Handlon, CET
Nec. Bauder College
7955 NW 12 St.
Miami, FL 33126
(305) 477-0251

Karl A. Hunter, CET
13850 Ketch Cove Dr.
Jacksonville, FL 32224-1143
(904) 633-8143

John Steven Richards, CET
ITT Technical Institute
2600 Lake Lucien Dr., #140
Maitland, FL 32751
(407) 660-2900

J.J. Villademoros, CET
ITT Technical Institute
5225 Memorial Highway
Tampa, FL 33634-7350
(813) 885-2244

Roy Chastain, CET
N.G.T.I.
197 N. Box 65
Clarkesville, GA 30523-0065
(404) 754-7751 Ext. 334

Daniel B. Mundy, C
Norman's Electroni
3653 Clairmont Rd
Atlanta, GA 30341
(404) 451-5057

James Peek, CET
Panasonic
4245 E Internationa
Norcross, GA 300
(404) 717-6858

W.R.Rooks, CET
Shiloh Rd. Rt.6
Box 181
Americus, GA 317
(912) 928-0283 Ex

Ebin Shepard, CE
Bloomfield TV Svs
2481 Rocky Creek
Macon, GA 31206
(912) 788-5281

James P. Van Sant
Pickens Tech.
240 Burnt Mountai
Jasper, GA 30143
(404) 692-3411

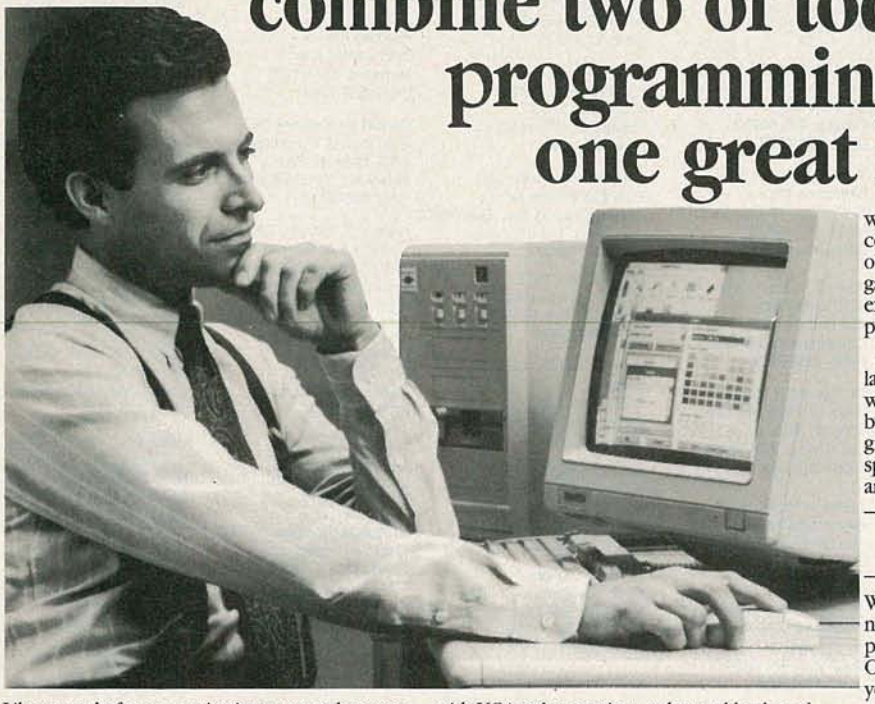
Mel Streeter
Lewis Clark St. col
8th Ave.at 6th St.
Lewiston, ID 8350
(208) 799-2225

Douglas E. Minter,
American College
1300 W. Washingt
Bloomington, IL 61
(309) 828-5151

F.A. Schwarzkopf,
Triton College, Rm
2000 Fifth Ave.
River Grove, IL 60
(312) 767-4126

Today's top-paying programming jobs go to those skilled in both C++ and Windows

NRI's new training in Programming in C++ with Windows lets you combine two of today's hottest programming skills into one great new career!



Like never before, organizations everywhere are paying top dollar for PC programmers who can combine the power of object-oriented C++ with the new freedom and ease of Windows to create in-demand software for business, industry, or consumer applications.

Pick up the classified section in any major newspaper and you'll see: C++ programming and the ability to create PC programs for a Windows environment top the list of job skills today's employers demand.

Now you can take advantage of today's hottest programming opportunities with NRI's new at-home training — Programming in C++ with Windows. It's the right training at the right time. And the only training that gives you everything you need to succeed today on the job, in a new career, or in a full- or part-time programming business of your own.

Get hands-on training with a 386sx-based mini-tower computer system

NRI knows: To program in C++ and create Windows applications, you need to work with a state-of-the-art computer system. That's why NRI gives you hands-on experience with a 386sx-based mini-tower computer — yours to train with and keep! Only a computer this powerful and fast would do. Best of all, your computer system comes complete with VGA color monitor, enhanced keyboard and mouse, 40 meg IDE hard drive, and three full megabytes of RAM.

This outstanding computer system gives you the memory, speed, and power you need to take advantage of all the features of your C++ compiler and Windows software ... and develop the kind of quality software programs today's employers and consumers demand. But hardware is just part of what makes NRI training so good ...

Get practical experience with a powerful 386sx-based computer, VGA color monitor, 3 meg RAM, 40 meg IDE hard drive, enhanced keyboard and mouse, and professional software ... all yours to train with and keep!

Master object-oriented programming using Borland Turbo C++®

With NRI you learn at home, at a comfortable pace. NRI's Discovery Learning Method takes you step-by-step from computer basics to advanced programming in C++, today's hottest object-oriented programming language. As you work with the top-rated Borland Turbo C++ compiler included in your course, you master object-oriented programming methods — gaining the practical experience and design expertise that will save you time and make future programming fast and easy.

You discover for yourself how this in-demand language allows you the freedom to write real-world applications that rival software produced by top-paid design teams — from stand-alone graphics and word processing packages to spreadsheets, text editors, database managers, and more! But that's still not all...

Learn to program for the exciting visual environment of Microsoft® Windows™

With NRI training you take command of today's newest design techniques as you master programming skills for Windows — using both C++ and the built-in functions and routines of your Microsoft Windows software.

As you actually build your own software application, you develop hands-on experience with Windows' easy-to-use features —includng graphics, memory management, multitasking, data exchange, and more!

Soon you're ready to use your computer and know-how to create fast, functional programs — complete with on-screen graphics, custom cursors, images, icons, and all the other Windows features you need to build high-performance software that meets today's competitive business needs.

Send for your FREE NRI catalog today!

Discover how NRI can give you the computer know-how you need for success. If the coupon is missing, write to NRI Schools, McGraw-Hill Continuing Education Center, 4401 Connecticut Avenue, NW, Washington, DC 20008.

SEND COUPON TODAY FOR FREE NRI CATALOG!

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

Yes! Send me the FREE catalog I've checked and show me how NRI can give me the state-of-the-art computer training I need for advancement, extra income, or a business of my own!

☑ **Check one FREE catalog only**
- ☐ **PROGRAMMING IN C++ WITH WINDOWS**
- ☐ PC Troubleshooter
- ☐ PC Applications Specialist

Other computer career training:
- ☐ Computer Programming
- ☐ Desktop Publishing and Design
- ☐ Bookkeeping and Accounting

Name_____ Age_____

Address_____

City_____ State_____ Zip_____

Accredited Member, National Home Study Council

5415-032

George Sopocko, CET
The Radio TV Lab
5631 W Irving Park Rd.
Chicago, IL 60634
(312) 545-3622

Paul K. Tan, CET
915 Augusta St.
Oak Park, IL 60302-1678
(312) 848-6327

Frank Teskey, CET
F.J. Teskey Enterprises
3094 Lafayette Rd.
Indianapolis, IN 46222
(317) 926-2639

Leonard E. Bowdre, CET
125 SE Thornton Ave.
Des Moines, IA 50315
(515) 964-6484

James E. Boyer, CET
Western Ia. Tech. Comm. Coll.
4647 Stone Ave.
Sioux City, IA 51102
(712) 274-6279

Donnin G. Custer, CET
West Ia. Tech. Comm. College
PO Box 265-4647 Stone Ave.
Sioux City, IA 51102-0265
(712) 274-6279

Michael L. Baughman, CET
KS City Area Vo. Tech.
2220 N 59th St.
Kansas City, KS 66104
(913) 334-1000 Ext 48

Stanley Creitz, CET
NCK Area Vocat. Tech.
PO Box 507, West Campus D
Beloit, KS 67420
(913) 738-2279

Dr. G.W. Ko, CET
550 N. Fountain
Wichita, KS 67208
(316) 686-4864

John E. Krier, CET
1606 Timothy
Wichita, KS 67212-3812
(316) 722-4041

Michael Dixon, CET
Somerset Vo. Tech. School
714 Airport Rd.
Somerset, KY 42501
(606) 679-4303

Sanford N. Dotson, CET
Lexington Elect. Tech.
3340 Holwyn Rd.
Lexington, KY 40503
(606) 223-9608

Edward J. Kimmel, CET
Kimmel Electronics
2061 Eastern Parkway
Louisville, KY 40204
(502) 451-3457

Jerry D. Middleton, CET
2906 New Haven Ct.
Flatwoods, KY 41139
(606) 836-4736

Edward M. Ondo, CET
Cumberland Valy Health Cntr.
PO Box 187
Pineville, KY 40977
(606) 337-3094

Jack B. Sellards, CET
Jack's TV & Appliances
509 Knox St.
Barbourville, KY 40906
(606) 546-5224

Lamarr W. Ritchie, CET
Hazard State Vo-Tech. School
101 Vo-Tech
Hazard, KY 41701
(606) 436-3101

Dr. I.F. Creel, CET
Sullivan Tech. Inst.
1710 Sullivan Dr.
Bogalusa, LA 70427
(504) 732-6640

W.H. Hartzfeldt, CET
Delta-Quachita Vo. Tech.
609 Vocational Pkwy.
W. Monroe, LA 71291
(318) 396-7431

M.G. McCann Jr.,CET
McCann Electronics
100 Division St.
Metairie, LA 70001
(504) 837-7272

James R. Sorrels, CET/CSM
110 Oakridge Dr.
Shreveport, LA 71106-7113
(318) 686-4637

Gordon L. Burgess, CET
Great Northern Paper Div.
Main St.
E. Millinocket, ME 04430
(207) 746-9912 Ext. 1300

Carl F. Miller, CET
5114 Baltimore Ave.
Hyattsville, MD 20781
(301) 864-5750

Earl Tickler, CET
Rets. Tech. Trng. Center
1520 S. Caton Ave.
Baltimore, MD 21227
(301) 644-6400

Robert A. Ciufetti, CET
444 Fairmount St.
Fitchburg, MA 01420
(508) 834-2052

Frank Serra, CET
Serra's TV Video
1686 Massachusetts Ave.
Cambridge, MA 02138
(617) 492-2667

Bob Bellers, CET
Washtenaw Comm. College
4800 E Huron River Dr.
Ann Arbor, MI 48106
(313) 973-3316

John P. Borris, CET
St. Clair Cnty Comm. College
323 Erie St.
Port Huron, MI 48060
(313) 984-3881 Ext 305

Dr.Joel Goldberg, CET
Macomb Community College
14500 12 Mile Rd.
Warren, MI 48093
(313) 445-7373

Gerald H. Heyn, CET
55 E. Jackpine St., Lot 113
Gwinn, MI 49841
(906) 346-6396

E. Eugene Ranta, CET
Macomb Comm. College
14500 Twelve Mile Rd.
Warren, MI 48093
(313) 445-7343

Willard Rush, CET
Oakland College
3361 Aspen-6304
Orion, MI 48359
(313) 333-2531

John Baldwin, CET
Faribault Campus
1225 SW 3rd St.
Faribault, MN 55021
(504) 334-3965 Ext 129

Larry Geissler, CET
3706 Chambersburg
Duluth MN 55811
(218) 722-9356

Steven M. Brumfield, CET
Southern Technical College
2305 Lakeland Dr.
Jackson, MS 39208
(601) 932-7809

Marion B. Denny Jr., CET
Audio-Video Service
1405 Corinne St.
Hattiesburg, MS 39401
(601) 545-7606

James D. Everett, CET
Platte County Avt. School
PO Box 1700
Platte City, MO 64079
(816) 329-4646

Annabel L. Gooch
Davis Hart Mavts.
905 N. Wade St.
Mexico, MO 65265
(314) 581-5684

Gregory J. Nesbo, CET
440 1st Ave.
Havre, MT 59501
(406) 265-8459

Jack Hopson, CET
First Television Serice
5214 Center
Omaha, NE 68106
(402) 551-4868

James Belanger, CET
Beltronics Inc.
19 Proctor Hill Rd., Box 330
Hollis, NH 03049
(603) 465-2422

Joseph T. Szumowski, CET
JTS Electronics
412 Pomona Rd.
Cinnaminson, NJ 08077
(609) 829-9669

Dr. Ronald P. Hartman
Tech. Training Institute
1320 S. Solano
Las Cruces, NM 88001
(505) 522-6533

Anthony Abram, CET
Bryan Stratton elect. tech.
1028 Main St.
Buffalo, NY 14202
(716) 884-9120

Joseph A. Passaretti, CET
Pyramid Electronics Ltd.
353 E 76th St.
New York, NY 10021
(212) 628-6500

Larry Steckler,EHF/CET
Radio Electronics Magazine
500 B Bi-county Blvd.
Farmingdale, NY 11735
(516) 293-3000

Fred H. Freeman Jr.
Reynolds Elect. & Engnr. Co.
PO Box 98521
Las Vegas, NV 89193-8521
(702) 295-1915

Linda Dickinson
Craven Community College
PO Box 952
Havelock, NC 28532
(919) 447-1141

William H. Mast, CET
Applachian State Univ.
Dept. of Ind. Ed. & Tech.
Boone, NC 28607
(704) 262-6352

Melvin E. Talbert, CET
Heilig Meyer Service Co.
PO Box 64189-2858, Owen Dr.
Fayetteville, NC 28306-0189
(919) 483-0801

Lloyd G. Chale, CET
301-3rd St. East
Fargo, ND 58078
(701) 282-0430 Ext 220

Lawrence M. Delonais, CET
National Education Center
1660 Martin Rd.
Mogadore, OH 44260
(216) 628-3115 Ext. 19

A.C.Falcione, CET
Falcon Electronics, Inc.
3266 Kent Rd.
Stow, OH 44224
(216) 688-2451

Andrew M. Flock, CET
Hickok Tech. Institute
5100 Pearl Rd.
Cleveland, OH 44129-1240
(216) 351-4600

David J. Garwacki, CET
Sales & Service
4846 Oak Glen Dr.
Toledo, OH 43613-3048
(419) 475-9221

J.R. Manchester, CET
University of Akron
PO Box 61, Buckingham Center
Akron, OH 44309
(216) 972-7575

Bary G. Rathbun, CET
ETI Technical College
4300 Euclid Ave.
Cleveland, OH 44103
(216) 431-4300

Rod Schlingerman, CET
PVS Electronics Inc.
3949 Cleveland Ave., Box 24400
Columbus, OH 43224
(614) 471-9010

Donald Sisk, CET
1650 Cobble Gate Ln.
Reynoldsburg, OH 43068
(614) 866-5667

John E. Valerio, CET
Sencore
612 Lovers Lane
Steubenville, OH 43952
(614) 264-3001

J.S. Glosemeyer, CET
East Okla. County Vo. Tech.
4601 N. Choctaw Rd.
Choctaw, OK 73020
(405) 390-9591

Dr. Bess Jenkins
Redlands Comm. College
Box 370-1300 Country Club Rd.
El Reno, OK 73036
(405) 262-2552

Hubert L. Wood
College of Americas of Tulsa
2514 East 71st St.
Tulsa, OK 74136
(918) 496-8324

Roy W. Yonce
Tec-Ed Corporation
PO Box 470992
Tulsa, OK 74147
(918) 663-9500

George W. Day, CET
Douglas Education Svc. Dept.
1871 NE Stephens St.
Roseburg, OR 97470
(503) 440-4774

William H. Manny, CET
Round-Up Electronics Inc.
2927 Riverside
Pendleton, OR 97801
(503) 276-3152

John F. Grzesiak, CET
27 Lighthouse St.
Erie, PA 16507-1937
(814) 459-2519

Gene Hedgepeth, CET
Tectronics Service Labs.
RD 4-639 E. Alberdeen Rd.
Mountaintop, PA 18707
(717) 868-6566

L.A. Leibensperger, CET
Lincoln Tech. Institute
5151 Tilghman St.
Allentown, PA 18104
(215) 398-5300

Thomas Plant, CET
ETG of Rhode Island
29 Dean St.
Pawtucket, RI 02861
(401) 723-3500 Ext. 333

Stanley A. Salter, CET
826 Bat Blossom
Sumter, SC 29150
(803) 469-3022

Donald Haag, CET
RR 3, Box 92
Watertown, SD 57201
(605) 886-8932

Charles Daugherty, CET
Electronic Service Center
166 First St. NE
Cleveland, TN 37311
(615) 472-0359

Ross Hutcherson, CET
781 Iron Workers Rd.
Clarksville, TN 37043-7911
(615) 362-9440

Herman Patrick
3715 Lamar Ave.
Memphis, TN 38118
(901) 362-8368

Ronald R. Rackley, CET
Tenn Inst. of Electronics
3203 Tazewell Pike
Knoxville, TN 37918-2530
(615) 688-9422

William S. Warren, CET/CSM
Warren's Audio-Video Service
2540 Sutherland Ave.
Knoxville, TN 37919
(615) 546-1121

Earl W. Hines, CET
Star Rt. 1 Box 1-A
1710 Lamar
Sweetwater, TX 79556
(915) 235-1849

Loren R. Hodge
3614-28th St.
Lubbock, TX 79410
(806) 795-8617

Joseph H. Hudson Jr., CET
1500 Yarborough Dr.
Sherman, TX 75090-5545
(214) 892-9356

ISCET
2708 West Berry St.
Fort Worth, TX 76109
(817) 921-9101

Charles W. Kelley, CET
7805 Estates Way
Rowlett, TX 75088
(214) 475-4406

Gerald Martin, CET
3347 Falcon Grove
San Antonio, TX 78247
(512) 496-1134

J.W. (Dub) Newson, CET
Advanced Electronics, Inc.
1310 19th St.
Lubbock, TX 79401
(806) 763-8246

Arthur J. Ruppert, CET
30217 St. Andrews
Georgetown, TX 78628
(512) 495-1679

Elizabeth Sheets
American Commercial College
2007 34th St.
Lubbock, TX 79411
(806) 747-4339

Frank Sosolik Jr., CET
T.S.T.I. Servicing Dept.
Box 154454
Waco, TX 76715
(817) 867-4883

Thomas C. Underwood, CET
Sony Service Company
3201 Premier, #100
Irving, TX 75063
(214) 550-5266

Leonard M. Cowherd, CET
Piedmont Tech. Ed. Center
PO Box 999
Culpeper, VA 22701
(703) 825-0476

Russell R. Offhaus, CET
PO Box 1116
Chincoteague, VA 23336
(804) 336-5980

Jame Richerson, CET
Blue Ridge Comm. Colle
Box 80
Weyers Cave, VA 24486
(703) 885-5960 Ext 276

Jim Teeters, CET
2937 E. Malden Ave.
Norfolk, VA 23518
(804) 428-5772

Cary D. Thomas Jr., CET
2209 Eastover Dr.
S Boston, VA 24592
(804) 572-6474

M.B. Hixenbaugh, CET
B N H Service
3635 S. Lawrence
Tacoma, WA 98409
(206) 475-8861

Leonard Laabs, CET
Walla Walla College
204 S. College Ave.
College Place, WA 9932
(509) 527-2712

Carl E. McDonald, CET
Sun Tech
417 S 6th
Sunnyside, WA 98944
(509) 837-8800

Arthur B. Mitchell, CET
922 N. 97th St.
Seattle, WA 98103-3210
(206) 525-8331

Ralph E. Oscarson, CET
ITT Technical Institute
N. 1050 Argonne Rd.
Spokane, WA 99212
(509) 926-2900

Cecil C. Poe, CET
1012 McClain Dr.
Sunnyside, WA 98944-1
(509) 839-3995

Ted Rodriquez, CET
Skagit Valley College
2405 College Way
Mt. Vernon, WA 98273
(206) 428-1248

James C. Shambow, CE
ITT Technical Institute
12720 Gateway Dr., Suit
Seattle, WA 98168-333
(206) 244-3300

Duane Busby, CET
Motorla Computer Syste
2027 Sherman Ave.
Madison, WI 53704
(608) 244-0339

Larry Geissler, CET
Indian head Tech. Colle
600 N. 21st St.
Superior, WI 54880
(715) 394-6677 Ext. 275

Jacob Klein, CET
Northcentral Tech. Colle
1000 Campus Ave.
Wausau, WI 54401
(715) 675-3331 Ext. 263

David E. Nida
National Education Cen
5514 Big Tylor Rd.
Cross Lanes, WV 2531
(304) 776-6290 Ext. 24

W. Clem Small
RT 1, Box 64-1
Weybridge, VT 05753
(802) 545-2141

Robert Ing, CET
Atropos Telecom
PO Box 378 Postal Sta
Toronto, Ontario,
Canada M4A-2N9
(416) 580-7508

Antonio M. Avellanosa
MPTITI
YMCA Building
Baguio City, Philippine
Phone# 442-6532

Take Any 3 PROFESSIONAL BOOKS for only $9.95

Values to $121.40

when you join the ELECTRONICS ENGINEERS' BOOK CLUB

9255 $97.50
Counts as 3

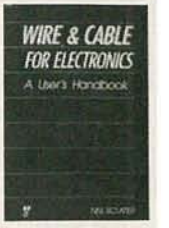
8225P $19.95

3272 $24.95

9832 $36.95

003957-7 $49.95
Counts as 2

3557 $29.95



3787 $29.95

3279 $36.95
Counts as 2

3205 $24.95

9340 $44.95
Counts as 2

3212 $34.95

9401P $19.95

3138 $60.00
Counts as 2

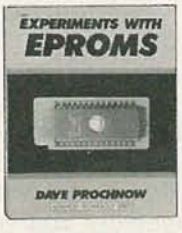
2672 $49.50

033559-1 $29.95

3102 $49.95
Counts as 2

9244P $18.95

3365 $34.95



2962P $17.95

020975-8 $99.50
Counts as 3

3199 $52.00
Counts as 2

3321P $16.95

9354 $39.95
Counts as 2

3710 $32.95

071231-X $54.95
Counts as 2

3540 $26.95

All books are hardcover unless number is followed by a "P" for paperback.

©1991 EEBC, Blue Ridge Summit, PA 17294-0860

How the Club Works

YOUR BENEFITS: You get 3 books for $9.95 plus shipping and handling when you join. You keep on saving with discounts of up to 50% off as a member.

YOUR PROFESSIONAL BOOKSTORE BY MAIL: Every 3-4 weeks, you will receive the Electronics Engineers' Book Club News describing the Main Selection and Alternates, as well as 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 selection at all, simply indicate your choice on the reply form provided. You will have at least 10 days to decide. As a member, you agree to purchase at least 3 books within the next 2 years and may resign at any time thereafter.

BONUS BOOKS: Starting immediately, you will be eligible for our *Bonus Book Plan*, with savings of up to 80% off publishers' prices.

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.

(Publishers' Prices Shown)

The Electronics Engineers and Designers Book Club and the Electronics and Control Engineers' Book Club have joined forces to bring you *all* the best titles from the most prominent electronics publishers.

ELECTRONICS ENGINEERS' BOOK CLUB

Blue Ridge Summit, PA 17294-0860

☐**YES!** Please accept my membership in the ELECTRONICS ENGINEER'S BOOK CLUB and send the 3 volumes listed below, billing me $9.95. 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 2 years, and may resign any time thereafter. A shipping/handling charge and sales tax will be added to all orders.

Name _____

Address _____

City _____

State _____ Zip _____ Phone _____

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 Engineers' Book Club. RPIF392

EQUIPMENT REPORTS

Dallas Semiconductor Touch Memory Starter Kit

The electronic equivalent of the Post-It note.

CIRCLE 10 ON FREE INFORMATION CARD

People were once naive enough to believe that computers and other office-automation equipment would bring about the "paperless office." We haven't heard anyone suggest such a thing for some time, but Dallas Semiconductor (4401 South Beltwood Parkway, Dallas, TX 75244) might have come up with a way to replace a good deal of paper with silicon chips. Their DS199x *Touch Memory* devices are non-volatile memory packaged in a button-shaped can. They can be read or written with a momentary contact. We recently had the opportunity to examine the devices and see how they work, using Dallas Semiconductor's *DS9092K Touch Memory Starter Kit*.

Touch Memory is available in two main configurations: One is ROM only, the other is a combination of ROM and battery-backed RAM. The ROM-only device would be used primarily for electronic identificaion. If attached to an employee ID badge, for example, it could be used to permit access to secure areas of a building. The ROM/RAM device could be used for a good deal more. In manufacturing, for instance a Touch Memory could be attached to the device being manufactured. It could contain proper calibration settings for the assembly technician to read. The technician could then in put the results of the calibration tests into the Touch Memory, along with his identification and a date stamp.

The potential applications aren't limited to electronics and manufacturing. Imagine if your checked airline baggage was identified by a small Touch Memory tag that not only contained your destination, but your name, address, flight itinerary, and the name of each baggage handler who handled your luggage—including the one who put your bags on the flight to Bogata instead of Boston.

The Touch Memory Starter Kit is a good way to get a feel for what Touch products can do. It includes five assorted Touch Memories, a Touch Memory probe (for reading and writing the devices) an adapter that lets you attach the probe to the serial port of a PC, and a floppy disk that contains the interface software.

Three of the five included Touch Memory devices are DS1990 "Touch Serial Numbers." They contain a 64-bit ROM into which is written an 8-bit family code, a 48-bit serial number, and an 8-bit CRC (cyclical redundancy check). One of the devices is mounted to a key fob, while the other two are mounted on a "peel and stick" sheet. Two DS1991 touch memories are also provided. They contain 3 384-bit blocks of non-volatile RAM and a 64-bit ROM.

The probe included with the evaluation kit is is strictly for evaluation—it's not packaged with any handle or base, and instead, ha on the end of a pair of wires. other end of the wire is terminate a RJ-11 modular telephone ja That, in turn, plugs into an adap that converts the RJ-11 jack to a pin D-type connector for a PC se port, as well as converting the c puter's RS-232 interface into a gle, bi-directional data line.

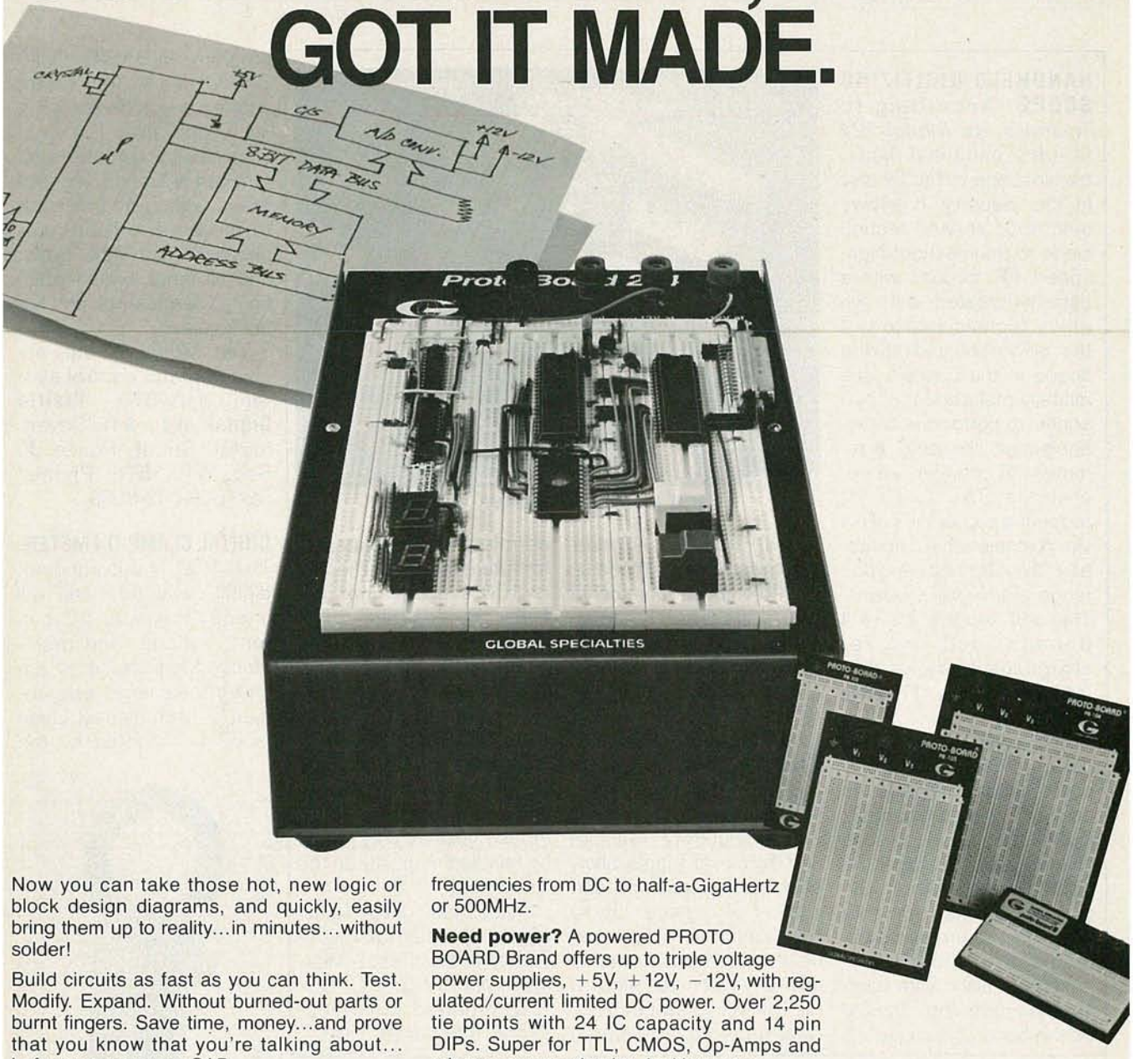
The probe doesn't have to l good to get across its strong poi however. Most important, it's v forgiving of how it's positioned the memory. One of the reasons memory is packaged in a round croCan" is becuase the cur edges can guide the probe for s alignment. The one-wire data tra fer is what helps to make To Memory rugged. The top of the is the data connection, while edge and bottom is ground. Dat transferred at speeds up to 1 kilobits per second, which see instantaneous for small memori

Even with fast data rates, it's l ly that a momentary contact wil interrupted before a data tramsfe complete. However, the To Memory uses two verification te niques to ensure data integ First, data is written to a scratch memory and verified before i transferred to memory. If the c nection is broken early, scratchpad contents won't transferred to the main memory the integrity of the previous mem is maintained. A CRC check is a performed on data.

The non-volatile memory will for five or ten years—the life of built-in lithium battery. T stainless-steel case is resistan corrosion from moisture, acid, plain old dirt.

From what we've seen of self-stick data carrier, we think we may be seeing fewer bar coc and a bit less paper. If you'd like get an idea of how they work, Touch Memory Starter Kit is av able for $75.

ONCE YOU'VE GOT IT DESIGNED, YOU'VE GOT IT MADE.



Now you can take those hot, new logic or block design diagrams, and quickly, easily bring them up to reality...in minutes...without solder!

Build circuits as fast as you can think. Test. Modify. Expand. Without burned-out parts or burnt fingers. Save time, money...and prove that you know that you're talking about... before you use your CAD.

Specify PROTO BOARD Brand, Today's recognized Standard for Quality in breadboarding. Here are five expandable breadboards, offering countless arrays of solderless sockets and bus strips that emulate pc board layouts. Pop in components. Pop them out again. Microprocessors. Memory. Large DIPs. Tiny discretes. Makes no difference. The patented aluminum backplane lets you work at frequencies from DC to half-a-GigaHertz or 500MHz.

Need power? A powered PROTO BOARD Brand offers up to triple voltage power supplies, +5V, +12V, −12V, with regulated/current limited DC power. Over 2,250 tie points with 24 IC capacity and 14 pin DIPs. Super for TTL, CMOS, Op-Amps and microprocessor circuits. And lots more.

Best of all, your hassle-free American-made PROTO BOARD Brand comes with an unlimited lifetime guarantee on all the breadboard sockets. Prices are so modest, you'll wonder why you waited this long to specify PROTO BOARD Brand. Order today.

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

A0010

CIRCLE 186 ON FREE INFORMATION CARD

NEW PRODUCTS

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

HANDHELD DIGITIZING SCOPE. According to Tektronix, its *Model 224* 60-MHz handheld digital oscilloscope is the fastest in the industry. It allows electronic service technicians to troubleshoot high-speed TTL circuits with a battery-operated unit, avionics technicians to get the power of a digitizing scope in the cockpit, and military-maintenance personnel to perform accurate equipment servicing in remote land or under-sea operations. The *224's* TV triggering capabilities allow video repairmen to monitor and troubleshoot a wide range of imaging systems. The unit weighs just 4.4 pounds, and two rechargeable batteries provide three hours of reliable operation.

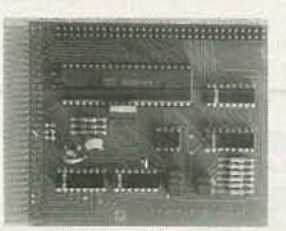
CIRCLE 16 ON FREE INFORMATION CARD

The *224's* dual-channel design allows input-to-output comparisons and its unique "Isolated Channel" architecture, in which each channel is isolated from the other channel and from earth ground, makes truly safe floating measurements (as opposed to other handhelds that claim safe floating measurements simply on the basis of their plastic cases). True floating measurements can be made up to 400 volts per channel or 800 volts peak-to-peak, without risk to the operator or to the device under test.

Like the other members of Tektronix's popular 222 family of portable digitizing oscilloscopes, the *224* features a clear, bright CRT display; ease of use; and PC compatibility. AutoSet and Autolevel Trigger allow effortless acquisition and display of signals. Up to four front-panel setups can be defined and stored in memory, then recalled at the touch of a button. Four waveforms can be stored as reference templates or for future analysis. The *224* is 100% programmable from the RS232C port. When linked by modem, the 224 can be controlled remotely from a PC equipped with Tek's Virtual Instrument Software (CAT200). The scope's controls can be manipulated at the keyboard or mouse, just as they would be handled manually on the instrument.

The *224* handheld digitizing scope costs $2750.—**Tektronix, Inc.**, Test & Measurement Group, P.O. Box 1520, Pittsfield, MA 01202; Phone: 1-800-426-2200.

DATA-ACQUISITION AND CONTROL SYSTEM FOR PC'S. Claimed to be the lowest-priced general-purpose data-acquisition and control system for personal computers, Prairie Digital's *Model 30* is available for XT's, AT's, 386's, and PS/2 model 30's. The system's printed-circuit board plugs into the PC's expansion bus and occupies a 1/4 slot. The unit includes 24 lines of programmable digital input/output; an 8-channel, 8-bit A/D converter; and a 12-bit CMOS counter. (An 8-channel, 30-volt, 0.5-amp driver is available for an additional $5.) The system communicates with the PC via four I/O memory locations and is easily interfaced to all popular languages. Sample programs in BASIC, C BASIC, and Assembly guage are included on a -inch floppy disk. The d acquisition and control tem can be used to cor relays, lights, and mot to measure temperat pressure, and light lev and to input switch p tions, thermostats, anc uid levels.



CIRCLE 17 ON FREE INFORMATION CARD

The *Model 30* data quisition and control tem costs $79.—**Pra Digital, Inc.**, 846 Se teenth Street, Prairie Sac, WI 53578; Pho Fax: 608-643-8599.

DIGITAL CLAMP-ON ME The *ACD-11* autorang digital clamp-on meter directly measure AC rent, voltage, and re tance. Measurements shown on a large, easy read, ½-inch display. C range is indicated by letters "O.L." appea on the display. The ins ment features circuit tection to 550 volts ar low-battery indicator. It

CIRCLE 18 ON FREE INFORMATION CARD

a maximum jaw opening of 2.14 inches. The *ACD-11* meter comes with a wrist strap, a removable belt clip, a 9V battery, safety test leads, a carrying case, and instructions.

The *ACD-11* clamp-on volt/amp/ohmmeter has a list price of $119.95.—**Amprobe Instruments**, 630 Merrick Road, P.O. Box 329, Lynbrook, NY 11563; Phone: 615-593-5600; Fax: 516-593-5682.

MONOLITHIC OP-AMP. With a unity gain bandwidth of 140 MHz, Analog Devices' *AD811* is the industry's fastest monolithic operational amplifier operating from a ±15V supply. Video specifications such as gain flatness, which ensures broadcast-quality signal transmission, and differential gain and phase, which

CIRCLE 19 ON FREE INFORMATION CARD

are critical for video cameras, multimedia systems, and special-effects units, are optimized. The *AD811's* output is capable of driving two back-terminated 75-ohm cables, making the device well-suited as a line driver in video routers or distribution amplifiers. The *AD811* current feedback amplifier meets stringent HDTV video specifications, and offers the transient response characteristics needed for high-speed pulsed applications such as infrared imaging and digital oscilloscopes. When used as a buffer for analog-to-digital or digital-to-analog converters, the *AD811* offers low distortion and, as a result of the current feedback design, a wide bandwidth over a large range of gains. The amplifier operates from power supplies ranging from ±4.5V to ±18V, with a minimum output drive current of 100 mA. The video-speed op-amp is available specified over the industrial (−40°C to +85°C) and military (−55°C to +125°C) temperature ranges. Package options include an 8-pin plastic DIP, 16- and 20-pin SOIC, 8-pin Cerdip, or 20-pin LCC.

Specified over the industrial temperature range and packaged in an 8-pin plastic DIP, the *AD811* costs $3.35 in hundreds or $2.85 in thousands.—**Analog Devices**, Literature Center, 70 Shawmut Road, Canton, MA 02021; Fax: 617-821-4273 (for applications assistance, contact Jay Cormier, Analog Devices, Inc., 804 Woburn Street, Wilmington, MA 01887; Phone: 617-937-2507).

SMT PICK-AND-PLACE SYSTEM. Designed for prototyping or low-volume production of surface-mount boards, O.K. Industries' *SMT-880 Series Manual Pick and Place System* provides up to three times greater throughput with substantially improved accuracy over hand placement. The operator chooses a component from the loose-component carousel or the stick or tape feeders, picks

Train at HOME to be an Electronics Technician!

As the demand for computers and microprocessors in business, manufacturing and communications continues to grow, so does the need for qualified technicians. It's not unusual for experienced technicians to earn from $30,000 to more than $40,000 a year.* Now through Peoples College of Independent Studies you can train for this exciting field without interrupting your job or home life.

Choose From Five Programs of Study

- Electronics & Microprocessor Technology
- Industrial Electronics & Microprocessor Technology
- Communications Electronics with Microprocessor Technology
- Computer Servicing & Electronics Technology
- Specialized Associate Degree In Electronics Technology

Professional Equipment Is Included

Depending on the program you select, you'll perfect your skills using this advanced equipment, included in the price of tuition:

- IBM-Compatible Personal Computer
- Digital Multimeter
- Digital Logic Probe
- Elenco Oscilloscope
- Portable Cellular Telephone

(* Source: U.S. Bureau of Labor Statistics)

Exclusive Extras That Enhance Your Training

Peoples College introduces some training firsts to make your learning experience more complete:

- Accelerated Learning System — a scientifically proven study system that helps you learn faster and easier than ever before.
- Video Tutor Training Tapes — give you a permanent, visual record of informative lectures and close-up demonstrations.
- Experience Labs — professionally designed experiments that give you hands-on "bench" experience.
- Industry Certification Training Guide — provided with four of our programs. Prepares you for examinations you may take for your professional license or certification.

Easy Payment Plans — No Finance Charges

To help you get started on your education, Peoples College has reduced tuition rates and offers low monthly payment plans with no finance fees. So don't delay, call or write for more information today!

For COLOR CATALOG Mail Coupon or Call TOLL FREE 1-800-765-7247

Programs offered only in United States, Canada, Puerto Rico and Virgin Islands. No Obligation. No sales person will call.

Our programs are accredited by the Accrediting Commission of the National Home Study Council

YES! I would like to know more about your training programs. Send a catalog to:

Name _____

Address _____

City _____

State _____ Zip _____

Phone # _____

PEOPLES COLLEGE OF INDEPENDENT STUDIES
233 Academy Drive • P.O. Box 421768
Kissimmee, FL 34742-1768
Member, D.L. Peoples Group R0392

CIRCLE 183 ON FREE INFORMATION CARD

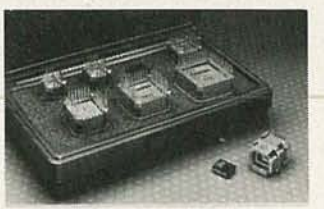
CIRCLE 20 ON FREE INFORMATION CARD

it up with the vacuum head, and then guides it with the free-floating X-Y-Z arm to the appropriate position on the board. A control knob on the vacuum head provides theta rotation to ensure proper component orientation. When the component is lowered, the vacuum head automatically releases it when contact with the board is made.

The *SMT-800* provides a total working area of 8×12 inches, with an adjustable board holder. The system comes complete with an ESD-safe carousel vacuum pump and a movable hand rest that glides over the board holder and provides the user with a stable, fatigue-relieving platform. For easy compatibility with larger automatic machines, optional tape and stick feeders mount on the vise. Other options include a lighted magnifier with four diopter lenses to assist in component alignment. The system is available for 115-volt or 230-volt operation.

Prices for the *SMT-800* pick-and-place system start at $3495.—**O.K. Industries**, 4 Executive Plaza, Yonkers, NY 10701; Phone: 914-969-6800.

PLCC QUAD CLIP KIT. The selection of test adapters included in ITT Pomona's *Model 5515A PLCC Quad Clip Kit* was specifically chosen to test the most popular surface-mounted plastic leaded chip carriers (PCC and PLCC) with "J" leads (JEDEC MO-047 and MO-052). The design of each test adapter incorporates a "snap ring" that allows the quad clip to fit directly onto an IC and provides simultaneous access to all the pins of the surface-mount device for hands-free testing. The wipe action of the snap-ring design, as it is pushed down with normal force into position against the contact, wedges against the IC for a tight fit and assures a good connection.



CIRCLE 21 ON FREE INFORMATION CARD

The kit contains seven items: one each 20-, 28-, 32- (7×9, EEPROM), 44-, 52, 68-, and 84-pin Pomona Quad Clip test adapters. All the adapters have gold-plated center contacts, silver-plated bodies, and 0.064mm (0.025-inch) square pins staggered on 2.54mm (0.100-inch) centers. The kit is packaged in a durable, reusable plastic case.

The *5515A PLCC Quad Clip Kit* costs $245.—**ITT Pomona Electronics**, 1500 East Ninth Street, P.O. Box 2767, Pomona, CA 91769; Phone: 714-469-2900; Fax: 714-629-3317.

CONTROLLERS/INDICATORS. For start, stop, or limit control of a wide range of process variables, Simpson Electronics has introduced the *Hawk Series* of controllers/indicators that fit in a ⅛ DIN cutout. The series offers high accuracy and ease of installation in electrical, chemical, petrochemical, and other process industries. The controllers accept AC and DC voltage and current, 4–20-mA DC, 1–5V DC resistance, 3-wire potentiometer, frequency, and tachometer (RPM) inputs. RTD inputs may be two-, three-, or four-wire configuration. The Hawk models also accept several thermocouple types, including J, K, R, and S, which input without calibration or internal hardware changes. The compact units are AC or DC powered and are housed in impact-resistant, flame-retardant, plastic cases. Their front-panel keypads are used to program, set, or check the operating parameters of hysteresis, time delay, and set point, as well as alarm levels and relay settings. A user password prevents unauthorized program access. Each instrument also features a highly visible, 0.51-inch, red LED display; plug-in circuit boards for user-selected functions; dual set point with optional

CIRCLE 22 ON FREE INFORMATION CARD

dual relays; a fast, easy, input terminal block that can be unplugged; and an edge-type connector for analog and digital output options.

The *Hawk Series* of controllers/indicators are priced starting at $199.—**Simpson Electric Company**, 833 Dundee Avenue, Elgin, IL 60120-3090; Phone: 708-697-2260; Fax: 708-697-2272.

PC AUDIO CONTROL SOFTWARE. Voyetra's *Sound Central*, a software utility for Windows 3.0, provides a convenient way to control

CIRCLE 23 ON FREE INFORMATION CARD

every aspect of sound g
erated by PC sound ca
or Multimedia PC's (MP
Its graphical audio edi
can be used to audition a
edit digital waveforms
the VOC or .WAV forn
and modify them with su
special effects as ec
data compression, bit re
lution, and sample-ra
conversion. A MIDI so
file editor provides cont
over major parameters i
MIDI song file so that t
music generated by the
can be manipulated—
instance, re-orchestrat
lengthened, or shorten
The full-featured CD "c
trol panel" provides a c
venient way to sort, vi
and play CD audio trac
A mixer control panel p
vides access to all of t
MPC's mixer functions
cluding input/output c
trol levels and line/m
monitor settings. Also
cluded are a MIDI file ma
per and a "patch editor"
the MPC's FM synthesiz

Sound Central auc
control software has a su
gested retail price
$199.95.—**Voyetra Tec
nologies**, 333 Fifth Aven
Pelham, NY 10803; Pho
1-800-233-9377
914-738-4500; Fa
914-738-6946.

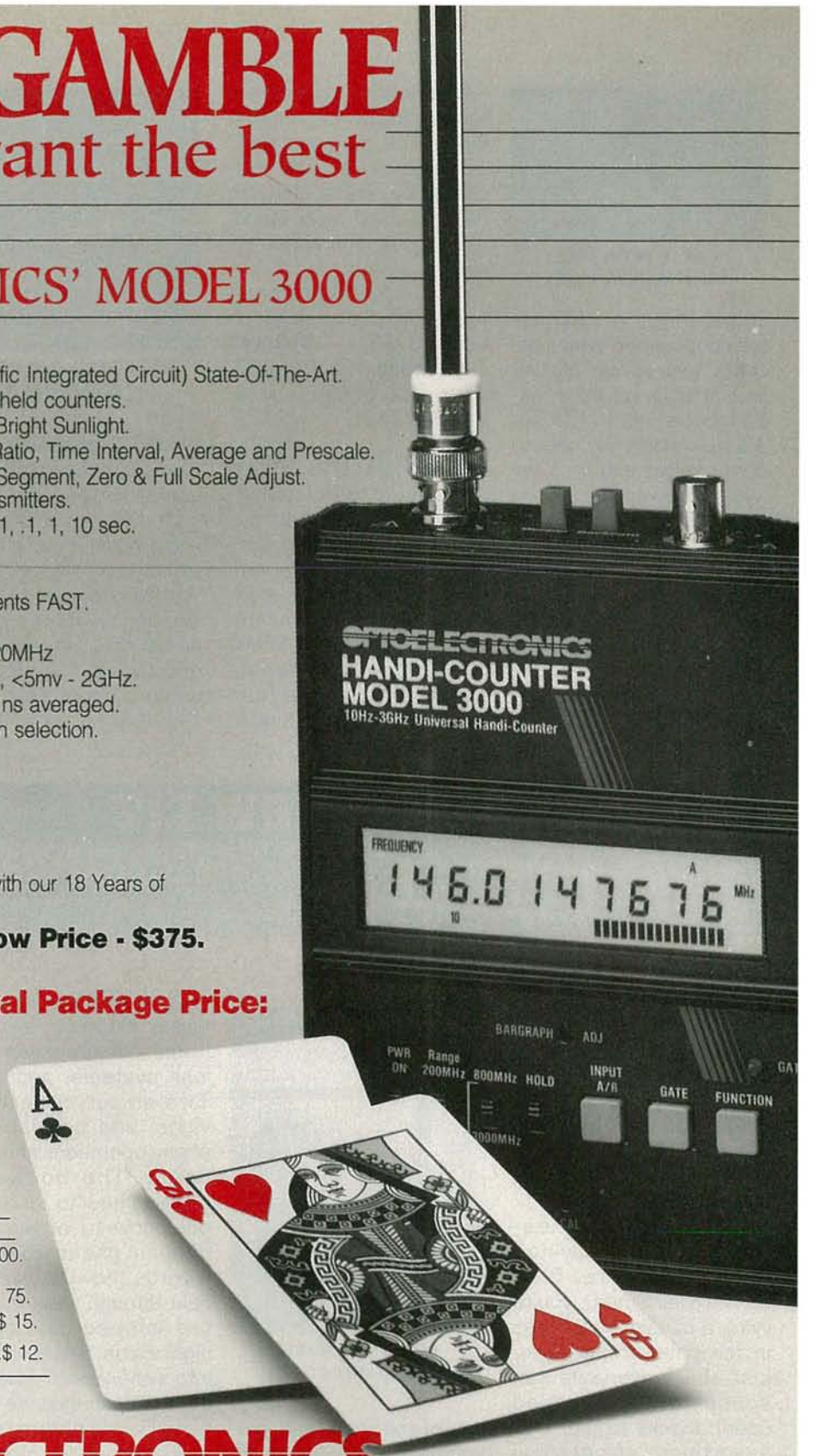
**OSCILLOSCOPE PRO
SWITCH.** Providing a sim
way to observe and c
pare waveforms at differ
points in a circuit, Micro

DON'T GAMBLE
when you want the best

1 Reasons To Buy
OPTOELECTRONICS' MODEL 3000

1. RANGE- 10Hz to 3GHz.
2. Hi-Speed ASIC (Application Specific Integrated Circuit) State-Of-The-Art.
3. 256 Times Faster than other hand held counters.
4. 10 Digit LCD. Readability even in Bright Sunlight.
5. 6 Functions - Frequency, Period, Ratio, Time Interval, Average and Prescale.
6. RF Signal Strength Bargraph - 16 Segment, Zero & Full Scale Adjust. Excellent for locating Hidden Transmitters.
7. Four extremely Fast Gate Times .01, .1, 1, 10 sec.
8. Dual High Impedance Amplifiers.
9. Maximized Sensitivity
10. Hold Switch - Locks in measurements FAST.
11. ± 1PPM Accuracy
12. Direct Count - 1Hz resolution to 220MHz
13. Sensitivity <1mv 10MHz - 200MHz, <5mv - 2GHz.
14. Single Shot Time Interval 100ns, .1ns averaged.
15. Push-button Input, Gate & Function selection.
16. Extruded Aluminum Enclosure.
17. NiCad & Charger Included.
18. Low Battery Indicator.
19. 1 Year Parts & Labor Warranty
20. 30 day Money Back Guarantee.
21. OPTOELECTRONICS backs this with our 18 Years of Dependability & Service.

All this and more for the Low Price - $375.



Also Available at Special Package Price:

For A Limited Time Only
Model 3000, Backlight/Beeper, Carry Case & TA-100s Whip Antenna
All this for only $449.

OPTIONS:

TCXO 30 ± .2ppm TCXO .....$100.
BLB30
Back light & two step audible signal level indicator ..$ 75.
CC30 Carry Case .....$ 15.
TA100S Telescoping Whip Antenna .....$ 12.

OPTOELECTRONICS

YOU CAN'T LOSE!

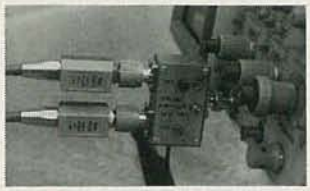
Factory Direct Order Line

1-800-327-5912

305)771-2050 • FAX(305) • 2052 5821 NE 14th Ave. • Ft. Lauderdale, FL 33334

% Ship/Shandling (Max. $10) U.S. & Canada. 15% outside continental U.S. Visa & Master Card Accepted.

CIRCLE 180 ON FREE INFORMATION CARD

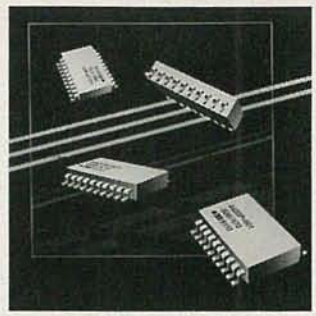


CIRCLE 24 ON FREE INFORMATION CARD

Engineering's *MV103* oscilloscope probe switch accepts two scope probes and attaches to the oscilloscope input. The accessory allows the user to easily select either of the two probes with the flip of a switch. With the *MV103*, a dual-channel scope can accept four separate inputs without performance degradation. High-frequency relay technology provides high isolation and low insertion loss. Compact all-metal design provides excellent shielding and allows the *MV103* to be installed directly on the input BNC connector of the oscilloscope. The switch can also be used as a stand-alone, general-purpose RF switch.

The *MV103* oscilloscope probe switch costs $275.00—**Microvolt Engineering**, P.O. Box 777, Tustin, CA 92680; Phone: 714-544-3441.

EMI/RFI FILTERS. When controlling electromagnetic and radio frequency interference to the environment and complying with FCC regulations on maximum level emissions are concerns, the *601 Series* of surface-mount resistor-capacitor networks from Bourns provide a simple



CIRCLE 25 ON FREE INFORMATION CARD

solution. Shielding is required between the RS232 connector and the input/output drivers in electronic equipment. The *601 Series* of low-pass filters prevent the transmission of high-frequency noise components and are especially effective on lines to external connectors. Featuring a T-configuration of 16 resistors in series and 8 pacitors bused to a c mon ground, the surfa mounted RC networks suppress high-freque EMI/RFI noise for up eight separate lines. Sn er than inductive-type ters, the devices packaged in wide-body cases. Typical applicati for the filters are in pers al computers, data te nals, test equipment, process controllers high-frequency suppr sion into or out of e tronic equipment.

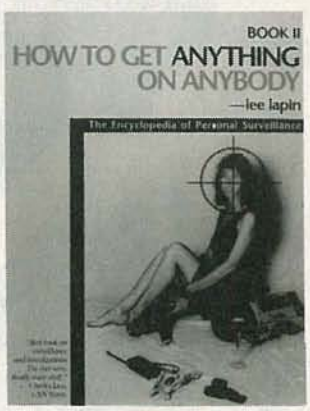
Prices for the *601 Se* of surface-mount EMI/ filters begin at $2.15 e in quantities of 10,(pieces.—**Bourns Netwo Inc.**, 1400 North 1(West, Logan, UT 843 Phone: 801-750-7200.

NEW LIT

Use The Free Information Card for fast response.

HOW TO GET ANYTHING ON ANYBODY: BOOK II; by Lee Lapin. ISECO, Inc., 2228 South El Camino Real #349; San Mateo, CA 94403; Phone: 415-513-5549; Fax: 415-578-8741; $38.00 postpaid (plus 8% sales tax on California orders).

If the words "espionage" and "spying" bring to mind James Bond (or Maxwell Smart), you're living a couple of decades in the past. These days, just about everyone can snoop (or be snooped upon), thanks to the huge assortment of personal surveillance devices now available. Subtitled "The Encyclopedia of Personal Surveillance," this book provides a guided tour of audio surveillance, including unconventional bugs,



CIRCLE 40 ON FREE INFORMATION CARD

parallel and serial taps, carrier-current bugs, and IR and encrypted transmitters; acoustic analysis and hardwiring, including how to purchase and how to plant super-sensitive subminiature microphones; video surveillance using special cameras and trick lenses hidden in everyday items, inexpensive wireless systems, and using TV's as surveillance devices; and cellular telephone operations and intercepts. The book also explains how to tail someone, how to obtain confidential phone-company records, how to see and hear through walls, how to use infrared devices for night vision, and how to tap into a phone with no equipment. It describes the art of surveillance photography, and shows how to put together a complete dossier on anybody. Also included are legal guidelines and the addresses of more than 200 suppliers of surveillance and counter-surveillance gear.

COMPUTER VIRUSES A DATA PROTECTION; by R Burger. Abacus, 5370 52 Street SE, Grand Rapids, 74512; Phon 616-698-0330; Fa 616-698-0325; $19.95.

Computer viruses—p grams with the potential destroy data and disal computer systems—c be quite costly in terms lost time, data, and mon The best protection agai such viruses is educ tion—learning what ste to take to minimize or av losses. Intended as a g eral guide rather than a erence work, this bo aims to teach reade about all kinds of compu viruses to allow them protect themselves. Beg ning with a short history viruses and a description

CIRCLE 39 ON FREE INFORMATION CARD

how a virus can gain control over a computer, the book explains how viruses are created and how to remove them from a system. It explores the design and function of viral programs, and includes sample program listings in BASIC, Pascal, and machine language as well as examples of viral software manipulation. The book outlines the protection options available, and provides practical advice about what to do when your PC is infected. Along with examples of protection viruses and strategies, a simple virus-detection program in provided. In addition, the book explains how to design virus-proof operating systems.

HOME REMOTE-CONTROL & AUTOMATION PROJECTS (SECOND EDITION); by Delton T. Horn. TAB Books, Division of McGraw-Hill Inc., Blue Ridge Summit, PA 17294-0850; Phone: 1-800-822-8138; $18.95.

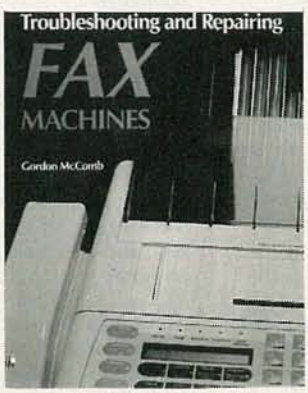
Besides being practical and educational, the projects described in this book are sure to impress your friends and family. Remote-control and automation projects can also save you both time and money, by letting electronics do the job for you. Although the emphasis is on the practical—in the form of 77 different projects—the book does provide background information on the basics of remote control, mechanical devices, motors, sensors, digitally-controlled potentiometer IC's, and building and safety procedures. The projects themselves fall into 11 categories: lighting, doors and windows, temperature control, liquid control, audio and video, telephone, motor control, electronic switching, timers, wireless control, and computer con-

CIRCLE 38 ON FREE INFORMATION CARD

trol. The second edition presents 15 all-new projects and updates and improvements of the original projects. Each project is accompanied by a circuit drawing and a parts list, and most are fairly simple to build. Most of them can also be adapted in various ways to meet other, custom applications.

TROUBLESHOOTING AND REPAIRING FAX MACHINES; by Gordon McComb. TAB Books, Division of McGraw-Hill Inc., Blue Ridge Summit, PA 17294-0850; Tel. 1-800-822-8138; $16.95.

It stands to reason that as soon as an electronic device becomes a necessity in our homes or offices, the need arises for people who know how to maintain and repair that device. This book was written to provide that know-how to the non-technical fax owner. By following its instructions, and using a few inexpensive tools, consumers should be able to keep their fax machines in proper working order—and to recognize a major problem that must be handled by a professional repair person. Aimed at non-technical folks, the book provides plenty of background information about how fax machines work. Most of the book is devoted to the troubleshooting and repair of mechanical problems, which account for about 85% of fax breakdowns. Full coverage of the major electronic subsystems—power supplies, solenoid controls, etc.—is also provided. Because most problems that occur with fax machines involve such things as dirty switch contacts or printing elements, broken wires, aging rubber belts and rollers, and damaged paper, preventative maintenance is emphasized. Simple illustrated instructions show how to clean and lubricate the paper path, light-sensitive reader bar, thermal printing mechanism, paper



CIRCLE 37 ON FREE INFORMATION CARD

cutter, fluorescent lamp, and front-panel controls. The book also explains how to diagnose and fix bad phone connections and printing and transmission errors. Emergency first-aid procedures in case of fire or water damage are detailed. An entire chapter is devoted to troubleshooting flowcharts illustrating the proper steps to follow to locate and solve problems.

MS-DOS 5 QUICK REFERENCE; by Timothy S. Stanley. Que, 11711 North College Avenue, Suite 140, Carmel, IN 46032; Tel: 1-317-573-2500; $9.95.

This slim volume puts the essentials of MS-DOS 5 at your fingertips, providing an instant reference to critical commands and procedures, batch files, the

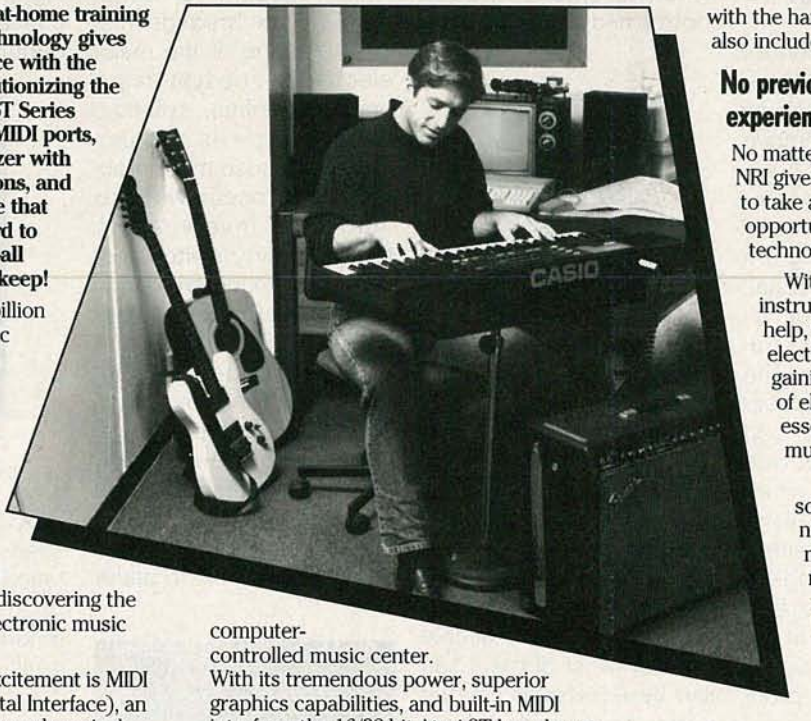
CIRCLE 36 ON FREE INFORMATION CARD

DOS Editor, and error messages. Short on documentation, but full of practical pointers, the book is intended as a supplement to a full-size MS-DOS guide. It explains the proper use of primary DOS functions, as well as advice on how to avoid making serious errors.

In a compact, easy-to-use format, the book explains the proper DOS commands to use for specific operations. The book is arranged alphabetically by command. Each command name is accompanied by an explanation of its purpose, followed by the syntax needed to invoke the command and the rules for its use. Examples are provided for some of the commands. Separate sections provide in-depth coverage of batch files, the DOS Editor, MS-DOS messages, and error messages. A "DOS Survival Guide" lists specific procedures and the commands needed to invoke them. **R-E**

Now! Experience the electronics behind the MIDI revolution as you build your own computer-controlled music center

Only NRI's innovative, at-home training in Electronic Music Technology gives you hands-on experience with the equipment that's revolutionizing the music industry—Atari ST Series computer with built-in MIDI ports, Casio HT-3000 synthesizer with advanced MIDI operations, and ingenious MIDI software that links computer keyboard to synthesizer keyboard—all yours to train with and keep!



This year, over $1.5 billion worth of digital electronic music instruments, from keyboards to drum machines, will be sold in the U.S. alone. Enthusiasts everywhere—professional musicians and recording technicians, even people who have never touched a musical instrument before—are discovering the excitement of today's electronic music technology.

At the heart of this excitement is MIDI (Musical Instrument Digital Interface), an innovation that's transformed musical instruments into the ultimate computer peripherals...and opened up a whole new world of opportunity for the person who knows how to use, program, and service this extraordinary new digital equipment.

Now NRI's breakthrough Electronic Music Technology course puts you at the forefront of this booming new technology with exclusive training built around a MIDI-equipped computer, MIDI synthesizer, and MIDI software you keep.

Dynamic new technology opens up new career opportunities

The opportunities are unlimited for the person who's trained to take advantage of today's electronic music phenomenon. Now you can prepare for a high-paying career as a sound engineer, recording engineer, or road technician... even start your own business selling and servicing today's high-tech musical instruments. Or simply unleash your own musical creativity with the breakthrough training and equipment only NRI gives you.

Only NRI gives you hands-on training with today's MIDI technology

The Atari ST Series computer included in your course becomes the heart of your own computer-controlled music center. With its tremendous power, superior graphics capabilities, and built-in MIDI interface, the 16/32-bit Atari ST has almost overnight become the computer of choice for today's most knowledgeable electronic musicians.

Your Casio HT-3000 synthesizer features a five-octave, MIDI-compatible digital keyboard with built-in monitor speakers, advanced tone editing and writing, pattern memory, keyboard split, tone and rhythm banks, chord memory, and dozens more state-of-the-art capabilities.

Plus you get ingeniously designed MIDI software that opens up amazing new creative and technical possibilities... you actually build your own 4-input audio mixer/amplifier...and you test the electronic circuits at the core of today's new equipment with the hand-held digital multimete also included in your course.

*NRI training **includes** an Atari ST computer, Casio synthesizer, exclusive MIDI software, and much more—all yours to train with and keep! (TV not supplied)*

No previous electronics or musi experience necessary

No matter what your backgrounc NRI gives you the skills you need to take advantage of today's opportunities in electronic mus technology.

With your experienced NRI instructor always available to help, you master the basics o electronic theory step by ste gaining the full understandin of electronics that's now so essential for technicians an musicians alike.

You move on to analyz sound generation tech-niques, digital logic, microprocessor funda-mentals, and sampling and recording tech-niques... ultimately getting first-hand experience with today explosive new technology as you explore MIDI, waveshaping, patching, sequencing, mixing, special effects, and much more.

Plus, even if you've never been involve with music before, NRI gives you enough basic training in music theory and musical notation to appreciate the creative potenti and far-reaching applications of today's electronic music equipment.

Send today for FREE catalog

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

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

For Career courses approved under GI bill ☐ check for details.

- ☑ **Check One FREE Catalog Only**
- ☐ **Electronic Music Technology**
- ☐ Microcomputer Servicing
- ☐ Computer Programming
- ☐ TV/Video/Audio Servicing
- ☐ Desktop Publishing and Design
- ☐ Security Electronics
- ☐ Fiction/Nonfiction Writing
- ☐ Basic Electronics
- ☐ Bookkeeping & Accounting

Name _____ Age _____

Address _____

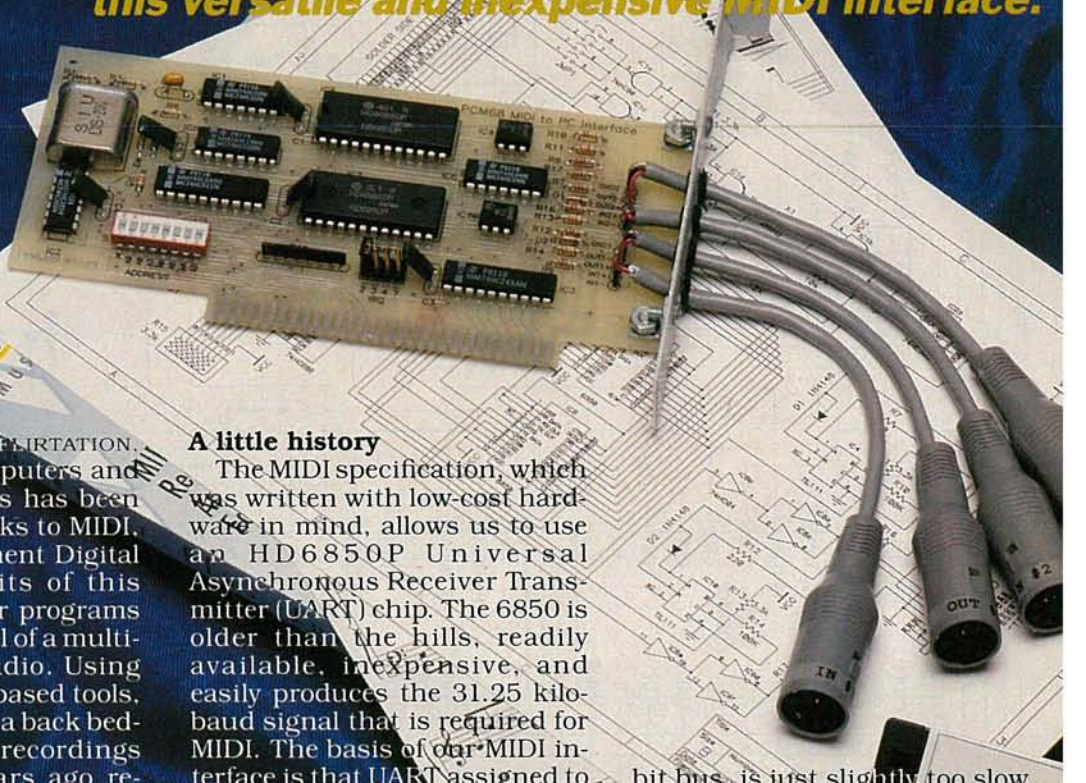
City/State/Zip _____

Accredited Member, National Home Study Council

3-032

BUILD THIS MIDI INTERFACE FOR YOUR PC

Bring the world of music to your PC with this versatile and inexpensive MIDI interface.



JOHN SIMONTON

AFTER A LONG-TERM FLIRTATION, the marriage of computers and musical instruments has been consummated, thanks to MIDI, the Musical Instrument Digital Interface. The fruits of this union are sequencer programs with the look and feel of a multitrack recording studio. Using those and other PC-based tools, a single musician in a back bedroom can produce recordings that only a few years ago required orchestras and an office staff.

Professional musicians aren't the only ones to benefit—you can too. Instruments with MIDI interfaces are so common that even your local discount store probably has several to choose from. The only thing standing between you and the artistic gratification of writing and performing like the philharmonic is the interface from your PC to the MIDI world, so lets take care of that little detail right now. We'll show you how to build a MIDI interface that is both low-cost for the beginner and upgradable for the serious user. With little further delay we begin, but first...

A little history

The MIDI specification, which was written with low-cost hardware in mind, allows us to use an HD6850P Universal Asynchronous Receiver Transmitter (UART) chip. The 6850 is older than the hills, readily available, inexpensive, and easily produces the 31.25 kilobaud signal that is required for MIDI. The basis of our MIDI interface is that UART assigned to one of the PC's output ports. For more information on MIDI, see **Radio-Electronics**, August 1989.

The most frequent MIDI commands are NOTE ON and NOTE OFF as keys are pressed and released. Those messages happen relatively infrequently; even when a chord is played, there is generally a slight delay between the individual notes. But the protocol also has provisions for continuous controllers such as pitch wheels and foot pedals, and the messages that signal that kind of activity can really spew out data. With nothing more than a UART for an interface, the original IBM PC, with its 4.77-MHz 8088 MPU and 8 bit bus, is just slightly too slow to handle MIDI at the maximum rate possible. It's not so much of a problem for the avocational user, but in a professional environment with lots of equipment, there is the possibility that data can be lost. Losing a little pitch wheel information isn't usually the end of the world, but if a NOTE ON or NOTE OFF command comes in the middle of it, missing that data is a very big deal.

The first widely accepted MIDI interface to overcome that problem was the MPU-401 made by Roland. It has its own dedicated processor and memory, and gets around the lost-data problem by maintaining a first-in-first-out (FIFO) buffer for the MIDI data

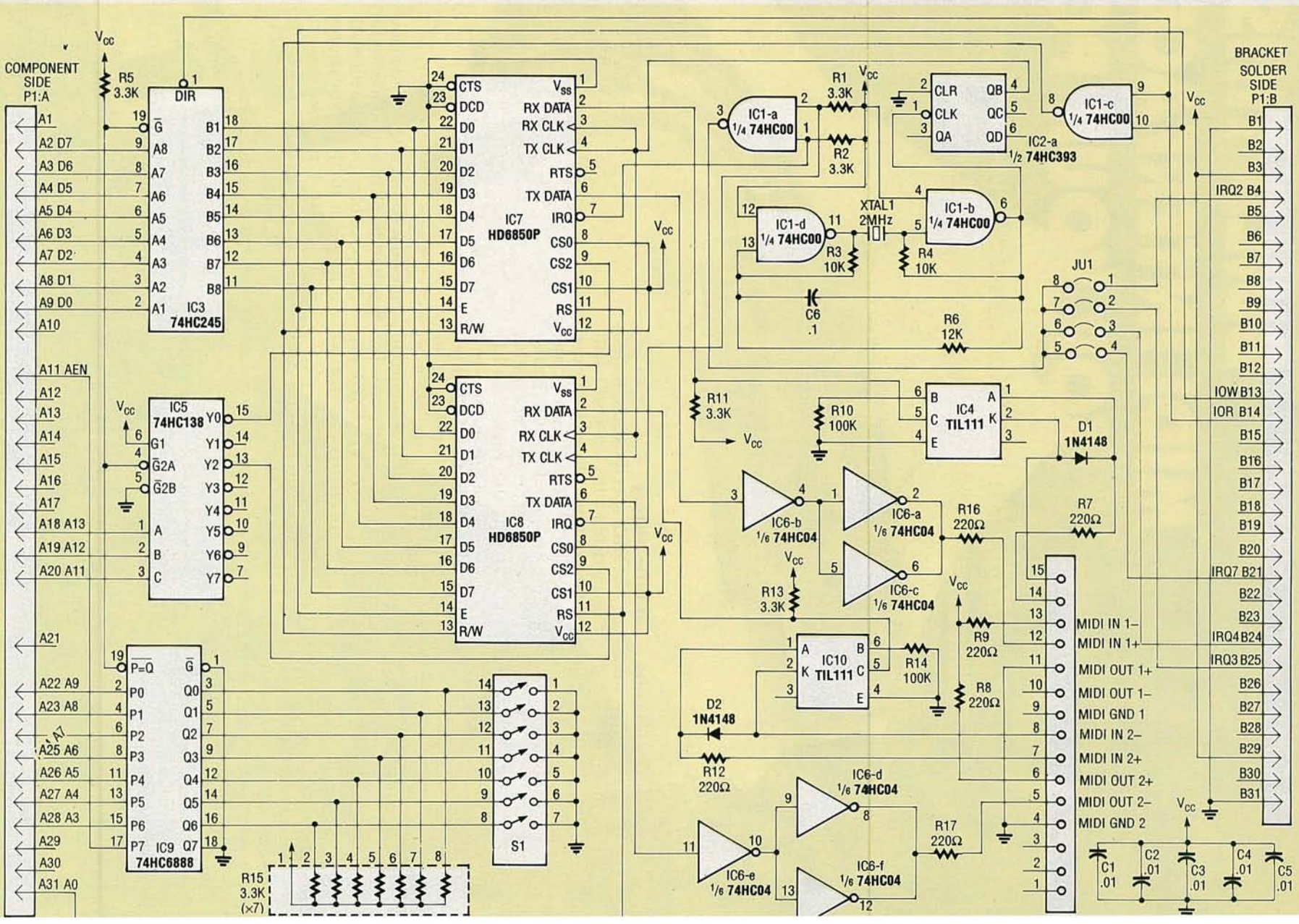


FIG. 1—TWO 6850 UART's are the heart of our MIDI interface. The circuit can be built in either a single-port version for the beginner or dual-port for the more experienced.

received. It also does some tricks such as data filtering and providing a metronome.

All well and good, but the introduction of the first XT-class PC made an intelligent interface unnecessary because the computer alone was fast enough to handle the throughput. As faster and more powerful PC's have become available, the need for an intelligent interface has decreased until finally the MPU-401 has technically become a bottle-neck in the system (though you would never notice that the interface is slowing things down).

What *has* turned out to be a noticeable problem to serious users is the bandwidth limitation of the MIDI channel itself. The solution to that problem has been multiple, separate In and Out jacks, equivalent to multiple interface cards. And here the MPU-401 runs into serious problems. Synchronizing multiple 401's is not trivial—and worse than that, each has to have its own slot and dedicated interrupt. Interrupts and slots, is there anything more precious in the PC world? You can switch MPU-401's into a "dumb" mode so that several of them share an interrupt. But then you have expensive UART's and serious slot depletion.

So, having faster computers and the need for lower-cost multi-port interfaces has started a resurgence of interest in UART's, and all software publishers support them. De-facto standards being what they are, the MPU-401 "standard" continues to hang on. But meanwhile, really hip "power users" are stepping back in time to just the sort of card that we'll come up with here.

Design analysis

The 6850 UART's, which are the heart of our MIDI interface, are shown as IC7 and, optionally, IC8 in the schematic Fig. 1. The circuit can be built in either a single-port version for the beginner or dual-port version for the more demanding user. Much of the rest of the circuitry is concerned with decoding addresses and managing control lines on the PC's slot.

The lowest-order address line (A0) directly drives the RS (REGISTER SELECT) pins (pin 11) of the UART's to allow selection of either Status/Control or Data registers internal to the chip. We'll look at what those registers do when we test the interface. The next two address lines (A1 and A2) are not used, so each chip occupies 8 bytes of space consisting of four 2-byte chunks which overlay one another.

The next seven address lines (A3–A9) are routed to one set of inputs on IC9, a 74HC688 8-bit magnitude comparator. The other "side" of IC9 connects to DIP switch S1 and seven pull-up resistors in SIP-network R15. When the pattern of bits from the address bus matches the pattern of bits set by S1, pin 19 is pulled low. Notice that the 8th input to IC9 (Q7, pin 18) is grounded on one side and connects to the slot's AEN on the other (P7, pin 17). An address match will be valid only when AEN (ADDRESS ENABLE) is low, indicating that it's not the DMA controller that has the bus.

An address match does two things. It strobes IC3, a 74HC245 transceiver, which routes data either from the slot to the card or from the card to the slot depending on the direction selected by the $\overline{\text{IOR}}$ (I/O READ) line (which connects to the DIR pin (pin 1) of the chip). It also enables IC5, a 74HC138 3-to-8 line decoder which does the final address decoding for UART selection. UART IC7 is selected when A11–A13 match the pattern 0h, and IC8 is selected when the pattern is 2h. $\overline{\text{IOW}}$ (I/O WRITE) ties to the R/W pins of the UART's to select either a read or write to the chips.

The $\overline{\text{IRQ}}$ (INTERRUPT REQUEST) output pins of the two UART's are pulled up by R1 and R2 and combined by NAND gate IC1-c so that an interrupt request by either of them shows up on a line which can be routed to IRQ2, IRQ3, IRQ4, or IRQ7 depending on the placement of jumper JU1. Subsequently, the software will poll the two UART's to determine which of them generated the interrupt.

A 500-kHz transmit and receive clock starts out with the oscillator formed by the two NAND gates IC1-b and IC1-d. The

PARTS LIST

All resistors are ⅛-watt, 5%, unless otherwise noted.
R1, R2, R5, R11, R13*—3300 ohms
R3, R4—10,000 ohms
R6—12,000 ohms
R7, R8*, R9, R12*, R16, R17*—220 ohms
R10, R14*—100,000 ohms
R15—3300 ohms × 7, 8-pin SIP
Capacitors
C1–C5—0.01 µF, Mylar
C6—0.1 µF, Mylar
Semiconductors
IC1—74HC00 quad NAND gate
IC2—74HC393 dual 4-bit binary counter
IC3—74HC245 octal transceiver
IC4, IC10*—TIL111 opto-coupler
IC5—74HC138 3-to-8 line decoder
IC6—74HC04 hex inverter
IC7, IC8*—6850 UART
IC9—74HC688 8-bit magnitude comparator
D1, D2*—1N4148 silicon diode
Other components
J1, J2, J3*, J4*—inline 5-pin female DIN connector
JU1—8-pin IDC header w/jumper blocks
S1—7-position DIP switch
XTAL1—2 MHz crystal
Note: Components marked with a "*" are optional for a second MIDI in/out.
Miscellaneous: Printed circuit board, hold-down bracket, wire, solder, etc.
Note: The following are available from PAIA Electronics, Inc., 3200 Teakwood Ln., Edmond, OK 73013 (405) 340-6300:
- **PCM68pc double-sided, plated thru, PC board and bracket—$24.95**
- **PCM68k kit of all parts needed to build the single-port interface, including PC board, bracket, wire, MIDI jacks, etc.—$49.95**
- **PCM68ex expander parts for adding second MIDI port—$14.95**
- **MIDIpac MIDI starter set consisting of PCM68k interface kit and Voyetra SPJr. 64-track polyphonic sequencer software for PC/clones—$99.00**

Add $3.00 P&H per order.

frequency of the oscillator is set to 2 MHz by crystal XTAL1 which is then divided by 4 in one section of the 74HC393 dual 4-bit binary counter IC2.

Two TIL111 opto-couplers (IC4 and IC10) are used on the MIDI inputs to prevent grounds though the path. A continuous ground on the MIDI inputs would likely duplicate a similar ground at the audio inputs and outputs, leading to circulating ground currents and noisy audio. The TIL111's are not the fastest opto's in the world, but are more than fast enough for this application and less expensive than their faster brothers. On the MIDI outputs, two inverter stages from IC6 are paralleled to increase drive current capabilities.

Assembly

Because things run fairly slowly on slot I/O operations of even the fastest PC, there are no extraordinarily high frequencies involved on the PCM68. That means that prototyping boards and wire-wrap can be used to put together a card if you like. Be careful, though; 0.8-inch spacing between slots in a PC doesn't leave a lot of room for wire-wrap pins. And a misplaced conductor can cause a lot of damage in no time at all. It should go without saying that the shortest possible wires should be used to get a signal from the card edge to the IC it connects to.

Of course it's always best to use a PC board for any project, and you can either make your own from the foil patterns we've provided, or purchase a ready-made board from the source mentioned in the parts list.

A parts-placement diagram is shown in Fig. 2. IC sockets can be used, but certainly are not necessary. Note that if you've elected to put together the single MIDI in/out configuration, you can leave out the following parts: IC8, IC10, D2, R8, R12–R14, and R17.

Since PC-slot access holes weren't designed with MIDI in mind, they typically aren't wide enough for DIN connectors to peek through. Current practice

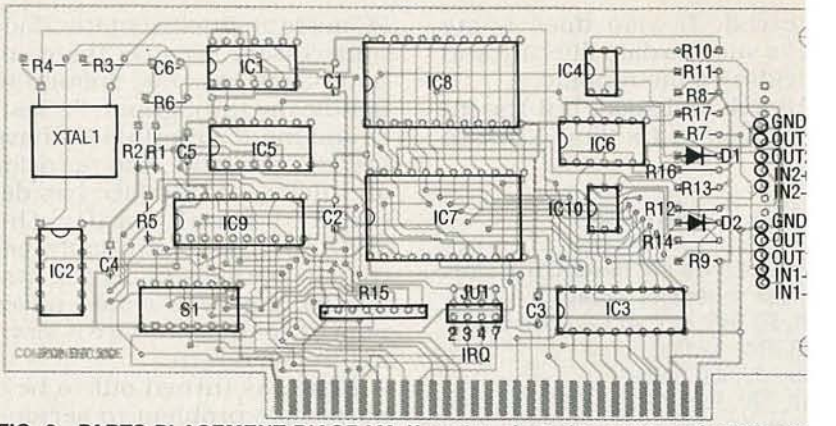


FIG. 2—PARTS-PLACEMENT DIAGRAM. If you've elected to put together the sin MIDI in/out configuration, you can leave out IC8, IC10, D2, R8, R12–R14, and R17.

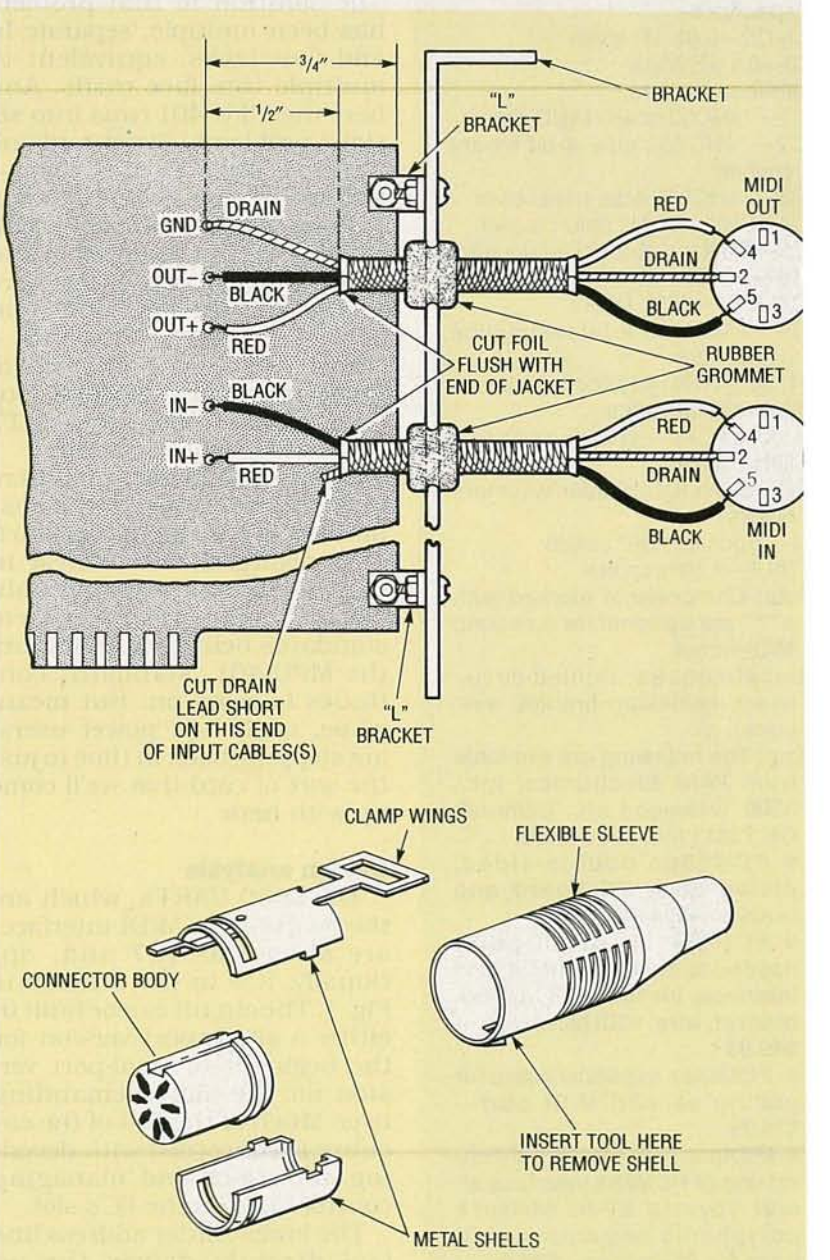


FIG. 3—PC-SLOT ACCESS HOLES aren't wide enough for DIN connectors, so we ha in-line female connectors out on pig-tails. Labeling the connectors will make it eas to tell them apart.

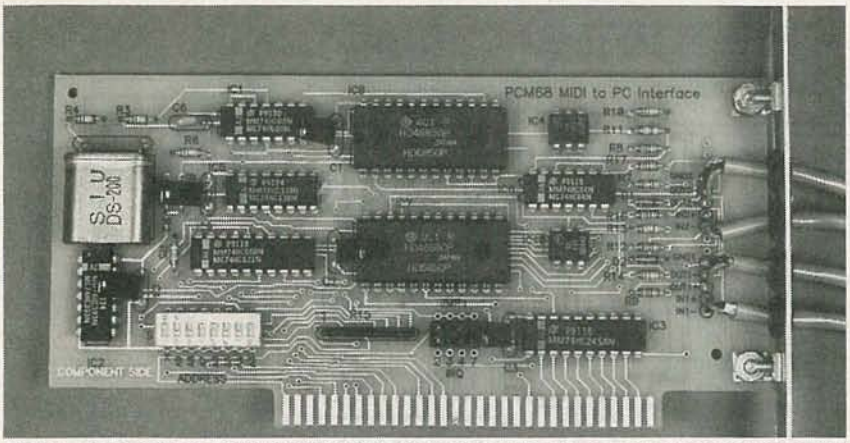


FIG. 4—THE COMPLETED PROTOTYPE CARD. The MIDI jacks are wired directly to the circuit board using shielded twisted pair.

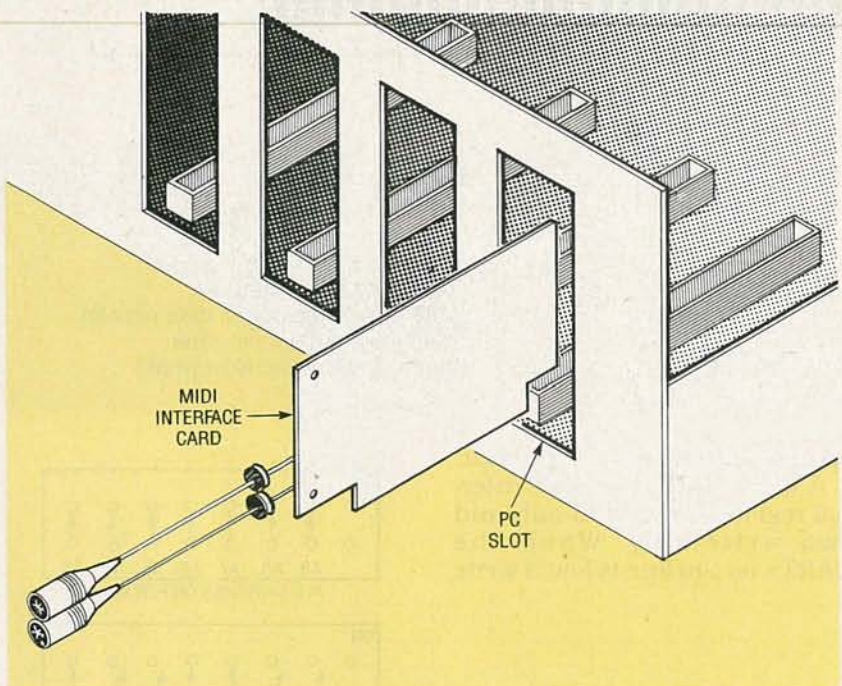


FIG.5—THE CARD FITS through the computer's rear slot.

on many interfaces is simply to hang in-line female connectors out on pig-tails and that's what we'll do here. The circuit board end of those connections can be soldered directly to the circuit board. Use 6-inch lengths of shielded, twisted pair; see Fig. 3. Note that while the shield's drain wire (the wire that connects to the shield itself) is soldered to pin 2 of all the DIN connectors, it connects to the circuit board ground only on the MIDI outputs. Be sure to slide a ¼-inch rubber grommet onto each wire as shown in Fig. 3 before soldering both ends of the wires. It's a good idea to label the connectors, as they are all identical and it will be hard to tell them apart once things are sealed up. Figure 4 shows the completed prototype card.

Installation

When it comes time to install the card in your PC, you'll notice right away that the DIN connectors won't fit through the hole in the back of the case. But by now you've probably also noticed that the interface is somewhat smaller than a usual card, and that's because the card itself is designed to fit through the rear of the PC (see Fig. 5).

A hold-down bracket for the PCM68, shown in Fig. 6, can be fabricated from any material that's handy; ours is bent from 0.040-inch aluminum. After the card is slipped through the access hole in the case, the bracket mounts to the card with two small "L" brackets, and the rubber grommets that you slid on the wires during assembly fit into the notches in the bracket. Finally, push the card down into the selected slot and secure the whole affair with the traditional screw at the top.

Address/interrupt selection

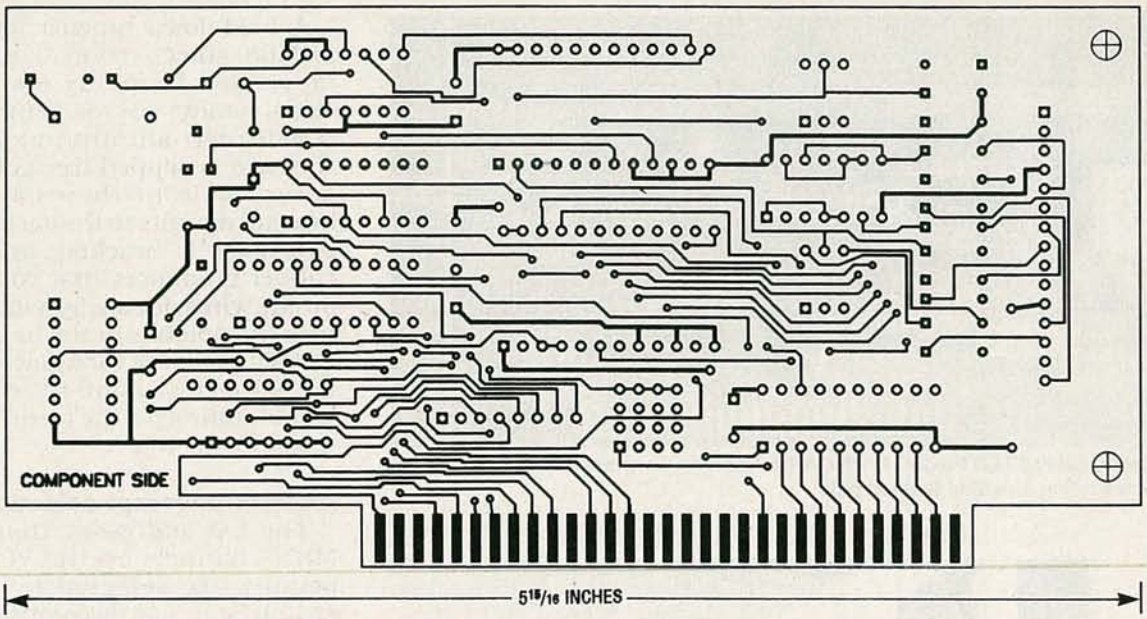
The I/O addresses that the MIDI channels on the PCM68 occupy are selected by DIP-switch S1. It's fairly common for software to default to an address of h330 for the first set of connectors, and Fig. 7 shows the setting of the switches for that situation. If it turns out that there is a conflict, the switches can be set to any address from h0–h3f8. Any software that you select will have some provisions outlined in the owner's manual for changing the port address.

If you've built the interface with two ports, the second pair of inputs and outputs will be at the base address set by S1 plus 1000h. If the first port is at 330h, the second port will be at 1330h.

For interrupts, IRQ2 is normal, and placing a jumper at that location on JU1 will set the card that way (see Fig. 8). If there's a conflict, the jumper can be set to send interrupts to IRQ4 (COM2), IRQ3 (COM1), and IRQ7 (LPT). That's about the order you should try them in if you have to search for one that's unused. Your software will probably default to IRQ2 (or possibly IRQ9 which is re-directed to IRQ2 in AT's) and will definitely have some provisions for changing the default if needed.

Testing

Your software will have a complete test of the interface, but we'll do some simple tests here that will give you a feel for what's going on and confirm that things are working properly. In-



COMPONENT SIDE of the MIDI interface card.

terface tests check to see that data sent from the output side appear at the input side, so the first step is to connect the input to the output with a MIDI jumper cable.

We'll use DOS's handy do-all tool, DEBUG, to directly control the UART and see that it can talk to itself—one of the few cases where that is an indication of sanity. After making sure that DEBUG exists somewhere in the path of your system, invoke it by simply typing "debug" at the DOS prompt. DEBUG responds with its own "-" prompt.

TABLE 1

>debug	
-o 330 03	This resets the UART
-o 330 15	/16, 8 data bits, 1 stop bit
-o 331 aa	Write hAA to the output data register
-i 331	Read the input data register
AA	Alright, a response! Now what?

A 6850 UART has four internal registers; two read-only and two write-only. When the UART's RS (A0) line is low, a write operation puts data into the Control Register which sets the chip's operating parameters and a read brings back the contents of a Status Register which is information on whether the transmit and receive registers

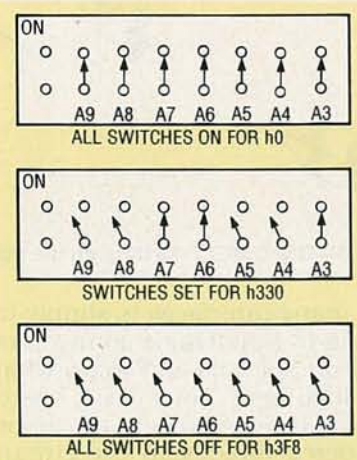


FIG. 7—THE I/O ADDRESSES that t MIDI channels on the PCM68 occupy a selected by DIP-switch S1. Setting t address DIP switches as shown he puts the interface on port h330.

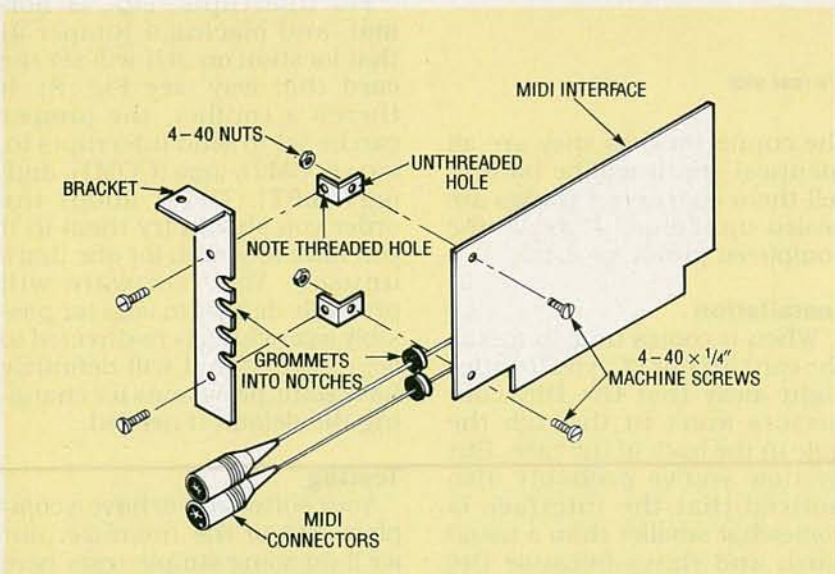
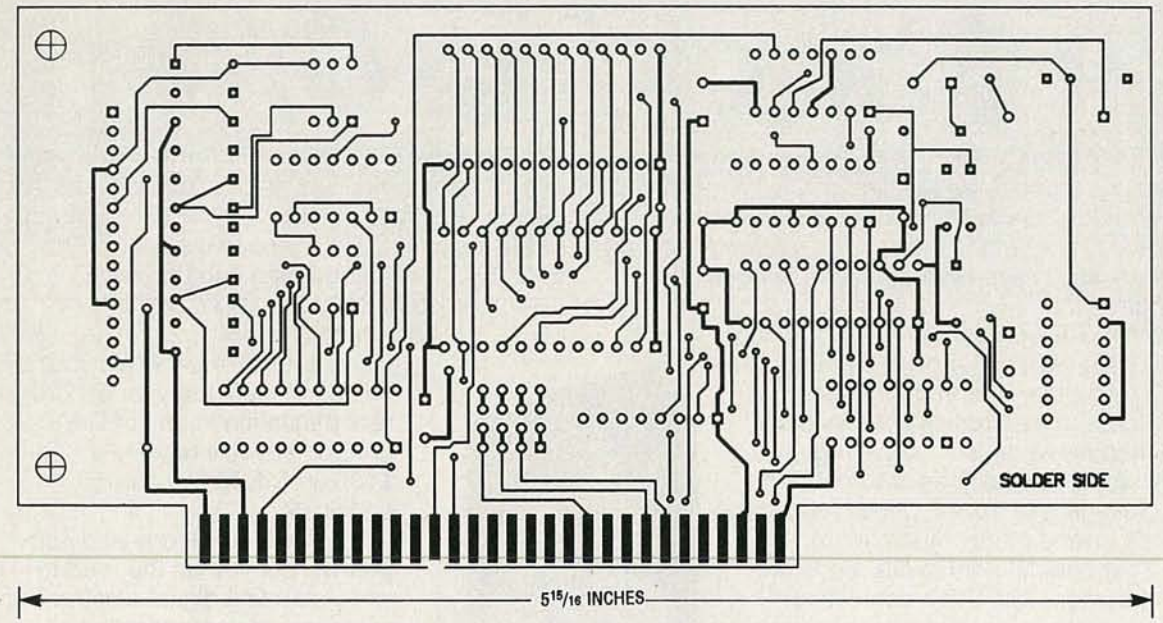


FIG. 6—A HOLD-DOWN BRACKET was fabricated from 0.040-inch aluminum. After the card is slipped through the access hole in the case, the bracket mounts to the card with two small "L" brackets.



SOLDER SIDE of the MIDI interface card.

are empty or full. One address higher up (RS high) are the Data Registers, and writing to that address sends data out on the serial output, while reading brings back anything which has been received from the serial input.

Unlike some interface chips, a 6850 has no hardware reset line. Instead, a "reset word" is written into the Control Register. The first part of our test will be to do that by entering "o 330 03" from the keyboard. To DEBUG that means to write (output) the datum 03h to the port at address 330h. "03" is the reset word and if you have set up the base address to be other than 330h you will want to change that part of your entry.

The next instruction will be "o 330 15," and that writes a byte to the Control Register, which sets the UART to a mode of 8 data bits and one stop bit and sets the internal frequency divider on the transmit and receive clocks to divide by 16.

Now we output a byte by typing "o 331 aa" which writes the datum hAA to the Data Register of the UART, which in turn sends the data out serially. To see that the data was received, the entry "i 331" reads (inputs) from port h331 and should cause the screen to display "AA." The test process is summarized in Table 1.

The pattern in Table 1 shows how you can write whatever data you like with "o 331 xx" and check to see that the data was received with "i 331." The second port, if you have one, can be checked by writing the reset and setup words to h1330 and writing and reading data to h1331.

Using the interface

After installing your software following its publisher's instructions and fully testing the interface using their tests,

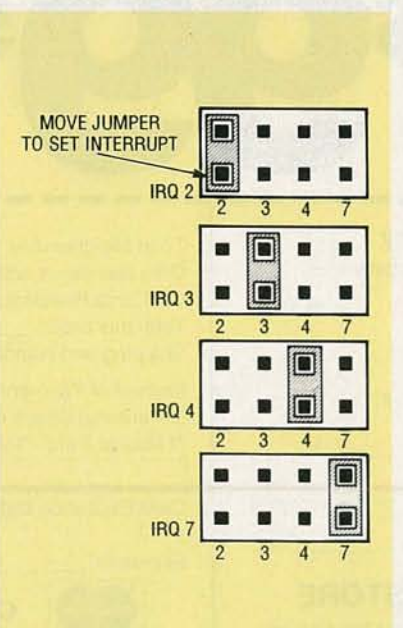


FIG.8—JU1 SETS THE INTERRUPT (see text).

you're ready to plug things together and start composing and recording. As you become more involved with MIDI, you'll realize that there are a lot of different ways to hook things up, depending on what you're going to be doing. But the simplest configuration for the beginner is simply to use MIDI patch cords to connect the MIDI output of your keyboard to the MIDI input of the PCM68 and vice versa.

The keyboard that you choose may have its own means of enabling MIDI, such as a slide switch which has a "MIDI" position or something similar. Of course that switch should be set appropriately. More professional instruments might have more exotic capabilities such as re-mapping the keyboard or other controllers onto different MIDI channels, but you'll learn about those things as you go along.

MIDI can be dealt with at a fairly low level for the beginner, yet it offers the capability of becoming as complex as you like. A good place to start learning is "All About MIDI" in the August 1989 issue of **Radio-Electronics**. And for a really well done treatment of MIDI (not only the technical details but also the user side of it), try reading *MIDI for Musicians* by Craig Anderton, published by Amsco Publications. **R-E**

A Shocking Offer!

Now for the first time in CIE's 56 year history you do not have to be enrolled at CIE to receive our Electronics and Electricity Lesson Modules. Available for a limited time to non-students for the shockingly low introductory price of only $99.5O.

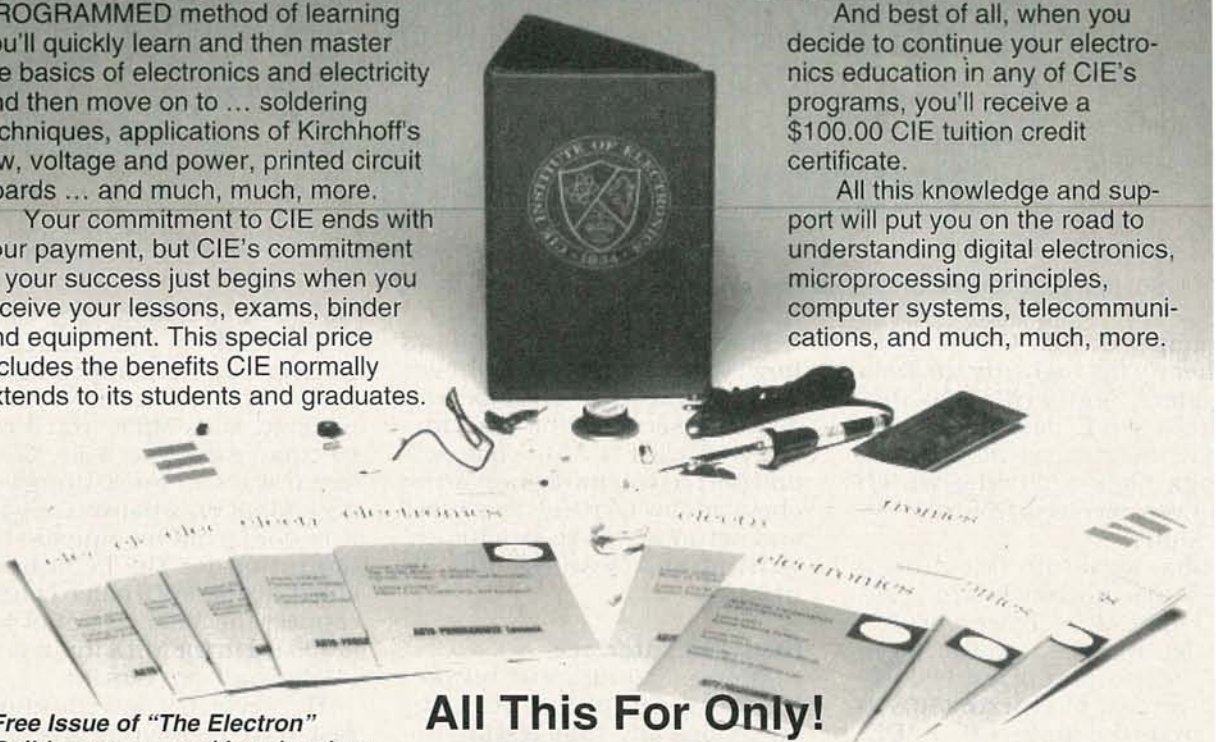
With CIE's patented AUTO-PROGRAMMED method of learning you'll quickly learn and then master the basics of electronics and electricity and then move on to ... soldering techniques, applications of Kirchhoff's law, voltage and power, printed circuit boards ... and much, much, more.

Your commitment to CIE ends with your payment, but CIE's commitment to your success just begins when you receive your lessons, exams, binder and equipment. This special price includes the benefits CIE normally extends to its students and graduates.

You'll receive CIE Bookstore privileges, a patented learning method, access to CIE's student, faculty and alumni electronic bulletin board and a free issue of CIE's school newspaper "The Electron". 24-Hour grading and unlimited access to CIE's faculty is available on an optional basis.

And best of all, when you decide to continue your electronics education in any of CIE's programs, you'll receive a $100.00 CIE tuition credit certificate.

All this knowledge and support will put you on the road to understanding digital electronics, microprocessing principles, computer systems, telecommunications, and much, much, more.



- *Free Issue of "The Electron"*
- *Build your personal burglar alarm*
- *Theory and hands-on training lessons and exams covering "current and voltage" through "printed circuit boards"*
- *CIE Bookstore privileges*
- *Patent learning method*
- *Electronic Bulletin Board privileges*

All This For Only!

$99.50

- ***A $100.00 CIE TUITION CREDIT CERTIFICATE***

☐ **Yes, send me CIE's Introductory Electronic and Electricity Lessons and Equipment.** A7303

Name: _____

Street: _____ Apt. #: _____

City: _____

State: _____ Zip: _____

Age: _____ Phone (____) _____

CIE **BOOKSTORE**
1776 East 17th Street
Cleveland, Ohio 44114

Total Merchandise: $99.50
Ohio Residents add 7% Sales Tax: _____
California Residents add 6 1/2% Sales Tax: _____
Total this order: _____
Shipping and Handling Charges: $5.00

Method of Payment: Amount Enclosed: $
❒ Personal Check or Money Order
❒ Master Card ❒ Visa

Card Expiration Date: _____

Signature: _____

CHARGE BY PHONE!
9 AM to 4:30 PM Eastern Time;
1-800-321-2155 ext. 7303; In Ohio 1-800-523-9109 ext. 730

WARNING!
Please note that unauthorized wire and electronic communications interception and interception of oral communications is illegal under Federal and State Law. In addition Federal Law renders illegal the intentional manufacturing, assembling, possessing, or selling any electronic, mechanical, or other device, knowing or having reason to know that the design of such device renders it primarily useful for the purpose of surreptitious interception or wire, oral, or electronic communications. Federal law imposes both civil and criminal penalties for violations of the applicable statutes. Thus, the use of the Scanner Converter described in this article is intended for and should be restricted to educational, scientific, and/or informational purposes. This is not intended to constitute legal advice and readers are advised to obtain independent advice as to the propriety of their use thereof based upon their individual circumstances and jurisdictions.

SCANNER CONVERTER

We'll be converting those 800–1000 MHz signals down to 400–500 MHz in no time at all.

WILLIAM SHEETS and RUDOLF F. GRAF

WE ARE IN THE MIDDLE OF BUILDING our scanner converter—it's a device that allows the reception of signals from 800–1000 MHz on any scanner that covers frequencies in the 400–500 MHz range. Last month we discussed the scanner converter's circuitry. This month we are going to build the unit and get it working properly.

Construction

If you are going to make your own PC board from the foil patterns we've provided, you must use G-10 type PC material, 1/16-inch thick, with a dielectric constant of 4.8. There's nothing inherently special about the common material except that the printed inductors and filters were designed around it. If other PC-board material is used, the printed inductors and filters will not have the proper electrical characteristics. Because of the high frequencies involved, don't substitute components or change the layout. Also, when drilling the holes in the board, use the solder-side foil pattern as a drilling guide, and drill through any hole you see even if you don't see one on the component side. The parts layout is shown in Fig. 1. Note that a piece of wire must be inserted and soldered on both sides anywhere you see an "X" in Fig. 1.

The resistors should be installed while installing all jumpers, which are made from component-lead clippings. To ensure solid grounding, all components that have grounded leads, especially the trimmer capacitors, must be soldered top and bottom.

Coils L7, L8, and L9 are made from #22 enameled wire wound tightly on an 8-32 screw. See the parts list for coil-winding details. Coil L16, as shown in Fig. 2, is only a loop of wire and not at all critical, and L6 and L15 are simply ferrite beads placed over a length of wire, also shown in Fig. 2. Coil L14 is similar, although this time a ferrite bead is placed over one lead of R20, again as shown in Fig. 2. Coil

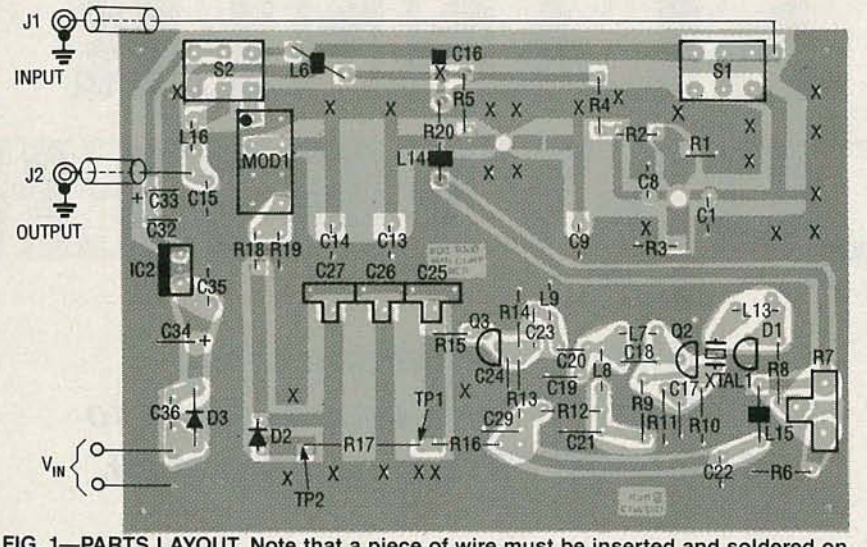


FIG. 1—PARTS LAYOUT. Note that a piece of wire must be inserted and soldered on both sides of the board anywhere you see an "X." The chip components mount on the solder side as shown in Fig. 3.

TP3. You should see arou
+12 volts ±0.5 volt. If not, fi
the problem before proceedi
Check your work for shorts, s
der bridges, missing solder co
nections, etc., and then inst
the remaining semiconduct
devices, observing the polar
on all of them. Watch the le
configurations of IC1 and Q
once soldered in, they are di
cult to remove without dama
ing them.

Keep all coaxial leads going
the PC board very short. Sold
them to the board as shown
Fig. 4 for best operation. T
two slide switches (S1 and S
must be ganged together. Y
can use the method shown
Fig. 5 or devise your own.

The converter board can

L13 is an RF choke and should have a ferrite core for a high "Q" value.

Slide switches S1 and S2 should be mounted very close to the PC board, with leads ⅛-inch or less, measured from the top surface of the PC board. Mixer MOD1 is a prepackaged diode bridge balanced mixer; the blue dot on MOD1 indicates pin 1. Note that IC1, Q1, and all chip capacitors are installed on the solder side of the PC board as shown in Fig. 3. However, do not yet install IC1 or Q1–Q3. You can install the chip capacitors after all regular capacitors are installed on top of the board.

Install IC2 and D1–D3. Now connect power (12 VAC or 15–25 VDC), place S2 in the "on" position, and connect a voltmeter to

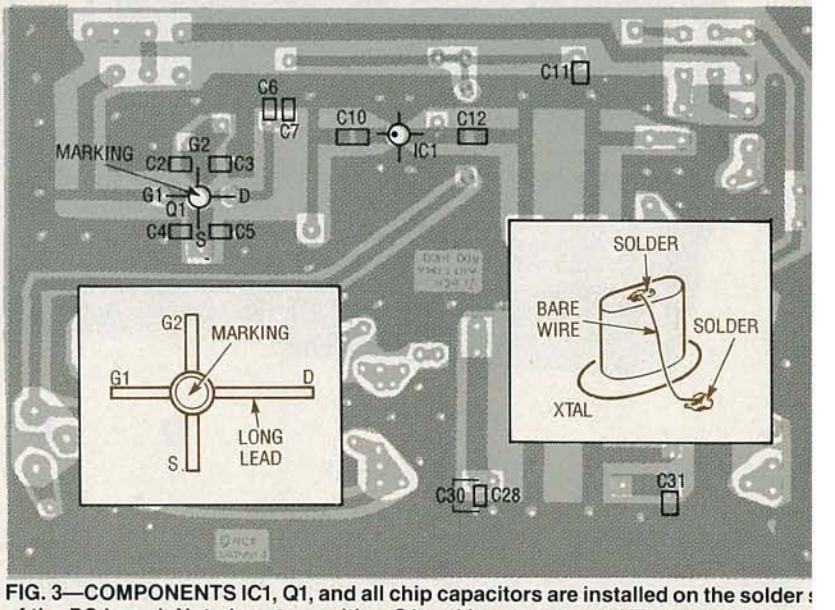


FIG. 3—COMPONENTS IC1, Q1, and all chip capacitors are installed on the solder s of the PC board. Note how to position Q1 and how to ground XTAL1.

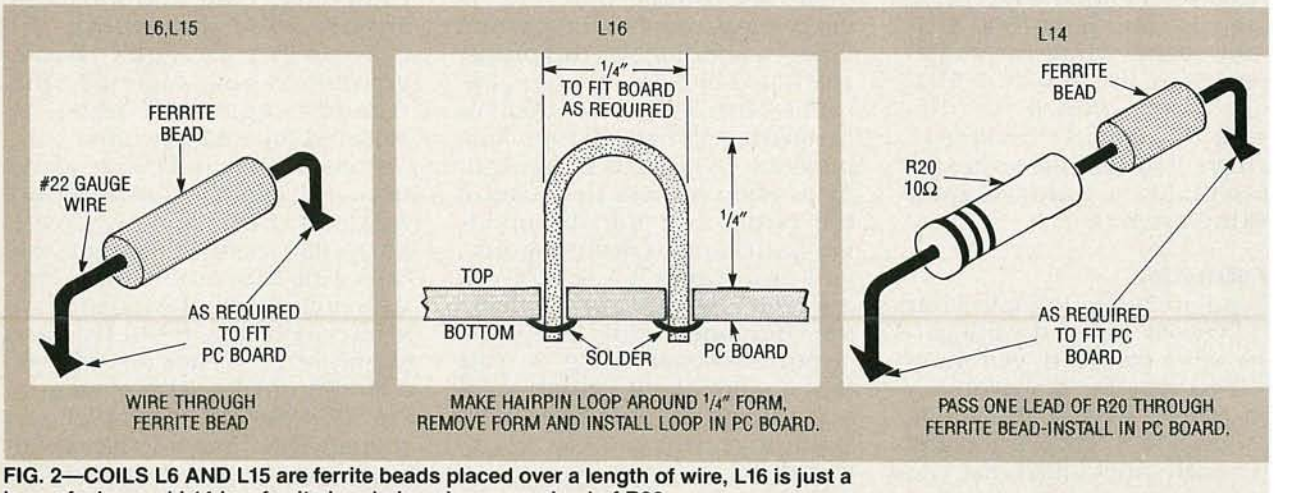


FIG. 2—COILS L6 AND L15 are ferrite beads placed over a length of wire, L16 is just a loop of wire, and L14 is a ferrite bead placed over one lead of R20.

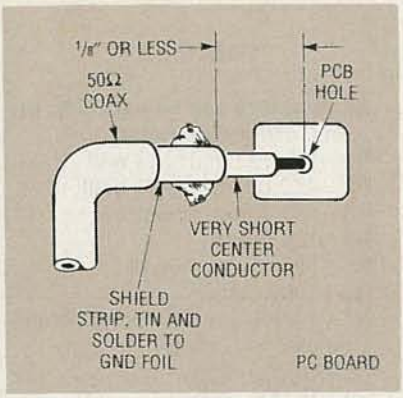


FIG. 4—ALL COAXIAL LEADS going to the PC board must be kept as short as possible. Solder them to the board as shown here.

mounted in a case with enough room for a 12-volt transformer. You can also mount the board inside an existing scanner, if +15 volts at 100 mA is available. If you have a regulated +12-volt supply, you can use it for power by connecting the +12 volts to the junction of C32, C33, and S2-b—in this case you can omit IC2, C34–C36, and D3 from the circuit. Figure 6 shows the inside of the completed prototype.

Tune and align

To align the scanner converter you'll need a VOM, a 100-MHz or higher frequency counter, and a non metallic screwdriver. Preset all trimmer capacitors as shown in Fig. 7, and set the slugs halfway in L7, L8, and L9.

First check all wiring for shorts, opens, and correct component orientation. Then connect either +14-volts DC or 12-volts AC to the power input and check for the following voltages:

- Junction of C16, L6, and R20 for +12 volts ±0.5 volt
- Source of Q1 (the junction of C4, C5, and R3) for +1 to +2 volts
- Drain of Q1 (the hot side C8) for +10 to +11 volts
- Gate 2 of Q1 (the junction of R1 and R2) for +1.5 to +2.5 volts
- Output of IC1 (the junction of R5 and C12) for +5 volts ±1 volt
- Wiper of R7 for +10 to +15 volts (vary the setting of R1)
- Junction of R8 and D1 for +10 to +15 volts
- Emitter of Q2 for +1.5 to +3 volts
- Collector of Q2 for +10 to +11.5 volts
- Collector of Q3 for +8 to +12 volts
- TP2 for −1 to +1 volt

Do not proceed any further until those voltages are obtained. Slight variations outside the stated ranges might be acceptable, but any major ones should be investigated. Table 1 gives some troubleshooting hints.

Couple a frequency counter to L7 using a 2-turn wire loop as shown in Fig. 8. Set R7 in the center of its range and adjust L7 for a 50-MHz reading. Vary R7 and see if you can obtain about ±1-kHz variation. Use the nonmetallic screwdriver.

Couple a frequency counter to L9 using a 2-turn loop, and connect a VOM between TP1 (negative lead) and TP2 (positive lead). Adjust L8 and L9 for maximum voltage reading, which should be between 2 and 3 volts. Check to see that your counter reading is about 100 MHz.

Make sure that you have set trimmer capacitors C25, C26, and C27 according to Fig. 7 for coverage of either 800–900 or 900–1000 MHz. Connect a voltmeter to TP2 and adjust C25,

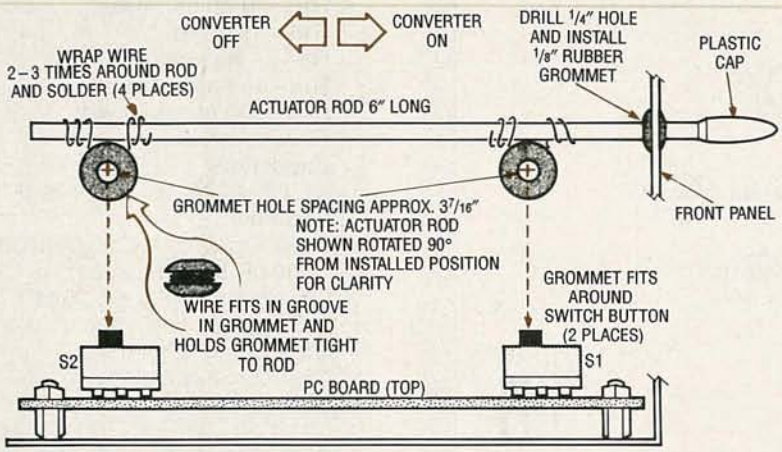


FIG. 5—ACTUATOR ROD S1/S2 CONSTRUCTION. The two slide switches (S1 and S2) must be ganged together. This method uses a brass rod or coat-hanger wire and rubber grommets. You can also devise your own method of ganging them together.

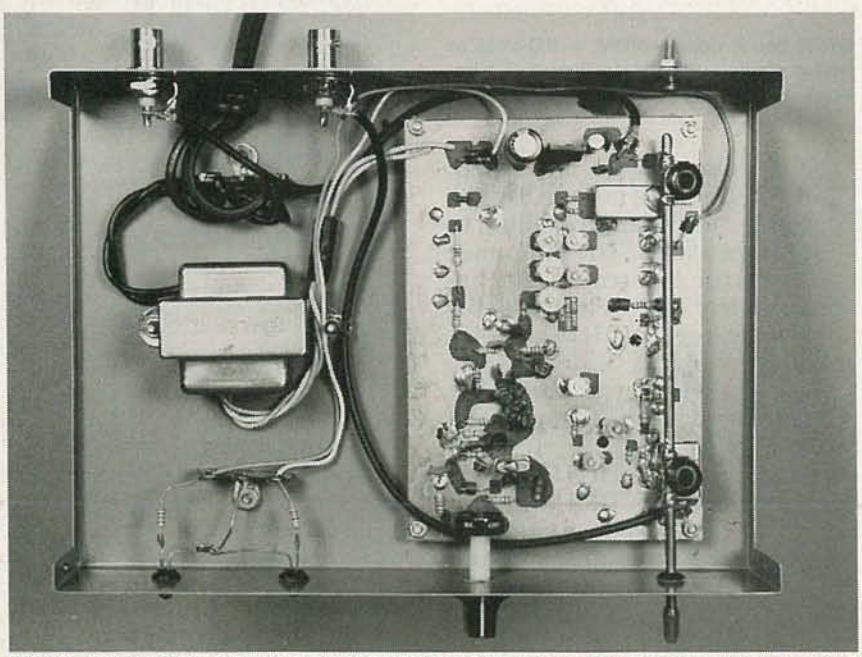


FIG. 6—THE INSIDE OF THE PROTOTYPE UNIT. The converter board can be mounted in a case along with a 12-volt transformer.

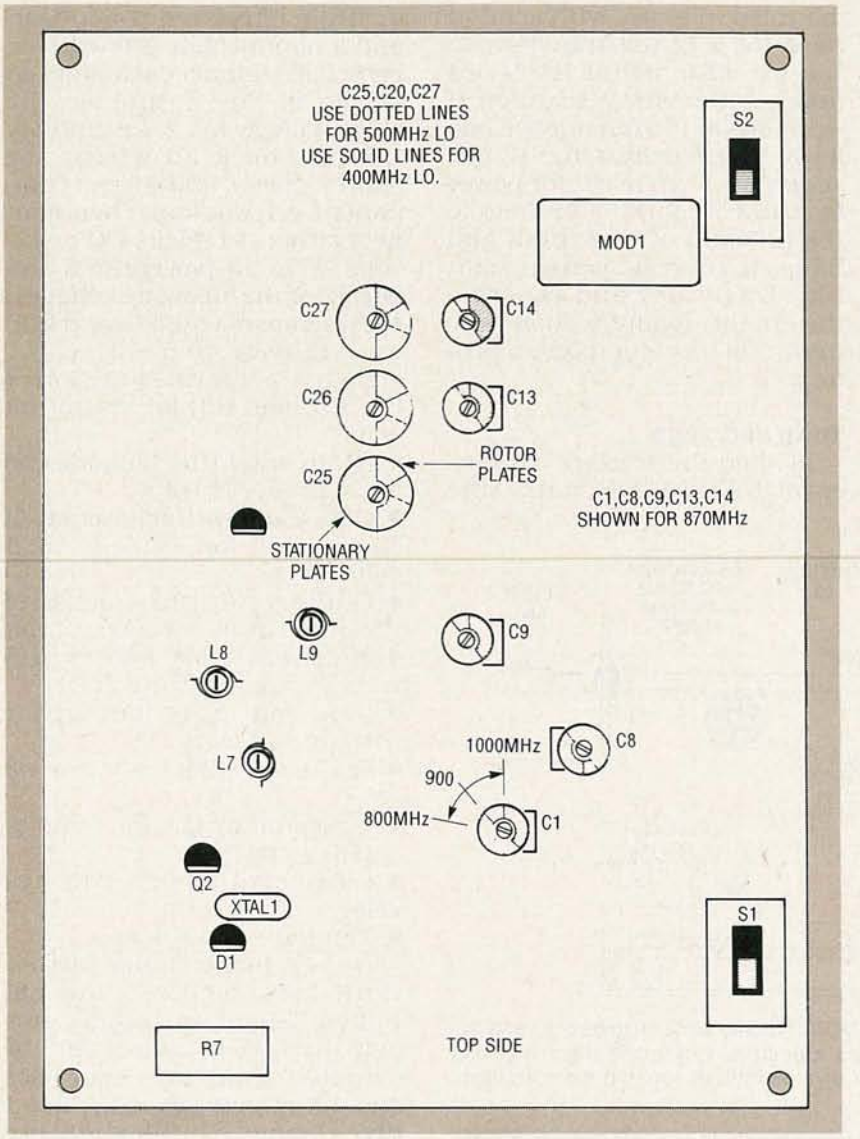


FIG. 7—TO ALIGN THE SCANNER CONVERTER you'll need a VOM, a 100-MHz or higher frequency counter, and an insulated non-metallic screwdriver. Preset all trimmer capacitors as shown here, and set the slugs halfway in L7, L8, and L9.

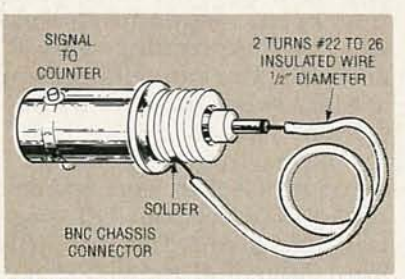


FIG. 8—COUPLE A FREQUENCY COUNTER to L7 using a 2-turn wire loop as shown here.

C26, and C27 for the greatest reading. Short the base of Q2 to ground; the reading at TP2 should be about +0.2 volt. With the short removed, the reading should drop and ideally even go negative, to about −0.1 to −0.15 volts. Adjust C25, C26, and C27 to go as far negative as possible. You should be able to obtain zero volts. The difference between the two readings is approximately the local oscillator injection level at R18, which should be about 0.3 volt RMS.

Use the counter to check the frequency of the signal at the junction of R18 and R19. It should be within a few kilohertz of either 400 or 500 MHz. Potentiometer R7 should vary the frequency ±5 kHz or more. Adjust L7 so that R7 can do that, and also so that R7 is in the middle of its range when either 400 or 500 MHz is produced.

Connect an antenna to J1. Preset C1, C8, C9, C13 and C as shown in Fig. 7, and conn output J2 to a scanner tune the vicinity of 500 MHz (47 530 MHz will do). Now, set scanner in a "search" mode as to gradually tune from low end to the high end of range. Find a suitable signa align the RF stages. If you h access to a signal generator

PARTS LIST

All resistors are ¼-watt, 5%, less otherwise noted.

R1—100,000 ohms, ⅛-watt
R2—470,000 ohms, ⅛-watt
R3—180 ohms, ⅛-watt
R4—180 ohms
R5—390 ohms, ⅛-watt
R6—1000 ohms
R7—10,000 ohms, trimmer potentiometer with shaft
R8—10,000 ohms
R9—15,000 ohms
R10—3900 ohms
R11—330 ohms
R12—100 ohms
R13—15,000 ohms
R14—2200 ohms
R15—10 ohms, ⅛-watt
R16—47 ohms
R17—1 megohm
R18—15 ohms, ⅛-watt
R19—390 ohms, ⅛-watt
R20—10 ohms

Capacitors

C1, C8, C9, C13, C14—1–5 pF trimmer
C2–C7, C10–C12, C16, C28, C3 100 pF, 50 volts, chip
C15—5.6 pF NPO ±0.25 pF
C17—100 pF NPO, 5%
C18—39 pF NPO, 5%
C19—22 pF NPO, 5%
C20—2.2 pF NPO, ±0.25 pF
C21, C29—470 pF ±20%, disc
C22, C30, C32, C35, C36—C µF, 50 volts, GMV disc
C23—33 pF NPO ±5%
C24—56 pF NPO ±5%
C25–C27—2–10 pF trimmer
C33—10 µF/16 volts, electrolyti
C34—470 µF/25 volts, electrol

Semiconductors

IC1—MAR-1 UHF amplifier
IC2—7812 +12-volt regulator
D1—MV2107 varactor diode
D2—HP5082-2800 hot carrier diode
D3—1N4007 rectifier diode
Q1—NE25137 dual-gate GaAsF
Q2—2N3563 VHF NPN transis
Q3—MPS3866 VHF NPN transistor

LED1—green light-emitting diode (optional)
LED2—red light-emitting diode (optional)

Inductors

L1–L5, L10–L12—part of PC-board etching
L6, L15—ferrite bead on wire jumper (see Fig. 2)
L7—0.2–0.32 μH (9½ turns #22 enameled wire wound on 8-32 screw with ferrite slug, Cambion part # 515-3225-06-21-00)
L8, L9—0.05–0.1 μH (3½ turns #22 enameled wire wound on 8-32 screw with ferrite slug, Cambion part # 515-3225-06-21-00)
L13—1.0 μH RF choke
L14—ferrite bead over lead of R20 (see Fig. 2)
L16—½-turn #22 enameled wire on ¼-inch form (see Fig. 2)

Other components

J1, J2—female BNC connector
MOD1—MCL SBL-IX mixer module
S1, S2—DPDT PC-mount slide switch
XTAL1—50-MHz 3rd overtone crystal
Miscellaneous: PC board, small-diameter 50-ohm coaxial cable, project case, 14.5–24-volt DC or 12-volt AC, 350-mA transformer (see text), hardware as required, brass rod or wire, two ¼-inch rubber grommets, line cord if required, solder, etc.

Note: The following items are available from North Country Radio, PO Box 53, Wykagyl Station, New Rochelle, NY 10804:

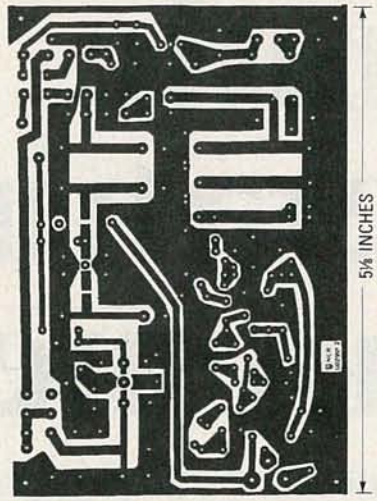
- **Converter kit including all parts except case and transformer—$67.50 + $3.50 S&H**
- **PC board only—$13.50 + $3.50 S&H**
- **Transformer—$9.50 + $3.50 S&H**

New York State residents must add appropriate sales tax.

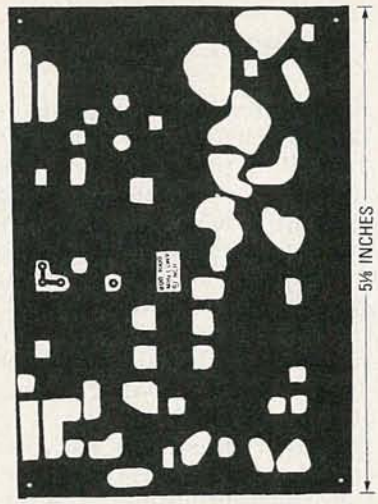
the 900-MHz range, use it (connected to J1) as a signal source.

On a weak signal, peak C1, C8, C9, C13, and C14 for best signal-to-noise ratio. If you use an off-the-air signal, the signal may disappear before you are through.

Do not mistake a stray 470–530 MHz signal that may leak into your scanner for 900 MHz. To check this, turn off the converter using the built-in switch. If the signal is false, it will get stronger. If it is a real 900-MHz signal, it will disappear when the converter is turned off. You can re-peak the converter at any time on any part of the frequency range. Typical RF bandwidth is 40 MHz at the 3 dB points. Signals will be heard 10 to 20 MHz beyond those limits, so if you use the converter for, say 800–825 MHz and 851–868 MHz (most common), you can peak the converter in the middle (825 MHz) and still get satisfactory performance. It is possible to "stagger tune" the circuits to increase bandwidth, although you will lose some gain. **R-E**



COMPONENT SIDE of the scanner converter board. Board shown half size.



SOLDER SIDE of the scanner converter board. Board shown half size.

Earn Your B.S. Degree in ELECTRONICS or COMPUTERS

By Studying at Home

Grantham College of Engineering now in our 41st year, is highly experienced in "distance education"—teaching by correspondence—through printed materials, computer material, fax, and phone.

No commuting to class. Study at your own pace, while continuing on your present job. Learn from easy-to-understand but complete and thorough lesson materials, with additional help from our instructors.

Our Computer B.S. Degree Program includes courses in BASIC, PASCAL and C languages — as well as Assembly Language, MS DOS, CADD, Robotics, and much more.

Our Electronics B.S. Degree Program includes courses in Solid-State Circuit Analysis and Design, Control Systems, Analog/Digital Communications, Microwave Engr, and much more.

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.

Write or phone for our free catalog. Toll free, 1-800-955-2527, or see mailing address below.

•

Accredited by the Accrediting Commission of the National Home Study Council

•

GRANTHAM College of Engineering

Grantham College Road
Slidell, LA 70460

Electronic Temperature Measurement

What is temperature and how can it be measured electronically?

HARRY L. TRIETLEY

TEMPERATURE IS PERHAPS THE most common of all physical measurements. From weather forecasts to industrial processes to patient monitoring, its measurement pervades our lives. Yet, unless our jobs directly involve temperature measurement, most of us don't give much thought to what temperature is or how it's measured. In this article we will look briefly at how temperature is defined and survey the field of electronic temperature measurement. We'll then begin an in-depth study of temperature sensors and application circuits, closing with a look at noncontact infrared thermometry.

What is temperature?

Any grade school science student knows that heat is molecular motion. The hotter something is, the faster its molecules move; absolute zero is defined as the point where all molecular motion ceases. All well and good but, since we can't see molecules move, how do we measure temperature?

The bedrock standard used by the NIST (National Institute of Standards and Technology, formerly the National Bureau of Standards) is based on the perfect gas law. The law states that as temperature rises, either the pressure or volume of the gas must increase in proportion. Mathematically, $P \times V = kT$, where P = pressure, V = volume, T = absolute temperature, and k is a constant. Doubling the molecular velocity in a constant volume results in twice as many molecular collisions per second, or twice the pressure. At absolute zero a perfect gas would collapse to zero volume and pressure.

Figure 1 illustrates the concept of a constant-volume helium gas thermometer. (Perfect gases do not exist, but helium comes close.) A mercury manometer—a device used for measuring the pressure of gasses and vapors—with an adjustable reservoir measures the gas pressure of a helium-filled bulb. As temperature changes, a plunger in the reservoir is adjusted to maintain the left leg of the manometer at a constant height, thus maintaining the helium at a constant volume. When a vacuum is pulled above the right leg, the mercury height indicates the gas pressure, and thus the temperature of the helium.

The concept sounds simple, but precision measurements are difficult. Temperature affects the volume of the bulb and the interconnecting tube is not at the same temperature as the bulb. Also, the relatively small change in mercury level, pl the meniscus of the mercur surface, limits measureme accuracy. On top of all that, c rections must be made for t lium's deviations from t perfect gas law. Therefore, ga law thermometry is used p marily by national standar laboratories such as the NIST

Temperature scales

Companies and laboratori which manufacture or calibra thermometers need a mo practical standard. For that re son, the International Temper ture Scale (ITS) was esta lished. Previously known as t International Practical Temp ature Scale to distinguish from the fundamental gas-la scale, it is regularly review and revised by internation conferences involving a numb of national standards laborat ries. The latest revision, pu lished in 1990, is known ITS-90.

The scale begins with a seri of agreed-upon fundamen temperatures, or fixed poin The freezing (or meltin point—or, in some cases, a va ation known as the trip point—of certain high-puri materials have been assign precise temperature values agreement among the pa ticipating labs. Figure 2 sho

a typical fixed-point cell. A graphite crucible containing a high-purity metal is sealed in a quartz envelope filled with argon or some other inert gas.

Table 1 lists several fixed points. The freezing point of silver, for example, has been assigned the value of 1234.93 Kelvin (absolute) or 660.323 degrees Celsius. Water's triple point, which can be controlled more precisely than the freezing point, is defined to be 273.16K or 0.01°C.

(The triple point is like the freezing point, except that the material is sealed in an evacuated glass container. Instead of being at atmospheric pressure, the water sees only its own vapor pressure. Since the freezing point is affected by both air pressure and contamination, the triple point is more repeatable. The term, "triple point," refers to the fact that the material is in three-phase equilibrium—vapor, liquid, and solid.)

To make the scale practical it is necessary to have sensors that can interpolate between the defined fixed points. ITS-90 defines several such sensors, covering various portions of the scale.

The "center" of the scale, between the hydrogen triple point and the silver freezing point, is interpolated using high-grade resistance thermometers known as SPRT's (Standard Platinum Resistance Thermometers). SPRT's are carefully constructed of high-purity platinum wire, wound and assembled with a minimum of support so as to be strain-free. The thermometers are calibrated at three or more fixed points, then used between those temperatures. Their R versus T equations are very complex and must be handled by computers. Figure 3 shows a SPRT enclosed in a Pyrex sheath.

The very low end of the scale, down to 0.65K, is defined by Helium gas-law thermometry. Several overlapping ranges are defined, each with its own set of complex equations and tables. At the high end, temperatures above the silver freezing point are defined using radiation thermometry. We'll look at radiation thermometry next month, but basically it makes use of the fact that infrared or optical radiation increases with temperature. (The older IPTS also used thermocouples made of platinum alloys to define part of the temperature scale, but this was dropped in the 1990 revision.)

Commercial sensors

For the balance of this article we'll examine and compare commercial temperature sensors: thermocouples, resistance thermometers, thermistors, and silicon (IC) sensors. Let's begin with a quick survey; Table 2 compares their characteristics, while Fig. 4 shows operating ranges and accuracies.

Incidentally, for a first-rate mail-order source of temperature sensors, instruments, and information contact Omega Engineering, One Omega Drive, Box 4047, Stamford, CT 06907, 1-800-826-6342 (CT and international, 203-359-1660).

Thermocouples are nothing more than two dissimilar metals joined together. When connected, an EMF is produced which increases (approximately linearly) with temperature. The thermocouple's sensitivity, linearity, and temperature range depend on the metals used.

Over the years several types of thermocouples have emerged as standards. In the US the NIST publishes millivolt-versus-temperature tables for eight types, identified by letter codes. Five (types J, K, T, E, and N), made from base-metal alloys, cover varying temperature ranges and applications. Sensitivities are typically tens of microvolts per degree C. The other three (types R, S, and B) are formed of platinum and platinum alloys. Obviously expensive, they are the most stable and repeatable of thermocouples, and most often used for high-temperature work, but their sensitivities are lower.

Thermocouple wire and probes made to these standards are available from a number of manufacturers and distributors. In addition, some manufacturers produce special thermocouples for high temperature, cryogenic, and other specialized applications. Most common of these are tungsten alloy thermocouples which allow measurements as high as 2315°C (4200°F).

A resistance thermometer (commonly called an RTD, or Resistance Temperature Device) consists of a coil of fine-gauge wire or metal film. Most metals change resistance with temperature, but platinum or nickel are most often used to make RTD's. RTD's generally are more stable, accurate, and sensitive than thermocouples, but are limited to lower temperatures. Platinum RTD's are the most stable and accurate and cover the highest temperature range.

Nickel's lower cost has made it attractive for moderate-temperature industrial applications; however, recent advances in the art of manufacturing platinum-film elements (similar in principle to metal-film resistors) has eliminated the cost advantage of nickel. Other metals, primarily copper and an alloy named Balco, are sometimes used as well.

Thermistors are probably somewhat familiar to most readers. Unlike thermocouples and RTD's, they are highly sensitive, highly nonlinear, and cover limited temperature ranges. Positive temperature coefficient (PTC) thermistors exist, but those best suited to temperature measurement are negative temperature coefficient (NTC) devices which decrease in resistance by about 3 to 5% per °C. Thermistors offer the widest variety of sizes, shapes, accuracies, and prices of any commercial temperature sensors.

Integrated circuit (IC) temperature sensors are newest and easiest for most experimenters to apply. They are sensitive and linear, and interface easily to op-amps and A/D converters. On the flip side, IC's have not become as standardized as other sensors. Precisely-calibrated (selected) grades tend to get expensive. Their temperature range is about the same as ep-

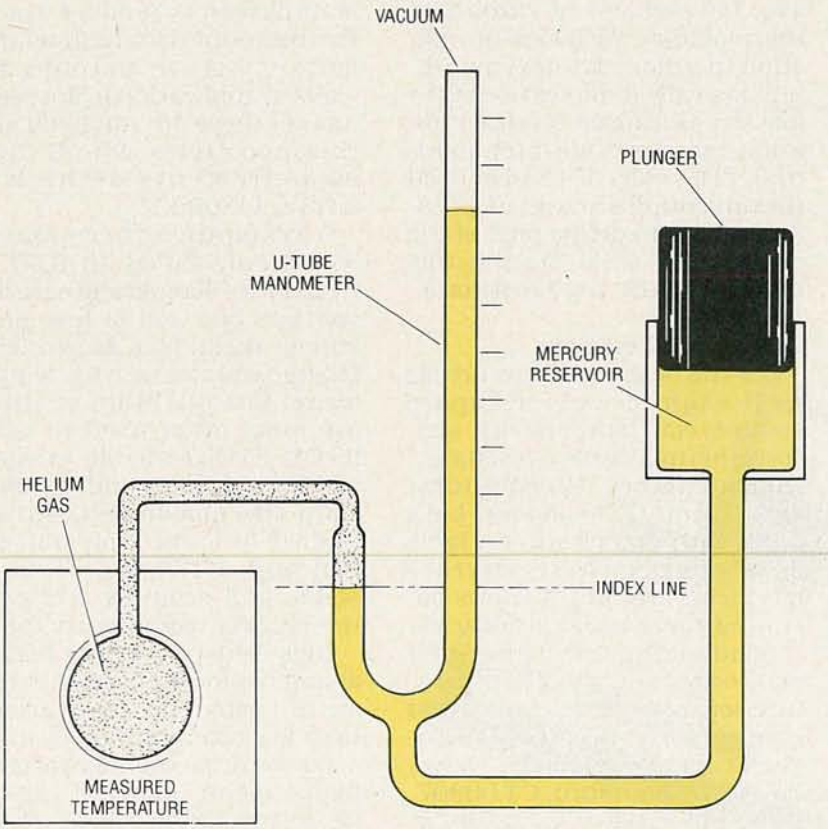


FIG. 1—CONSTANT-VOLUME GAS THERMOMETER. The plunger is adjusted to maintain the left leg of the manometer at the index line as the gas pressure changes.

TABLE 1

Fixed Point	Temp (K)	Temp (°C)
Hydrogen Triple Point	13.8033	−259.3467
Neon Triple Point	24.5561	−248.5939
Oxygen Triple Point	54.3584	−218.7916
Argon Triple Point	83.8058	−189.3442
Mercury Triple Point	234.3156	−38.8344
Water Triple Point	273.16	0.01
Gallium Melt Point	302.9146	29.7646
Indium Freeze Point	429.7485	156.5985
Tin Freeze Point	505.078	231.928
Zinc Freeze Point	692.677	419.527
Aluminum Freeze Point	933.473	660.323
Silver Freeze Point	1234.93	961.78
Gold Freeze Point	1337.33	1064.18
Copper Freeze Point	1357.77	1084.62

oxy-coated thermistors.

Which sensor is best?

It depends upon temperature, application and accuracy. At high temperatures thermocouples may be the only choice. Best accuracy generally is given by platinum RTD's, although precision thermistors may excel near room temperature. Thermistors, because of their high sensitivity, are superb in narrow-range applications such as medical thermometers. Thermistors and IC's both serve well for moderate accuracy measurements and temperature compensation applications.

IC's and, to a lesser extent, RTD's offer limited package selections. For small size and fast response, glass-bead thermistors are available in diameters from 0.014 down to 0.005 inch while uninsulated thermocouple wire is available down to 0.0005-inch diameter. At the other end of the scale, th mistor washers and discs are fered with diameters up t inch. Thermocouple wire available to 14 AWG and e larger, with insulations rang from PVC to ceramic fibers beads. Surface temperatu may be measured by ribb style thermocouples, or th mocouple wires may be wel directly to metal surfaces.

Now that our survey is co plete, let's look at each in det

IC sensors

Forward-biased silicon dio and base-emitter junctio have often been used to m sure temperature. At room te perature, a forward-bias

FIG. 2—FIXED POINT CELL. The gra ite crucible, visible through the qua enclosure, contains a high-purity me (Courtesy of YSI Inc.)

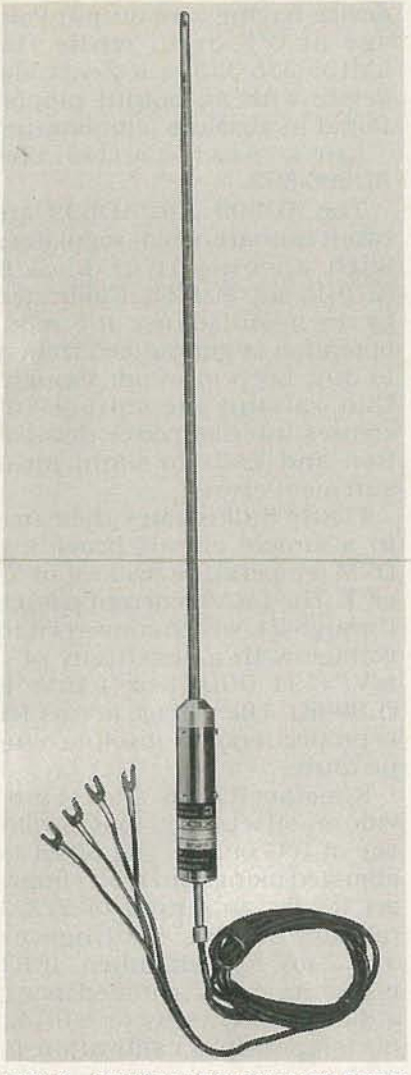


FIG. 3—STANDARDS-QUALITY SPRT, assembled into a quartz sheath. (Courtesy of YSI Inc.)

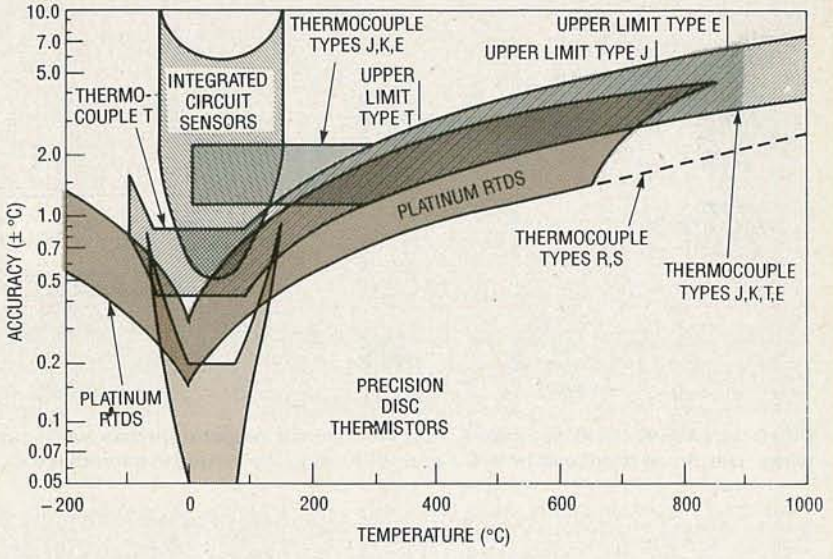


FIG. 4—THE "BEST" TEMPERATURE SENSOR depends on the temperature range and accuracy required.

TABLE 2—SENSOR COMPARISON CHART

Sensor Type	Typical Sensitivity	Temperature Range	Midrange Accuracy	Non-Linearity
Base Metal Thermocouples Types J, K, T, E, N	40 to 70 μV/°C	−270 to 1372°C	1.1 to 2.2°C	1 to 5%
Platinum Alloy Thermocouples Types R, S, B	7 to 12 μV/°C	−50 to 1820°C	0.6 to 1.5°C	1 to 5%
Tungsten Alloy Thermocouples	10 to 21 μV/°C	−17 to 2315°C	4.5°C	2 to 7%
Platinum Resistance Thermometers (100Ω)	0.4Ω/°C	−200 to 650°C	0.1 to 0.25°C	1 to 3%
Nickel Resistance Thermometers (100Ω)	0.7Ω/°C	−60 to 180°C	0.4°C	1 to 5%
Precision Disc Thermistors	−3 to −5 %/°C	−80 to 150°C	0.1 to 0.2°C	Inherently Nonlinear
Glass Bead Thermistors	−3 to −5 %/°C	−60 to 300°C	Noninterchangeable	Inherently Nonlinear
Integrated Circuit Sensors	1μA/°C or 1 to 10mV/°C	−50 to 150°C	0.5 to 5°C	0.3 to 3°C

junction drops about 0.7 volts, with a negative temperature coefficient of approximately −2mV/°C. The exact voltage and temperature coefficient depends upon the junction's geometry, current density, and other factors.

Precise calibration requires individual measurement of each diode or transistor at known temperatures. The basic equation for a P-N junction is:

$$I = I_o\left(e^{\frac{qV}{kT}} - 1\right)$$

where q is the charge of an electron, k is a physical constant known as the Boltzmann constant, and T is the absolute temperature (Kelvins). I_O is a constant, basically equal to the reverse-biased leakage current. At room temperature, the quantity kT/q is about 26 mV. Under normal forward-biased conditions the −1 term is insignificant and can be ignored, so:

$$I \cong I_o e^{\frac{qV}{kT}}$$

so

$$\ln\left(\frac{I}{I_o}\right) = V$$

An IC temperature sensor's operation is based on the difference between two base-emitter voltage drops where the junction currents are maintained at a constant ratio, I2/I1. Applying a little algebra to that equation shows that the voltage difference is given by:

$$V_2 - V_1 = \frac{kT}{q}\ln\left(\frac{I2}{I1}\right)$$

Circuits within the IC use that difference to create an output voltage or current which is proportional to temperature.

Table 3 lists four IC's. The AD590 and AD592 behave iden-

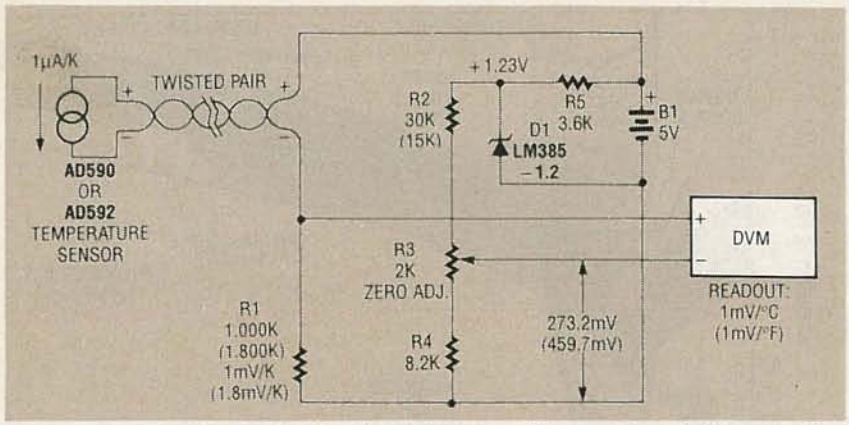


FIG. 5—AN AD590 OR AD592 makes it easy to transmit temperature data over a pair of wires. The circuit produces 1mV/°C (or 1mV/°F using the values in parentheses).

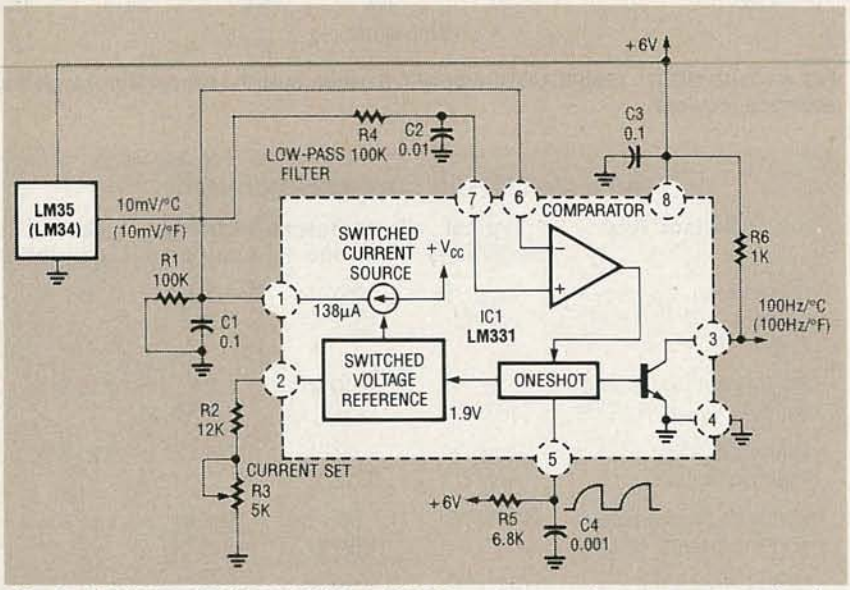


FIG. 6—AN LM35 OR LM34 PLUS A V/F IC produces a frequency proportional to temperature.

TABLE 3—TEMPERATURE SENSORS

Type & Mfr	Description	Available Ranges	Available Accuracies
AD590: Analog Devices, Harris	Two terminal current source 1μA/K	–55 to 150°C	1.7 to 10°C (0.5 to 5°C @ 25°C)
AD592: Analog Devices	Two terminal current source 1μA/K	–25 to 105°C	1 to 3.5°C (0.5 to 2.5°C @ 0 to 70°C)
LM34, LM35: National	Three terminal current source 10mV/°F (LM34) 10mV/°C (LM35)	–55 to 150°C	1.5 to 2°C (0.5 to 1°C @ 25°C)
LM135/235/335: National	Two terminal voltage regulator 10mV/K, calibratable	–40 to 100°C –40 to 125°C –55 to 150°C	2.7 to 9°C (1 to 6°C @ 25°C) without user calibration

tically, but the newer AD592 is less expensive (plastic TO-92 case), covers a narrower range, and, over that range, offers tighter accuracy. National's LM34/LM35 is a three-terminal device having zero output vo age at 0°F or C, while t LM135/235/335 is a Zener-l device with an output prop tional to absolute temperatu

Let's start with t AD590/592.

The AD590 and AD592 a two-terminal current regulat with an output of 1 μA (273.15 μA at 0°C). Calibrat by the manufacturer at 5 vol operation is guaranteed fron to 30V. Keep in mind, thoug that raising the voltage i creases internal power dissi tion and leads to slight me surement errors.

Figure 5 illustrates their u in a simple circuit providi DVM temperature readout in or °F. The 1 μA/K current pass through R1, which converts it voltage with a sensitivity o mV/°C (1.000K) or 1 mV/ (1.800K). The voltage across is proportional to absolute te perature.

Resistors R2, R3, and R4 pr vide an offset equal to R1's vo age at 0°C or 0°F. The offset adjusted using the DVM: simp set R3 for an output of 273 mV for Celsius readings 459.7 mV for Fahrenheit. If is purchased (or trimmed usi a digital ohmmeter) to ±0.1 no temperature calibration required to achieve the IC rated accuracy.

If you want to achieve supe or accuracy using a lower gra (looser tolerance) IC, you ca make R1 adjustable. Place t IC at a known temperature, co nect the DVM across R1, and a just it for the correct readi based on 1 mV/degree. (Sugge tion: place the IC in a closed-e sheath and let it come to equ librium in a stirred ice-an water bath. Trim R1 until t voltage across it is 273.2 at 0

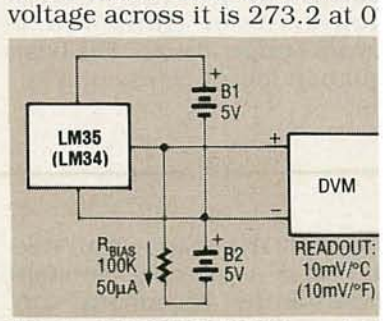


FIG. 7—A NEGATIVE BIAS is needed readings below zero degrees.

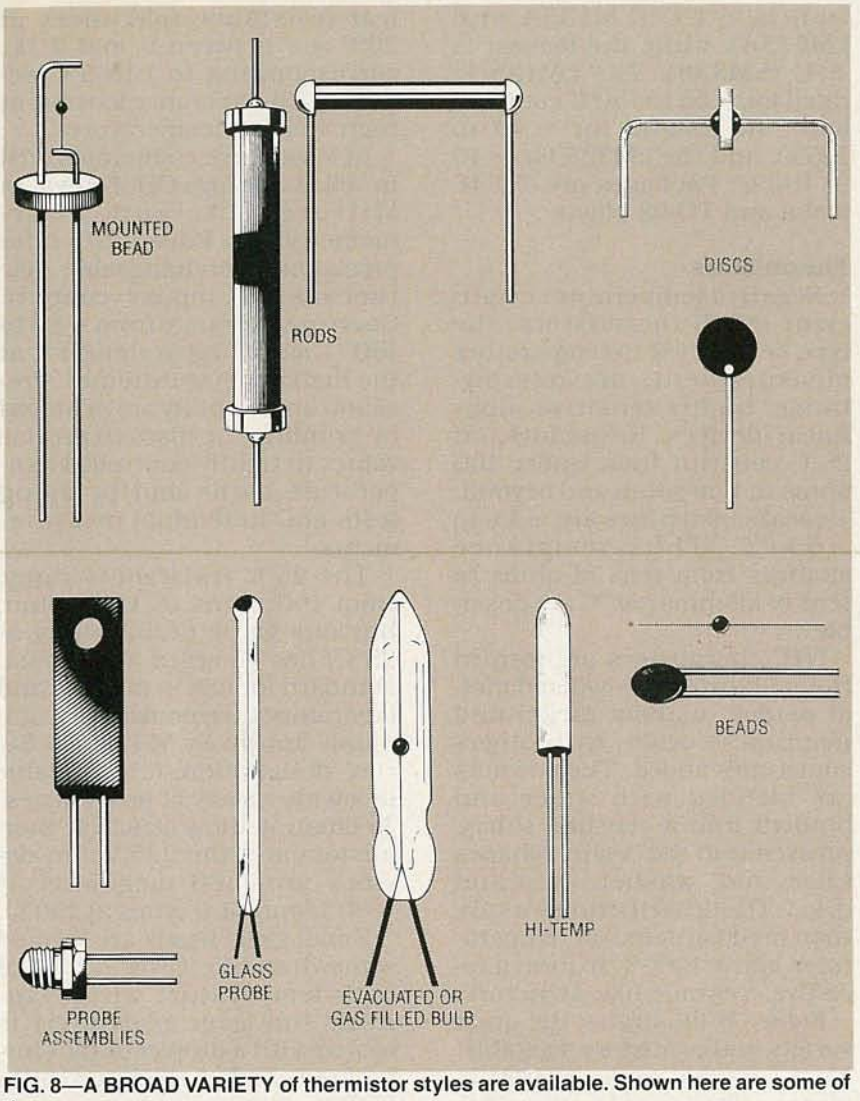


FIG. 8—A BROAD VARIETY of thermistor styles are available. Shown here are some of the more common ones.

TABLE 4—THERMISTOR CHARACTERISTICS

Thermistor Type	Available Resistances	Mid-Range Accuracy	Typical Temperature Range
Low Cost	100 ohms to 200K	5 to 20% (1 to 5°C)	−50 to 150°C
Precision Interchangeable Disc	100 ohms to 1 megohm	0.1 to 0.2°C (0.5 to 1%)	−80 to 150°C
Glass Bead	200 ohms to 1 megohm	20% (5°C)	−60 to 300°C
Glass Coated Interchangeable Disc	2.2K to 30K	0.05 to 0.2°C (0.2 to 1%)	−80 to 250°C

or 491.7 mV at 32°F.) Adjust R3 as described earlier.

The AD590 is available in several grades from ±5°C (AD590J) to ±0.5°C at 25°C (AD590M). The AD592's guaranteed 25°C accuracies range from ±2.5°C (AD592AN) to ±0.5°C (AD592CD). The AD590 is available in TO-52 transistor can or flat-pack enclosures, while the AD592 is sold in a TO-92 plastic transistor package. Both are sold as unpackaged, trimmed chips.

National's LM34/35 series is even easier to use. A three-terminal IC, it outputs 10 mV/°F (LM34) or 10 mV/°C (LM35) and is zero-based (zero millivolts at zero degrees). All that is needed to read temperature is a DVM and a battery or voltage source (anywhere from 4 to 30 volts).

Figure 6 combines an LM34 or LM35 with an LM331 voltage-to-frequency converter to provide a frequency proportional to temperature. The component values shown produce an output of 100 Hz/degree (10 kHz at 100°F or C). For more information on the LM331 and other V/F converters see "V/F Converters," **Radio-Electronics**, June 1991.

As with the AD590/592, no temperature calibration is necessary. To calibrate it, you temporarily disconnect the sensor, provide a precise 1.000 volt input, and adjust R3 for 10.00-kHz output. No zero adjustment is necessary. For improved accuracy using loose-tolerance IC's, you can place the IC at an accurately-known temperature near the high end of its range and adjust R3 for the proper output.

The LM34/35 needs a negative bias to track temperatures below zero. Figure 7 shows the basics; the IC is powered by a positive supply, but a negative bias current of approximately 50 μA is added to the output.

The LM35 is available with temperature ranges of −55 to 150°C, −40 to 110°C (suffix C), and 0 to 100°C (suffix D), and with 25°C guaranteed accuracies of ±1°C and ±0.5°C (suffix A). Similar grades are available for the LM34 Fahrenheit version. Packages are TO-46 metal and TO-92 plastic. The last IC in the table is National's LM135/235/335 series.

The LM135 operates as a Zener-like two-terminal voltage regulator IC, similar to an LM185 reference. A third terminal allows a potentiometer to be added for user calibration. The bias or "Zener" current may be anywhere from 400 μA to 5 mA. Its output is proportional to absolute temperature, 10 mV/K (2.73 volts at 0°C).

The tightest 25°C guaranteed accuracy without user calibra-

DIGITAL VIDEO STABILIZER
ELIMINATES ALL VIDEO COPYGUARDS

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. THE DIGITAL VIDEO STABILIZER: RXII COMPLETELY ELIMINATES ALL COPY PROTECTIONS AND JAMMING SIGNALS AND BRINGS YOU CRYSTAL CLEAR PICTURES.

WARNING
THE DIGITAL VIDEO STABILIZER IS INTENDED FOR PRIVATE HOME USE ONLY. IT IS NOT INTENDED TO COPY RENTAL MOVIES OR COPYRIGHTED VIDEO TAPES THAT MAY CONSTITUTE COPYRIGHT INFRINGEMENT.

FEATURES
- Easy to use and a snap to install
- State-of-the-art Microchip technology
- 100% automatic
- 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")
- Uses a standard 9 Volt battery (last 1-2 years)
- Fast UPS delivery
- Air shipping available
- UNCONDITIONAL 30 day money back guarantee
- 1 year warranty

(Dealers Welcome)
FREE 20P Catalog

To Order: **$59.95** ea +$4 for p & h
Visa, M/C, COD Mon-Fri: 9-6 EST
1-800-445-9285 ext. 6383
SCO Electronics Inc. Dept. 6383
581 W. MERRICK RD. VALLEY STREAM, NY 11580

CIRCLE 187 ON FREE INFORMATION CARD

CABLE TV DESCRAMBLERS
How You Can Save Money on Cable Rental Fees

Bullet Proof

	1 Unit	5+
BEST Super Tri-Bi Auto/ Var. Gain Adjustment	$119.95	$85
Jerrold Super Tri-Bi ...	$109.95	$79
Scientific Atlanta	$109	$79
Pioneer	$109	$79
Panasonic TZPC145....	$99.95	$79
Stargate Converter.....	$95	$69
Digital Video Stabilizer.	$59.95	$29
Wireless Video Sender..	$59.95	$49.95

US Cable'll Beat Anyone's Price Advertised in this Magazine!

30 Day Money Back Guarantee
FREE 20 page Catalog
Visa, M/C, COD or send money order to:
U.S. Cable TV Inc. Dept. 5383
4100 N. Powerline Rd., Bldg. F-4
Pompano Beach, FL 33073
1-800-772-6244 ext. 5383

For Our Record
I, the undersigned, do hereby declare under penalty of perjury that all products purchased, now and in the future, will only be used on Cable TV systems with proper authorization from local officials or cable company officials in accordance with all applicable federal and state laws. FEDERAL AND VARIOUS STATE LAWS PROVIDE FOR SUBSTANTIAL CRIMINAL AND CIVIL PENALTIES FOR UNAUTHORIZED USE.

Date:_____
Signed:_____
No Florida Sales!

CIRCLE 188 ON FREE INFORMATION CARD

tion is ±1°C (LM135A and LM235A), while the loosest is ±°C (LM335). The LM135 is rated for −55 to 150°C continuous, the LM235 for −40 to 125°C, and the LM335 for −40 to 100°C. Packages are TO-46 metal and TO-92 plastic.

Thermistors

Negative temperature coefficient (NTC) thermistors, the type best suited to temperature measurement, are narrow-range, highly sensitive, nonlinear devices. Resistances at 25°C can run from under 100 ohms to 1 megohm and beyond. Typical sensitivities are −3% to −5%/°C. Thus resistance changes from tens of ohms to tens of kilohms per °C are possible.

NTC thermistors are formed from mixtures of powdered metal oxides, usually nickel and manganese oxides with others sometimes added. The powders are blended with water and binders into a clay-like slurry, pressed into the desired shapes (disc, rod, washer, etc.) and dried. The dried thermistors are then fired (sintered) at temperatures above 1000°C to form a resistive, ceramic-like structure.

Figure 8 illustrates the great variety of thermistors available. Most common for temperature measurement applications are epoxy-coated discs, generally under 0.1-inch in diameter. Similarly-sized glass-coated discs perform at higher temperatures. Bead thermistors, both glass-coated and bare, offer small size and fast response. Sizes vary from around 0.05 inch down to 0.005 inch. At the other end of the spectrum, thermistor rods are available as well as disc and washer shapes up to 1-inch diameter. In addition, several manufacturers offer thermistor sensor assemblies ranging from straight-stick probes to bolt-on and surface-mount assemblies to transistor cans.

Specifications vary greatly, but Table 4 summarizes several types. Thermistors have a reputation of being not too accurate or stable—and that is true of most inexpensive devices. Typical resistance tolerances 25°C are between 5 and 20 corresponding to 1 to 5°C curacy. The tolerance loosens high and low temperatures.

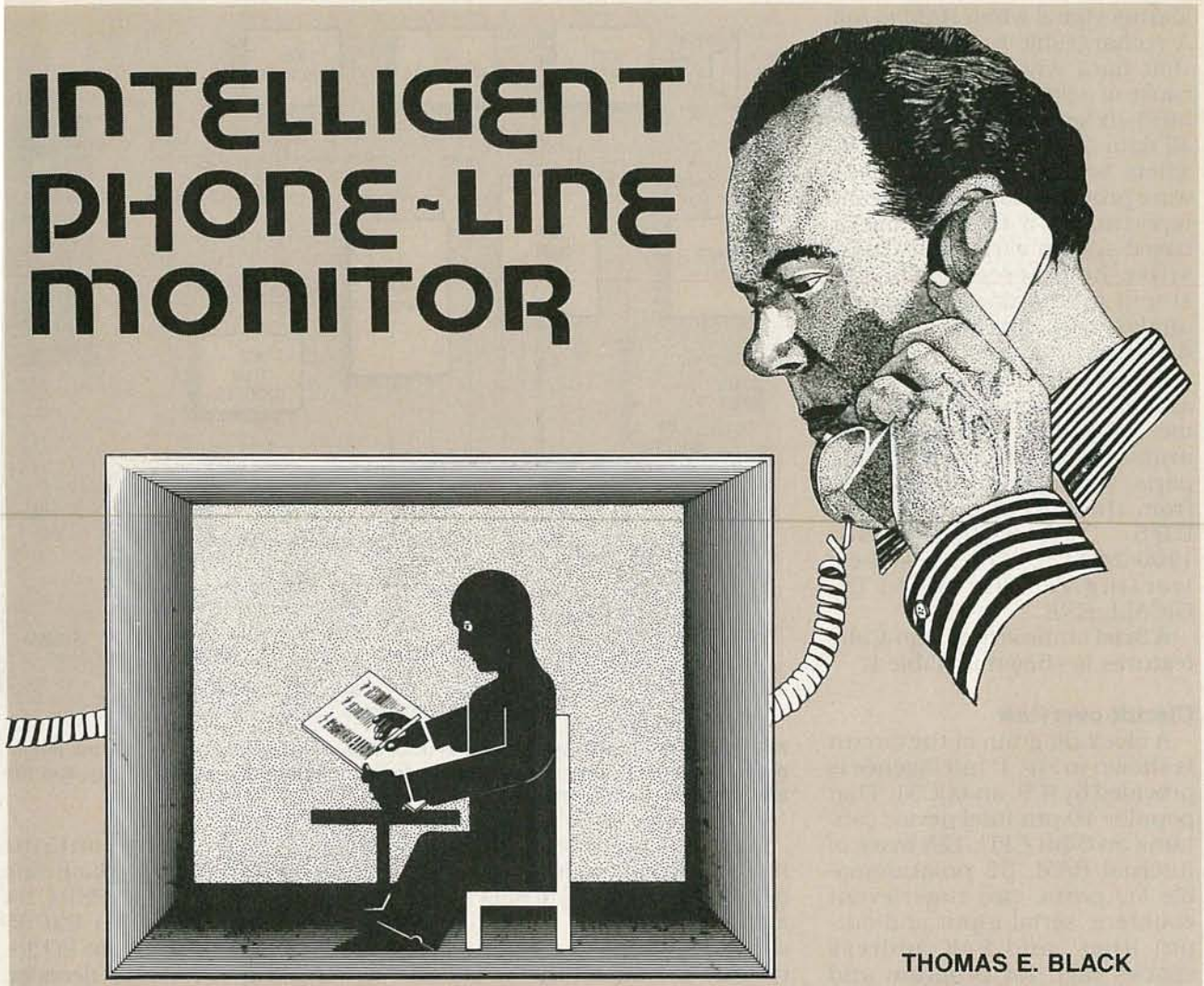
At least three companies (Y in Yellow Springs OH, Fenwal Milford MA, and The mometrics in Edison NJ) of precision interchangeable d thermistors (epoxy coate Covering the range from −80 150°C, loosening to about 1°C the high and low extremes. P cision and stability are achiev by grinding the discs to prec values in tightly-controlled te perature baths and by agi tests and individual measu ments.

The 25°C resistances ran from 100 ohms to 1 megoh but one value (2252 ohms 25°C) has emerged as a qua standard for use in medical a laboratory thermometers. Co monly known by YSI's "400 ries" designation, it is availa in a wide variety of probe styl To illustrate how sensitive th mistors are, the 2252-ohm vices are 1.66 megohms −80°C and 41.9 ohms at 150

Small glass beads are form somewhat differently. A pair high-temperature wires (t ically fine-gage platinum) coated with a droplet of the sl ry, fired, and then dipped i molten glass. The result i high-temperature device wh typically is more stable than oxy-coated discs but which c not be ground or trimmed. precision applications th mistors may be supplied by manufacturer with individ test measurements. For in changeability, the manuf turer may select and preass ble two thermistors in para to match a specific calibrat curve. Glass beads generally specified to about 300°C.

Next month we'll look at so thermistor application circu then move on to resistance th mometers and thermocoup We will conclude with a look noncontact radiation th mometry. If you want to st thermistors in detail, look **Radio-Electronics**' three-p series, "All About Thermisto January—March 1985.

INTELLIGENT PHONE-LINE MONITOR



THOMAS E. BLACK

Log telephone/modem/fax usage automatically and inexpensively with our intelligent phone-line monitor.

RESOLVING MONTHLY TELEPHONE bills can be a struggle, especially in a shared household. It seems that there are always some long-distance calls that we would like to dispute (did someone really call Oshkosh, Wisconsin?) One solution is to maintain a telephone log on paper, but doing so requires personal discipline that may be hard to keep up. Managing telephone usage is a problem that extends into the office, too. Knowing how long you spoke to each caller is a necessity if you bill for your time. If only one could log all phone calls automatically!

As a matter of fact, there is: Digi-Call (Digital Call Auto-Logger). This unobtrusive device can solve your telephone-management troubles. Digi-Call is a microprocessor-based system that connects to any standard telephone outlet and passively waits for incoming or outgoing calls. When you make an outgoing call, Digi-Call silently logs the time, telephone number, call length, and other vital information. When you receive an incoming call, Digi-Call records the time, call length, number of rings before answering, and more. A four-digit account-coding system optionally allows you to associate each call with a particular client, user, or housemate simply by pressing the appropriate code any time during the conversation. Digi-Call can work with both rotary and *Touch-Tone* phones, but the account-management feature is available only on tone phones.

Digi-Call's intelligence is provided by an 8-bit microprocessor, 32K of RAM, and 8K of EPROM-based realtime software. Digi-Call's internal RAM allows it to record more than 1550 calls without user intervention; audible and visual

alarms signal when RAM is full. A rechargeable battery ensures that data will not be lost because of a power interruption. A built-in serial interface allows all data to be uploaded to a PC where sophisticated host software provides data analysis and reporting in a friendly, menu-based system with context-sensitive help screens. Data is stored in standard format for analysis by spreadsheet and database programs.

A complete kit of parts is available for about $170; a commercial-quality PC board is also available, as are hard to find parts. All software is available from the author and the R-E BBS (516-293-2883, 1200/2400, 8N1) as a self-extracting ZIP file called DIGICALL.EXE.

A brief summary of Digi-Call's features is shown in Table 1.

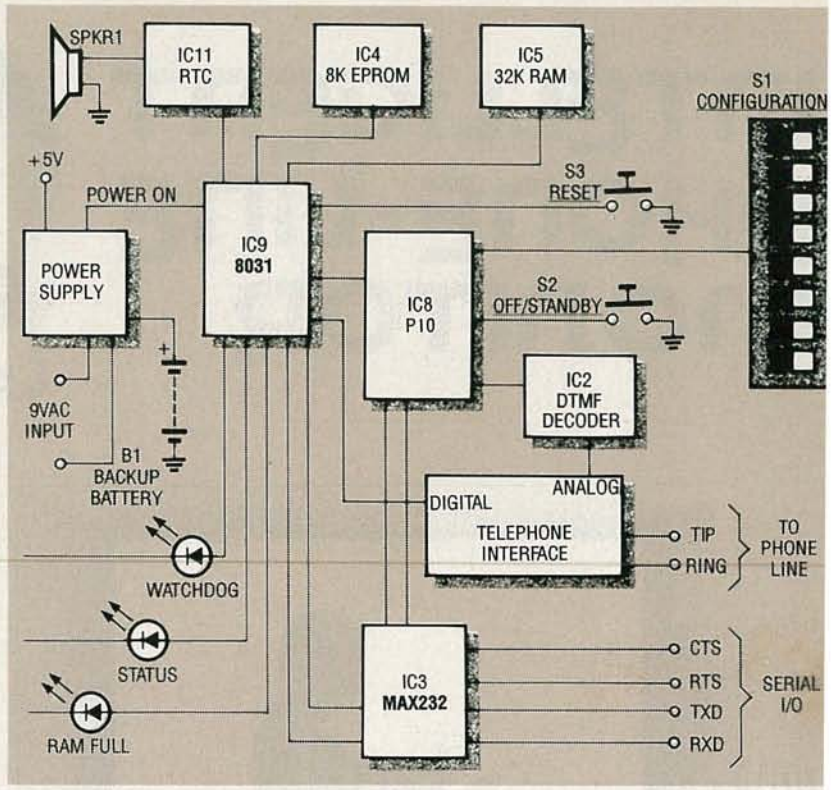


FIG. 1—BLOCK DIAGRAM shows the three major sections of the circuit: the micr processor and memory circuit, the phone-line interface, the power supply, and t switches, LED's, and speaker.

Circuit overview

A block diagram of the circuit is shown in Fig. 1. Intelligence is provided by IC9, an 80C31. That popular 40-pin Intel device contains an 8-bit CPU, 128 bytes of internal RAM, 32 programmable I/O ports, two timer/event counters, serial input and output lines, and 64K address spaces each for program and data memory. Telephone interface circuitry cleans up the audio and feeds it to DTMF (Dual-Tone, Multi-Frequcncy) decoder IC2, which drives a parallel input/output (PIO) expander, IC8. The line interface also provides a digital interrupt signal so that the microprocessor will know when something is happening on the line. A MAX232 buffers serial inputs and outputs from the microprocessor and provides RS-232 signal levels from a 5-volt supply; several lines from the PIO drive serial-control lines DTR (Data Terminal Ready) and CTS (Clear to Send).

Miscellaneous functions performed by the 8031 include driving several LED's for status indication, and monitoring the PWRON line from the power supply. When there is a power outage, the microprocessor senses and signals that fact both audibly and visually.

Support components include IC4 and IC5, which provide 8K of program and 32K of data storage, respectively. A realtime clock (IC11) allows the unit to record time and data of each call

TABLE 1—DIGICALL FEATURES

- Stand-alone operation while recording calls
- PC interface uses standard serial COM port
- Turn-on chime reminder
- Real time clock
- 32K buffer stores more than 1550 calls
- Built-in hardware diagnostic utilities
- Battery backup with alarm
- RAM full visual/audible alarm
- Data sorting, formatting and printing features
- Hardcopy and disk file report output
- Export feature compatible with many spradhsheet programs
- Supports popular PC/XT/AT video formats, including 50-line VGA color
- Account Group Recording (9999 accounts)
- Total Cost less than $200

accurately; it also contai some RAM for intermediate da storage, and drives SPKR1 f audible signalling. An 82C (IC8) provides 24 bits of I/O f interfacing the DTMF decod configuration switch S1, a the serial I/O control lines (D and CTS).

Circuit details

Due to its size, the schema cannot be presented in o piece. Instead we present it several sections: micr processor, memory, and dec ing (Fig. 2); telephone interfa (Fig. 3); miscellaneous (Fig. and power supply (Fig. 5). W start with the microprocess section.

The 8031 requires an 8- latch (a 74HCT373) to c multiplex the low-order mem address. The latch holds the a dress presented by the mic processor on the falling edge ALE (IC9, pin 30). Whenever A is low, those same 8 bits fu tion as the data bus.

The 8031 has separate 6 program and data spaces. T data space consists of 32K

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted
R1, R2—100,000 ohms
R3, R10, R13—470,000 ohms
R4–R6—22,000 ohms
R7, R14—470 ohms
R8—56,000 ohms
R9, R11, R12, R28—47,000 ohms
R15—1 megohm
R21, R23, R25—220 ohms
R17—10,000 ohms
R18, R29—1000 ohms
R19—100 ohms
R20, R22, R24—10,000 ohms
R30—10 megohms
R31—470 ohms, ½ watt

Capacitors
C1, C2—0.001 μF, 100 volts, polyester, radial lead
C3, C14—0.01 μF, 100 volts, polyester, radial lead
C4, C7, C15–C21, C28, C31, C32—0.1 μF, 50 volts, monolithic, radial lead
C5, C6, C8–C13, C22, C25, C33—10 μF, 16 volts, electrolytic, radial lead
C23, C24, C27—27 pF, 100 volts, ceramic
C26—5–35 pF, variable, top adjust, 5 mm, PCB mount
C29—1000 μF, 16 volts, electrolytic, axial lead

Semiconductors
BR1—DB103, 200 volts, 1 amp, bridge rectifier, DIP package
BR2—W005M, 50 volts, 1 amp, bridge rectifier
LED1, LED2—Not used
LED3, LED5—LED, red, T-1¾
LED4—LED, green, T-1¾
D1–D7—1N4148 or 1N914 switching diode
D8—1N4732A, 4.7 volts, 1 watt, Zener diode
D9, D10—1N4001, 50 volts, 1 amp, rectifier
Q1–Q4—2N2222, general-purpose transistor
IC1—LM324, low-power op-amp
IC2—75T204 (SSI204) or 75T202 (SSI202) DTMF decoder (see text)
IC3—MAX232 or ICL232, 5-volt RS-232 driver
IC4—27C64-2, 8K CMOS EPROM
IC5—M5M5256A or HM62256LP-15, 32K × 8 static RAM
IC6—74HCT373, CMOS 8-bit latch
IC7—74HCT138, CMOS 3-to-8 line decoder
IC8—82C55A, CMOS peripheral interface
IC9—80C31 or 80C32, CMOS microprocessor
IC10—74HCT14, CMOS hex inverter
IC11—MC146818A, realtime clock with RAM (see text)
IC12—LM2940T, 5 volts, 1 amp, low-power regulator

Other Components
B1—6 NI-Cd AA Cells, 400–600 mAH
P1—6-pin, 0.1" header connector
SPKR1—8-ohms, 1½"
S1—8-position DIP switch
S2—SPST, normally open, momentary, PC board mount
S3—SPST, normally open, momentary, panel mount
XTAL1—3.58 MHz, HC-18
XTAL2—11.0592 MHz, HC-18
XTAL3—4.194 MHz, HC-18
MOV1—ERZ-C07DK201U, 130 volts, 400 amps, ZNR surge suppressor
Miscellaneous: 6-cell AA battery holder, TO-220 heatsink, wall transformer (8–9 VAC, 300–1000 mA), PC board, IC sockets, enclosure (8.25 × 6.25 × 2), modular telephone line cord, assembly hardware, software.

Note: The following parts are available from Digital Products Company, Attn: Thomas E. Black, 134 Windstar Circle, Folsom, CA 95630: Complete kit of PC-board and parts without enclosure, $169.95; printed circuit board #DC001, $42.50; 75T204 DTMF decoder $14.50, programmed EPROM, $16.50, software on disk (5.25" only), $7.50. All orders add $3.75 S&H. CA residents add CA tax. U.S. funds only, no foreign shipments. Personal and business checks allow 3–4 weeks. No COD's or bank cards accepted. Prices subject to change.

static RAM (IC5), which occupies the lower 32K of memory. The realtime clock (IC11), and the peripheral interface (IC8) share the upper 16K of the address space, as decoded by IC7, beginning at C000h. Outputs of IC7 are enabled at 100h intervals, i.e., the realtime clock is addressed at C000h, the PIO at C100h, and the remaining outputs are unused.

Current time and date are maintained by realtime clock IC11, an MC146818A, which also has a simple square-wave tone generator and 50 bytes of RAM. The RAM serves as a buffer for incoming RS-232 data; Digi-Call uses the square-wave generator portion for audible signalling.

The EPROM (IC4) contains all system code; it is accessed beginning at 0000h whenever $\overline{\text{PSEN}}$ is low.

Telephone interface

The key to Digi-Call's operation is its telephone interface, shown in Fig. 3. Note that this circuit uses two separate grounds: analog and digital. Electrically, they meet at a common point near the power-supply ground. To avoid noise problems, the two ground circuits must remain separate except where they meet at the power supply. (Our PC board ensures that that is so.)

Digi-Call determines the status of the phone line by watching the voltages present on it. A standard phone line sits at −48-volts DC when not in use (when it is on-hook). When the phone is in use (when it is off-hook) the nominal voltage is about −7-volts DC. When the phone rings, a 90-volt, 20-Hz AC signal appears across the line.

When you dial a number using a rotary-dial phone (or the pulse-dial option on a modern phone, modem, or fax machine), what happens is that the device interrupts phone-line current, thereby causing line voltage to swing between the off- and the on-hook voltages. For instance, dialing the digit "9" causes nine oscillations between the two voltages, usually at a rate of about ten pulses per second. Rather than interrupt the flow of current, pushbutton phones usually send DTMF tones, which we will describe momentarily.

The telephone interface connects to the phone line at the tip

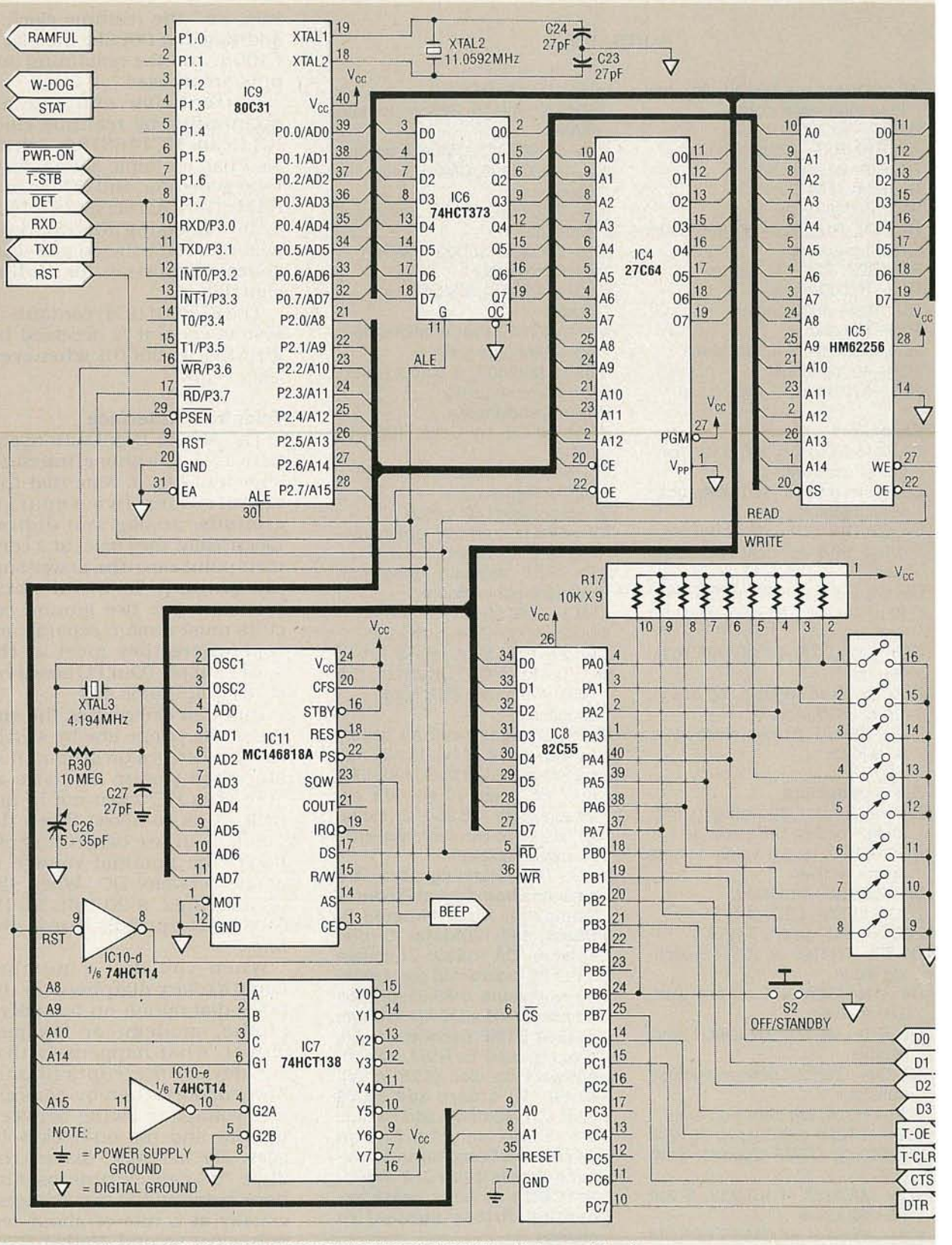


FIG. 2—DETAILS OF THE MICROPROCESSOR/MEMORY CIRCUIT, which consists of an 80C31 microprocessor, 32K of static RAM, and 8K of EPROM-based realtime software.

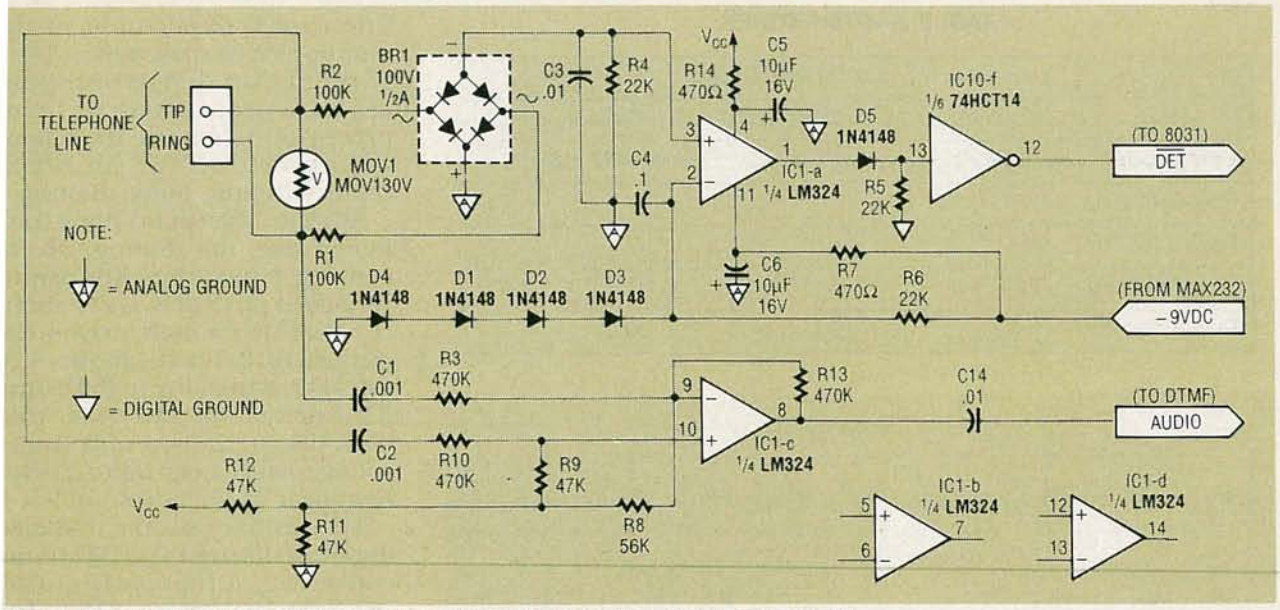


FIG. 3—TELEPHONE-LINE INTERFACE presents a high-impedance interface to avoid line loading. Note the use of separate analog and digital grounds.

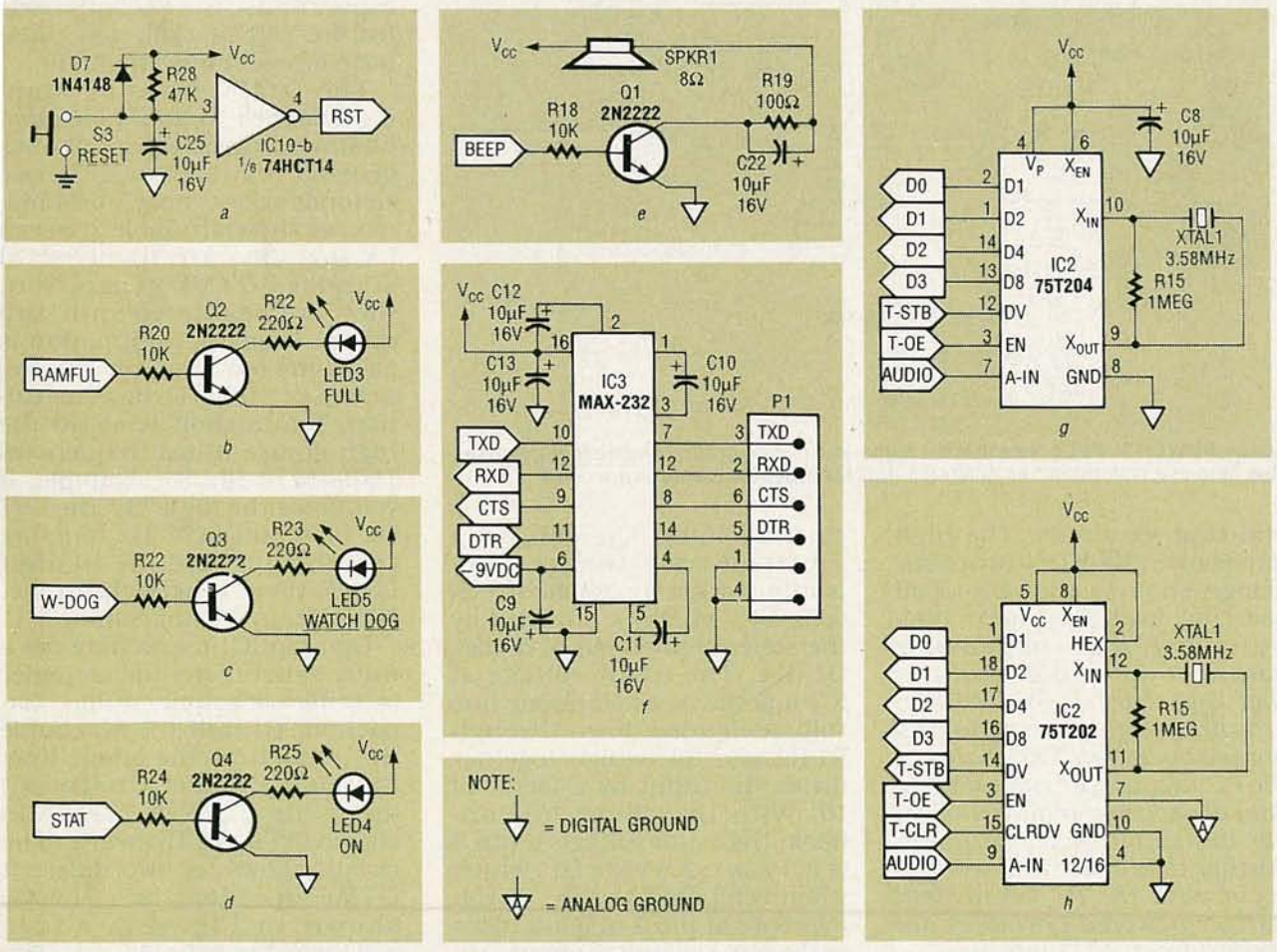


FIG. 4—MISCELLANEOUS CIRCUITS: (a) shows the reset circuit; (b), (c), and (D) show the status LED drivers; (e) shows the speaker driver; (f) shows the RS-232 interface; (g) and (h) show the DTMF interfaces. Use only one of (g) or (h), depending on the availability of DTMF decoder IC's.

TABLE 2—DTMF TONES

	High Group		
	Column 0	Column 1	Column 2
Low Group	1209 Hz	1336 Hz	1477 Hz
Row 0, 697 Hz	1	2	3
Row 1, 770 Hz	4	5	6
Row 2, 852 Hz	7	8	9
Row 3, 941 Hz	*	0	#

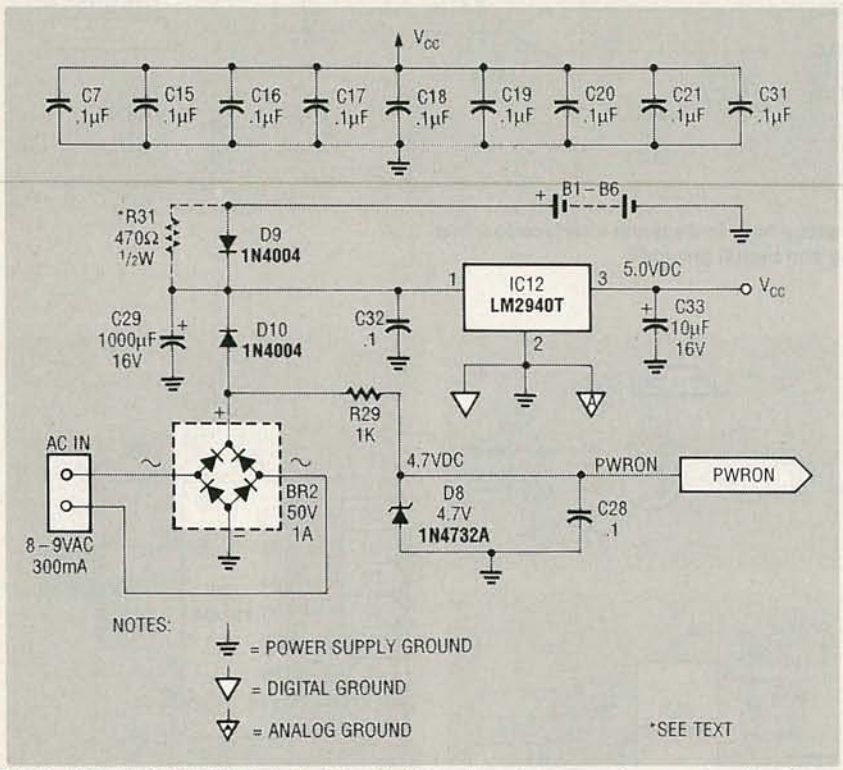


FIG. 5—POWER SUPPLY. Note that the digital and analog grounds come together here. Also note that R31 should be deleted if nonrechargeable batteries are used.

and ring terminals. The high impedance (200K) nature of our design ensures that Digi-Call does not load the phone line. *Note: The high-impedance nature of the circuit requires that Digi-Call be isolated from grounded equipment during normal operation. Only connect the PC's serial port cable during data downloads; remove the cable immediately when done. Further data recording will not occur with the PC connected! Battery-powered portables are exempt from this limitation.*

Surge absorber MOV1 provides protection against lightning strikes. Bridge rectifier BR1 provides polarity protection; BR1 also rectifies the AC ringer voltage. Op-amp IC1-a functions as a voltage comparator with a threshold of −2-volts DC, which is provided by the series connection of diodes D1–D4. The input voltage at IC1-a is the rectified phone line voltage divided down through R1/R2 and R4, which together divide the input by a factor of 10. With the phone line on-hook, the input voltage at pin 3 of IC1-a is −4.8-volts DC, which when compared to the −2-volt reference at pin 2 of IC1-a, drives the pin-1 output to about −9-volts DC. Diode D5 blocks this negative voltage, which would harm IC1-f; that input is normally pulled low by R5. The output of IC1-f, $\overline{\text{DET}}$, drives the interrupt 0 ($\overline{\text{INT0}}$) input of t microprocessor, as well as bit of input port 1. The interru feature helps the micr processor determine the follo ing states: off- or on-hoo phone-ringing, pulse dialing.

All states except on-hook (i. not in use, not dialing, no i coming ring) force the inp voltage at pin 3 of IC1-a to abo −1-volt DC, which drives t output of IC1-a to about + volts DC, which through D5 a IC1-f drives $\overline{\text{DET}}$ low. Note th both dialing pulses and ring voltages will cause digital puls to appear at the output of IC1

The primary source of dial digits is through the DTMF coder, IC2. Although Digi-C can recognize pulse-dialed d its, tone dialing is faster, and now the standard dialing pra tice in most areas. Also, if y expect to use the Account Co feature of Digi-Call, you mu have tone-dialing capability.

The DTMF encoding sta dard defines 16 dual-tone co binations, but standard phon generate only 12 of them. Th 12 tones arise from a 3-by-4 m trix, as shown in Table 2. Sev frequencies are involved standard DTMF generatic they are separated into t groups. The row information called the low group; it has f quencies 697–941 Hz. The c umn information is called high group; it has frequenc 1209–1477 Hz. For example you press the digit "3," the 6 Hz tone and 1477 Hz tone combined. (Note: In 16-di DTMF, there is an eighth to 1633 Hz, in a third column.)

Op-amp IC1-c functions a unity-gain differential ampli to buffer telephone audio. pacitors C1 and C2 AC-cou the audio from the phone li the pin-8 output of IC1-c (AUI drives the DTMF decoder (I shown in Figure 4) directly. (T circuit allows for two differ DTMF decoders, a 75T2 shown in Fig. 4-g, an 75T202, shown in Fig. 4-h. PC board allows use of eith The DTMF decoder incor rates switched-capacitor fil ing to separate the low- a

continued on page

RICHARD D. TENNEY

SINGLE-CHIP MESSAGING SYSTEM

Our one-chip voice messaging system makes it easy to add audio-storage capability to your next project!

ALKING DEVICES SEEM TO BE ALL round us today. Virtually everyhere we go we're being spoken o by vending machines, arcade ames, toys, cars, and even omputer-spoken junk phone alls! There seems to be no limit o applications for devices that imic the human voice, but the uality of the voice emanating rom most talking devices has everal serious flaws. It's usully monotone, lacking the natral inflection of real speech, nd has less than adequate nunciation. In other words, nost machine speech sounds robotic." Worse yet is the neessity of programming a ROM Read Only Memory) in order to hange the message. It's obious that the standard soluions are less than ideal.

The ISD 1016 Single-Chip oice Messaging System (Inforation Storage Devices, Inc., ustin, TX) eliminates all those lrawbacks while at the same ime introducing several feaures and functions which greatly enhance its versatility nd simplify system design.

Features

As the industry's first non-volatile analog storage chip, the ISD 1016 can record and play back up to 16 seconds of analog, or "audio" information. All analog signal conditioning circuits, amplification, and digital control circuits are contained in the single 28-pin package. Therefore, a complete voice record/playback system can be implemented by simply connecting an external microphone and speaker, and a few capacitors, resistors, and switches to the analog storage chip.

Several configuration options are available including multiple message, continuous repeat, and fast forward. These options are in addition to, but mutually exclusive of, the message addressing mode, which allows the user to directly address any segment of the analog storage array. By offering capabilities such as direct analog input, analog storage, and analog output, the ISD 1016 provides a high-grade voice record and playback system.

Novel approach

Key to the ISD 1016 is the unique method of storing the analog signal. Conventional circuits first sample the incoming analog signal and send it to an A/D converter that provides a digital output, typically eight bits wide, which is proportional to the amplitude of the incoming signal. Therefore, this method requires at least eight bits of storage per sample. Playback of the data requires that the eight bits of digital data be sent to a D/A converter to reproduce the original analog signal.

The ISD 1016 eliminates the A/D and D/A conversions by using CMOS EEPROM (Electrically Eraseable Programmable Read Only Memory) technology and storing the sampled data as an analog level in the EEPROM storage array. This method requires only one cell per sample and has the added advantage of being nonvolatile. The signal can be stored for ten or more years without power.

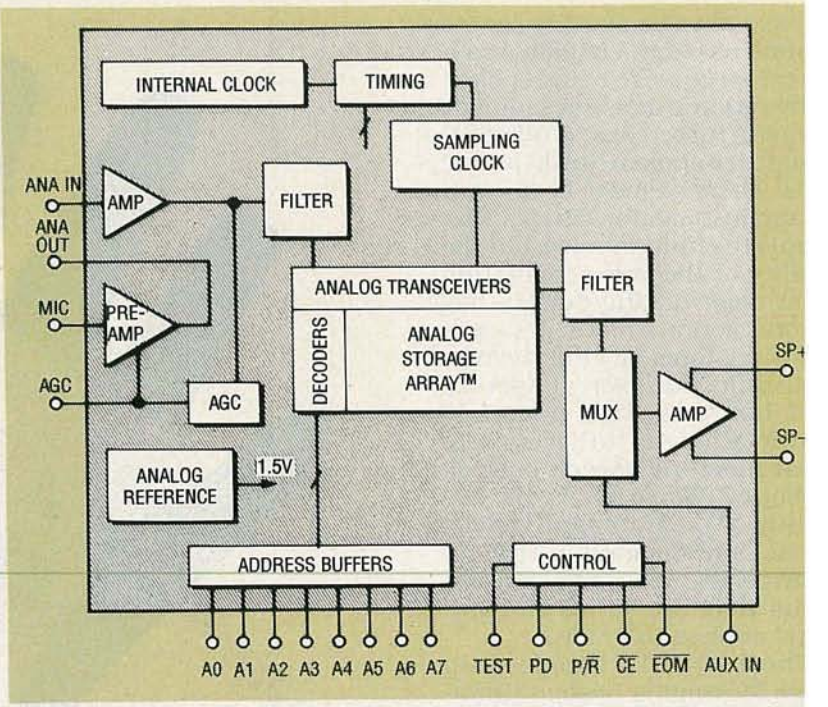


FIG. 1—FUNCTIONAL BLOCK DIAGRAM OF THE ISD 1016. The microphone signa capacitively coupled to the input preamp, and the gain of the preamp is dynamic adjusted by the AGC circuit.

PARTS LIST

All resistors are ¼-watt, 10%, unless otherwise noted.
R1—2000 ohms
R2—10,000 ohms
R3—470,000 ohms
R4—1000 ohms × 9, 10-pin SIP resistor
Capacitors
C1, C4—22 µF, 16 volts, tantalum
C2, C6—0.1 µF, ceramic
C3—4.7 µF, 16 volts tantalum
C5—0.22 µF, polystyrene
C7—1 µF, 16 volts, tantalum
Semiconductors
IC1—ISD 1016 Voice Messaging System
Other components
S1–S3—SPDT miniature slide switch
S4—8 position DIP switch
MIC1—miniature electret microphone
Miscellaneous: 28-pin IC socket, 16-ohm speaker, power source of at least 5 volts, wire, solder, etc.
Note: The following items are available from R. Tenney, 33 Eastmeadow Way, Manchester, N.H. 03109:
- **ISD 1016 IC—$35.00**
- **Etched and drilled PC board—$9.75**
- **A kit of all parts except speaker—$55.00.**

Please add $2.50 postage and handling.

How it works

Figure 1 shows the functional block diagram of the ISD 1016. The microphone signal is capacitively coupled to the input preamp. The gain of the preamp is dynamically adjusted by the AGC (Automatic Gain Control) circuit, which reduces the gain of the preamp for large input signal levels, and increases it for lower-level signals, thereby expanding the range of input signal levels that can be accommodated without distortion.

The output of the preamp is then coupled to an additional amplifier stage through an external capacitor. This stage has two main functions. One is to provide an input to the AGC circuitry so it can adjust the gain of the preamp according to the strength of the incoming signal. The second role of this stage is to drive the filter network which will remove noise and other unwanted signals outside of its passband.

The gain-adjusted and filte signal is then fed to the ana transceivers. In the rec mode, these transceivers t their input from the input fi and send the signal to the a log storage array. In playb mode they take their input fr the analog storage array a send it to the output filter n work.

Timing circuitry interna the ISD 1016 synchronizes operation of the analog stor array and the analog tra ceivers, and also generate sampling clock. The analog dio input signal is sampled that clock at an 8-kHz ra which is adequate for an au passband of 3.4 kHz (about same as a telephone), and stored in the analog storage ray as a voltage level. Dur playback, the storage array sampled and sent to the out filter via the analog tra ceivers. This filtered signa then sent to one input of analog multiplexer, which select one of its two inputs drive the power amp. In p back mode, the stored mess will be selected, amplified, sent to the speaker. When no record mode, and not play

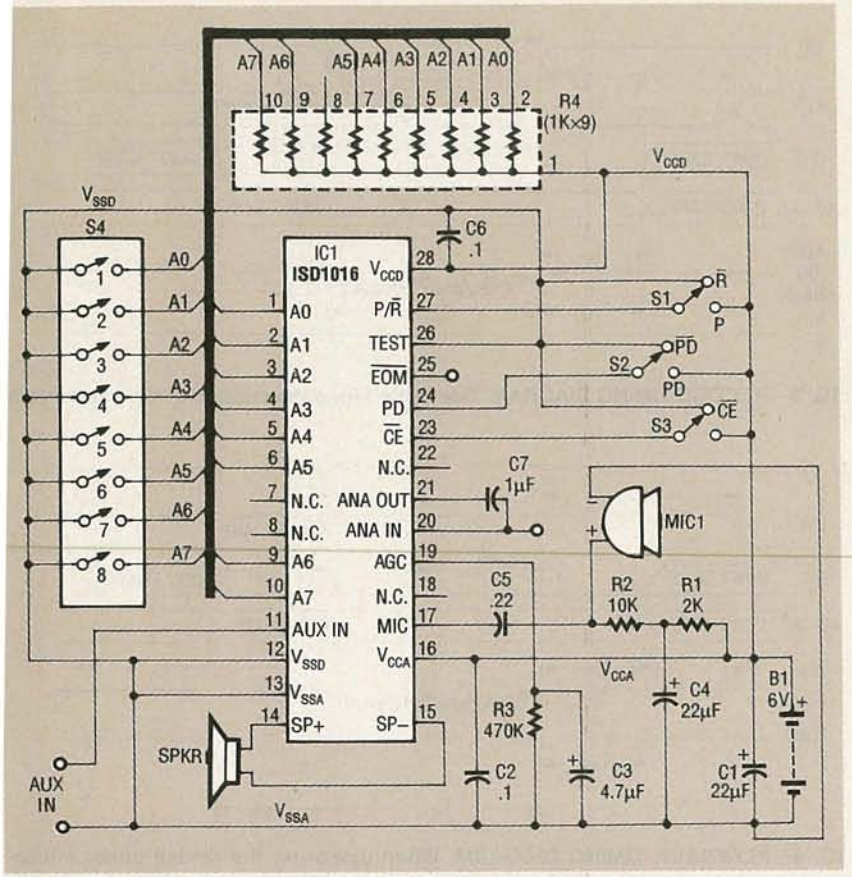


FIG. 2—SCHEMATIC DIAGRAM of the complete voice recording and playback system capable of storing up to 16 seconds of telephone-grade audio.

back a message, the multiplexer will select the auxiliary input as its source, thus allowing us to take advantage of the output amplifier when the ISD 1016 is otherwise idle.

Circuit details

Figure 2 shows the schematic diagram of a complete voice recording and playback system that is capable of storing up to 16 seconds of telephone-grade audio. Before we go over the schematic, let's go over the pin functions of the ISD 1016 to make it easier to understand the overall operation of the circuit.

- Microphone Input (MIC), pin 17—An external microphone is coupled to this input through a series capacitor. The value of the capacitor and the 10K internal resistance of the input determines the low-frequency cutoff for the ISD 1016. A good-quality omni-directional electret microphone is recommended. Its impedance should be about 1K, sensitivity 64 dB, frequency response 50 Hz to 8 kHz, and S/N ratio greater than 40 dB. Refer to the parts list for sources.
- Analog Out (ANA OUT), pin 21—The amplified analog input signal appears on the analog output pin. The gain of the preamp is determined by the voltage level at the AGC pin. Maximum gain is about 24 dB for low-level signals.
- Analog Input (ANA IN), pin 20—This pin has two roles. The analog output (pin 21) of the preamp can be coupled via an external capacitor to this analog input pin. The value of the capacitor and the 2.7K input resistance of this input pin can provide additional cutoff at the low-frequency end of the passband. Alternatively, this pin can be used to input analog signals other than the microphone signal.
- Automatic Gain Control (AGC), pin 19—As described in the section on the block diagram, the AGC circuit will dynamically adjust the gain of the preamp. Peak output voltages of the preamp will be detected and charge an external capacitor. The time it takes for the capacitor to charge to a level that will start to reduce the gain of the preamp (about 1.8V) is known as the "attack time," and is determined by the value of the capacitor and the 5K internal resistance of the AGC input. The "release time" of the AGC is determined by this capacitor in parallel with an external resistor.
- Speaker Outputs (SP+), pin 14 and (SP–), pin 15—The ISD 1016 can directly drive speakers with impedances as low as 16 ohms. The maximum output power of 50 mW is achieved when the speaker is connected between these two pins. In that configuration no coupling capacitor is required. The device can be used in a single-ended configuration; however, an AC coupling capacitor must be used and the output power will be reduced to about 12 mW. While recording, the speaker outputs are disabled. An 8-ohm speaker can be used, but the volume will be louder and some audio distortion can result.
- Power Down (PD), pin 24—This pin serves two purposes in the operation of the chip. First, it provides a low-power mode when the ISD 1016 is at idle (not recording or playing back) and the pin is high. The second function of this pin is to provide a means to reset the address counter. Whenever the ISD 1016 reaches overflow (after 16 seconds total record or playback time) the address counter is at its maximum recording count (9Fh) and an $\overline{\text{EOM}}$ (end of message) pulse will be generated. Activating $\overline{\text{CE}}$ (chip enable) will not restart the device until PD was cycled high and low. NOTE: When recording multiple messages, the user should terminate each message by disabling $\overline{\text{CE}}$ while keeping PD low. That will prevent the address counters from getting reset to zero at the start of the subsequent message, thereby causing the previous message to be overwritten.

• Chip Enable ($\overline{CE}$), pin 23—When taken low, this pin enables all playback and record operations. The address and play/record inputs that meet the setup time (300 ns) are latched on this falling edge. When this pin is taken high, the ISD 1016 is deselected and the auxiliary input is selected as the input to the output power amp.

• Play/Record (P/$\overline{R}$), pin 27—The state of this input is latched into the ISD 1016 on the falling edge of $\overline{CE}$ (along with the address inputs (A0–A7). A logic high selects playback mode and a logic low selects a record operation. The message to be played will start at the address latched when $\overline{CE}$ went low. The message will continue until an $\overline{EOM}$ (end of message) is encountered on pin 25. The $\overline{EOM}$ bit is automatically inserted during a record operation when the storage area is full or when the record operation is terminated by PD going low or $\overline{CE}$ going high. If multiple messages have been recorded, $\overline{CE}$ should be pulsed low for the device to play back a single message. If $\overline{CE}$ is held low (active), all the stored messages will be played back in sequence.

• Address Inputs (A0–A7), pins 1–6, 9, 10—Two functions are performed by the address inputs: mode and option selection, and message address. The ISD 1016 has two modes of operation, Address Mode and Configuration Mode. Address bits 6 and 7 determine which mode will be selected. If either bit 6 or bit 7 is low, Address Mode will be selected. In that mode the address pins specify the starting address of the operation to be performed. If both address 6 and 7 are high, the configuration mode is selected. Table 3 lists the configuration mode options. Of the options listed, continuous repeat and multiple message recording can be of the most use to the experimenter. Further details of their use can be found in the section on "Modes of Operation."

• End Of Message ($\overline{EOM}$), pin 25—At the end of each recorded message, an $\overline{EOM}$ marker is automatically inserted in a nonvolatile register. The $\overline{EOM}$ output will go low at the end of each message and at message overflow. The width of the negative pulse is 12.5 ms minimum. Another function of $\overline{EOM}$ is as a low-power indicator. If power to the chip should drop below 3.5V, $\overline{EOM}$ will be forced low and the ISD 1016 placed in playback mode. This feature helps prevent recording while in an unreliable power condition.

• Auxiliary Input (AUX IN), pin 11—As explained earlier, AUX IN is selected as the input to the output power amplifier when either $\overline{EOM}$ is true or $\overline{CE}$ is not true, thus allowing us to take advantage of the amplifier for other uses when the ISD 1016 is otherwise inactive.

• 5-volt Analog and Digital Power Inputs (V_{CCA}), pin 16 and (V_{CCD}), pin 28—The ISD 1016 voice messaging system chip incorporates both digital and analog circuitry. The digital circuitry generates considerable noise from rapid switching of gates within the device, as does any other digital device. The noise is easily detected by the analog c cuitry and can, therefore, be corded as noise in the anal signal. For that reason, separa power and ground buses a provided for the analog and d ital portions of the device. that manner, currents flowi in the digital portions of the c vice cannot cause significa voltage fluctuations in the ar log power buses. The two pow pins should be connected gether as close as possible to t power source. That is the o location where the two pow busses should be connected gether. If another direct conn tion between V_{CCA} and V_C were to be made at any oth point, a "loop" would be form and slight voltage differenc between the two points wou cause unwanted currents flow in this loop, providing a other source of noise.

• Analog and Digital Grou Connections (V_{SSA}), pin 13 a (V_{SSD}), pin 12—NOTE: T ground connections for the I 1016 do not conform to a st

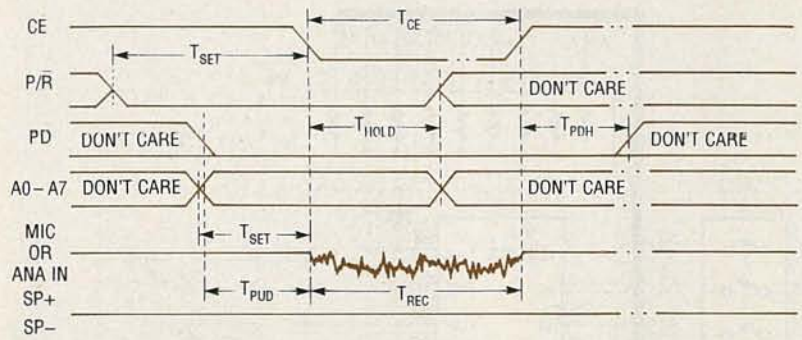


FIG. 3—RECORD TIMING DIAGRAM. See Table 1 for a description of the paramete

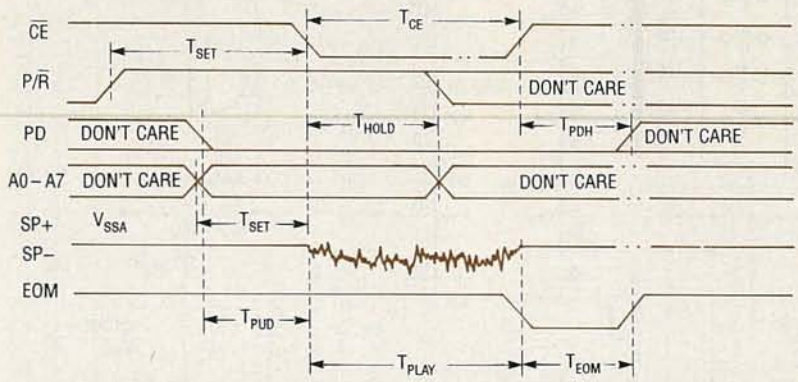
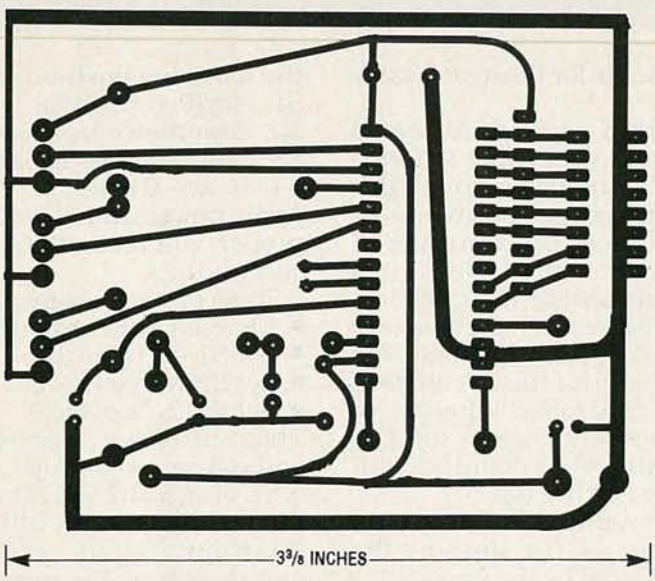


FIG. 4—PLAYBACK TIMING DIAGRAM. When operating the device under micr processor control or other high-speed device, these parameters must be considere

TABLE 1—TIMING & VOLTAGE PARAMETERS

Symbol	Parameter	Value
FS	Sampling Freq.	8 kHz
BW	Bandwidth	3400 Hz typ.
P_{OUT}	Speaker Output Power	50 mW max.
V_{IN1}	Mic Input Voltage	20 mV max. p-p
V_{IN2}	Ana Input Voltage	80 mV max. p-p
V_{IN3}	Aux Input Voltage	1.25 V max. p-p
T_{SET}	Control/Address Set-up	300 ns min.
T_{HOLD}	Control/Address Hold	0 ns max.
T_{CE}	$\overline{CE}$ Record Time	100 ns min.
T_{PUD}	Power Up Delay	25 ms min.
T_{PDH}	Power Down Hold	0 ns min.
T_{REC}	Record Time	16 s max.
T_{PLAY}	Playback Time	16 s max.
T_{EOM}	$\overline{EOM}$ Pulse Width	12.5 ms typ.



FOIL PATTERN for the voice messaging system.

dard 28-pin DIP. V_{SSA} and V_{SSD} are the return paths for the analog and digital sections of the device, respectively. Follow precautions similar to those described for the power inputs. Pins 12 and 13 should be tied together at the package, and power should be decoupled using 0.1µF capacitors between V_{CC} and V_{SS}, as close as possible to the package, for both analog and digital power.

• Test Input, pin 26 (TEST)—This pin is used during the manufacturing operation prior to product shipment. For proper device operation this pin *must* be tied low.

Now that we have a better understanding of how the ISD 1016 works, let's go over the schematic (Fig. 2). Resistors R1 and R2 supply the microphone bias for the electret microphone (MIC1) recommended in the parts list. Capacitor C4 provides microphone decoupling and C5 provides input coupling and DC blocking for the microphone while also acting as a single-pole, low-frequency cutoff filter. Capacitor C7 provides AC coupling between the preamp output and the input amplifier, and also provides additional low-frequency cutoff.

Resistor R3 and capacitor C3 provide the AGC attack/release time constants. For strong input signals, the AGC circuit internal to the ISD 1016 starts charging C3. If the signal remains strong long enough for C3 to reach the AGC threshold level (about 1.8V), the gain of the preamp is reduced to prevent it from being overdriven. If the input signal level decreases, C3 starts to discharge through R3, thus increasing the gain of the preamp for low-level signals.

Capacitor C1 provides V_{CC} decoupling, C2 is the V_{CCA} high-frequency decoupling capacitor, and C6 provides the same function for V_{CCD}. C1 should be located as close to the supply as possible, and C2 should be as close to IC1 as possible. Switches S1, S2, and S3 provide the control functions for PLAYBACK/RECORD, POWERDOWN, and CHIP ENABLE inputs respectively.

Resistor R4 is a SIP (Single-Inline-Package) containing nine resistors, one of which is not used. Those pull-up resistors are used so we can implement the address switches with an inexpensive eight-position DIP switch (S4) instead of eight individual switches.

The output amplifier of the ISD 1016 is designed to drive a 16-ohm speaker; a standard 8-ohm speaker can be used, but you'll end up with slightly louder volume, slightly greater power dissipation, and some distortion. In general, the better the quality of the speaker, the better the sound quality.

Timing diagrams

Figures 3 and 4 show the timing diagrams for the record and playback modes respectively. The parameters referenced are shown in Table 1. When operating the device manually, parameters such as setup and hold times are met by simply following the recommended procedures outlined later in this article. When operating the device under microprocessor control or other high-speed device, these parameters must be considered when controlling the chip. For example, to set up for a record operation the address lines should be set by one instruction and the $\overline{CE}$ line set by a subsequent instruction to ensure the 300-ns control/address setup time (T_{SET}) is met.

Construction

A complete kit of parts, including an etched and drilled

PC board, is available from the source in the parts list. A foil pattern is provided here if you would like to make your own board. None of the component values are critical, but be sure to leave pins 7, 8, 18, and 22 unconnected, no matter what you do.

If you're making your own layout, some simple guidelines should be followed for best results. Note that V_{CCA} and V_{CCD} should be connected at one point only, right where power enters the board. Likewise, V_{SSA} and V_{SSD} should be connected together right at pins 12 and 13 of IC1. That isolates the analog signal and ground paths from the digital paths, thus reducing noise. Also, the analog components should be physically separated from the digital components for those very same reasons.

TABLE 2—OPTIONS

Function	Address Bit	Use
Playback chip enable level activated	5	Provide switch debounce
Message start pointer reset only play/record changed	4	Recording multiple messages
Continuous repeat of message	3	Continuous repeat at $\overline{EOM}$ encounter
During playback $\overline{EOM}$ pulses low at overflow only	2	Concatenate chips for longer messages
$\overline{EOM}$ markers deleted by next message	1	Assures that $\overline{EOM}$ markers are cleaned up when recording ove message
Fast forward (speaker output is disabled)	0	Selecting messages when address is unknown

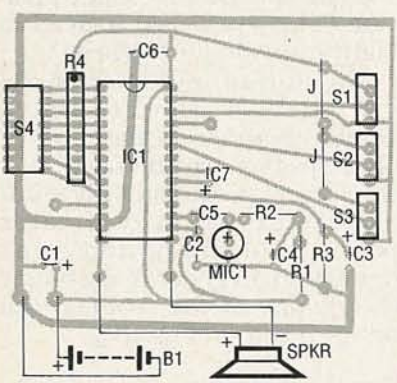


FIG. 5—PARTS PLACEMENT DIAGRAM. Mounting the DIP switch (S4) in a socket will give you convenient access to the address lines if you wish to control the circuit with a microcontroller. Be sure to position switch #1 of the DIP switch at the top.

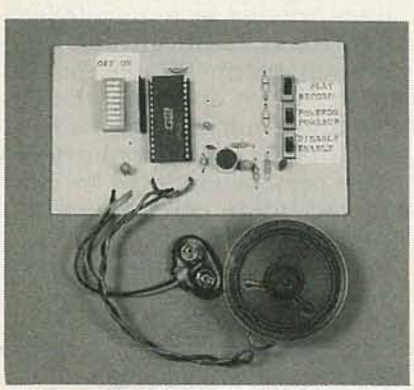


FIG. 6—THE COMPLETED PROTOTYPE. The 9-volt battery clip attaches to a 4-AA cell holder that has a matching connector; the prototype voice messaging system, therefore, is powered from a total of 6 volts.

Figure 5 shows the parts placement diagram. The ISD 1016 (IC1) should be mounted in a 28-pin socket, which can be installed now, but leave the IC out for the moment. DIP switch S4 should also be mounted in a socket to give convenient access to the address lines should you wish to control the circuit with a microcontroller. Whether or not you use a socket, the DIP switch should be mounted with switch #1 at the top.

Next mount SIP resistor R4 (with pin 1—the dot—at the top), followed by the various capacitors, discrete resistors, and the microphone. Be certain to observe polarity when installing C1, C3, C4, C7, and the microphone. Next mount switches S1–S3 and the leads for the speaker and the power source. (The prototype uses a standard 9-volt battery clip and a 4-AA cell holder that snaps onto the 9-volt clip.) Figure 6 shows the completed prototype.

After all components have been mounted, check for any shorts or solder bridges, and verify proper orientation of all components. After these checks have been made, install IC1 in its socket verifying proper orientation, and connect a speaker to the speaker terminals.

Operation

Before connecting power to the circuit, set all switches to the following positions:
S1, Play/Record—Play
S2, Powerdown/Up—Down
S3, Chip Enable—Disable
S4, A0–A7—Closed
Apply power and check for th proper voltages at IC1 befo continuing.

To record a message:
- Close all switches on S4.
- Set S1 to "Record."
- Set S2 to "Power up."
- Set S3 to "Enable."

That starts the "Record" tim and you can record up to 16 se onds of speech by speaking in the microphone, as with a tap recorder. Speak with you mouth close to the microphon in a normal voice. When you a finished recording your me sage you should:
- Set S3 to "disable."
- Set S2 to "Powerdown."
- Set S1 to "Play."

To play back a message:
- Set S1 to "Play."
- Set S2 to "Power up."
- Toggle S3 to the "Enable" sition and back to the "Disal position.

Your pre-recorded message now play back and stop at end. When the message is c plete, set S2 to the "Po down" position.

Addressing mode

The ISD 1016 has two mu ally exclusive modes of op tion: the "Addressing Mode" the "Configuration Mode." addressing mode is selec

continued on page

WORKING WITH LED DISPLAY DRIVERS

Let's take an in-depth look at LED display drivers.

RAY MARSTON

IT'S EASIER THAN YOU THINK TO DESIGN LED display drivers with National Semiconductor's LM391X and LM2917 series IC's. In this article, we'll show you how to use those IC's to build moving-dot and bar-graph voltmeters as well as frequency-to-voltage converters. We'll also give you an introduction to binary coded decimal (BCD) to 7-segment decoder/driver circuits that are commonly used in electronics design.

LM391X-series basics

National Semiconductor's LM391X dot/bar display drivers are versatile 18-pin DIP IC's that can be used to drive up to 10 LED's in either dot or bar mode. The three members of the LM391X display driver series are the LM3914, LM3915, and LM3916. All three versions use the same basic internal circuitry, as shown in Fig. 1, but have different output scaling modes, as shown in Table 1.

The LM3914 is a linearly-scaled device that's intended for use in LED voltmeters, with the number of lit LED's being directly proportional to the input voltage (pin 5). The LM3915 is a logarithmically-scaled device that's intended for use in power meters, and spans a range of 0–30 dB in ten 3-dB steps. Finally, the LM3916 is a semi-logarithmically-scaled device that's intended for use in volume-unit (VU) meters.

Figure 1 shows an LM3914 used in a simple 10-LED voltmeter, which ranges from 0 to 1.25 volts DC. The LM3914 has 10 internal comparators, each with its non-inverting terminal connected to a specific tap on a floating, precision, 10-stage, internal resistive voltage-divider. The inverting terminals on all ten of the comparators are fed by a unity-gain buffer on pin 5. Each comparator is externally accessible, and can sink up to 30 milliamps. The sink currents are internally limited, and are externally pre-set via R1.

The LM3914 also has a floating 1.25-volt DC reference between pins 7 and 8, externally connected to the 10-stage internal voltage divider on pins 4 and

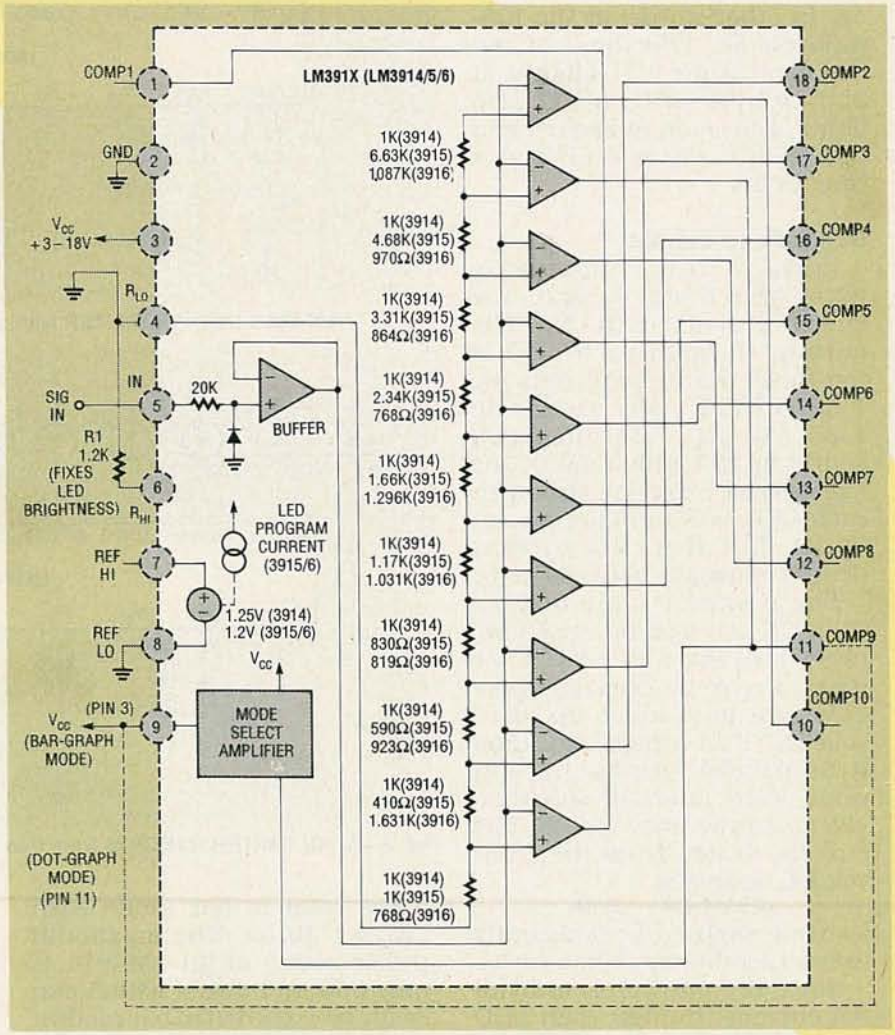


FIG. 1—INTERNAL CIRCUIT OF THE LM3914, with connections for making a 10-LED, 0 to 1.25 volts DC, linear meter using either dot or bar mode.

6. Pins 4 and 8 are grounded, so that the bottom of the 10-stage internal voltage divider is at ground, and the top is at 1.25 volts DC. The LM3914 also has an internal logic network that can be used to select either moving-dot or bar-graph mode.

If the LM3914 is set for bar mode, the 1.25-volt DC reference is connected across the 10-stage internal voltage divider. Because of the linear scaling of that divider, each succeeding inverting comparator input has an additional 0.125 volts DC applied to it.

When there is no signal on the input, pin 5 is at ground, all 10 internal comparators are disabled, and LED's 1–10 are off. With a slowly rising signal on the input, the voltage increases to 1.25 volts DC, and an LED lights for each 125-millivolt increment, until LED's 1–10 are on. In other words, at the 125-millivolt DC threshold of the first comparator, LED1 lights, at 250 millivolts DC, LED2 also lights, and so on. When used in dot mode, only one LED at a time lights.

Some finer details

In Fig. 1, R1 is connected between pins 6 and 4, fixing the current through each LED. The current through each LED is ten times that drawn from the 1.25-volt DC reference. The 1.25-volt DC reference can source up to 3 milliamps, so the maximum current through each LED is 30 milliamps, set by R1, but the LED current doesn't normally get that high.

The nominal value of 1.25 volts DC can also be varied between 1.20 and 1.32 volts DC, or its value can be externally programmed to produce up to 12 volts DC. If R1 equals 1.2K, then R1 in parallel with the full 10K value of the internal voltage divider is equivalent to 1.07K. The current drawn from the 1.25-volt DC source is

1.25 V/1.07K = 1.2 mA,

so that each LED nominally draws 12 milliamps when it's lit.

Since the maximum individual current through each LED is 30 milliamps, then the LM3914 draws up to 300 milliamps total in bar mode with LED's 1–10 on. The maximum power rating of an LM3914 is only 660 milliwatts, which can easily be exceeded in bar mode if you're not careful. The LM391X series runs on a supply of 3–25 volts DC, and the LED's can u the same voltage supply, or th can use an independent supp for minimal IC heat dissipatio

The internal voltage divide floating, with both ends ext nally available for maximu

TABLE 1—COMPARISON OF TYPICAL INPUT THRESHOLDS FOR THE LM391X IC FAMILY

LED	LM3914	LM3915		LM3916		
	V	V	dB	V	dB	VU
1	1.000	0.447	−27	0.708	−23	−20
2	2.000	0.631	−24	2.239	−13	−10
3	3.000	0.891	−21	3.162	−10	− 7
4	4.000	1.259	−18	3.981	− 8	− 5
5	5.000	1.778	−15	5.012	− 6	− 3
6	6.000	2.512	−12	6.310	− 4	− 1
7	7.000	3.548	− 9	7.079	− 3	0
8	8.000	5.012	− 6	7.943	− 2	+ 1
9	9.000	7.079	− 3	8.913	− 1	+ 2
10	10.000	10.00	0	10.000	0	+ 3

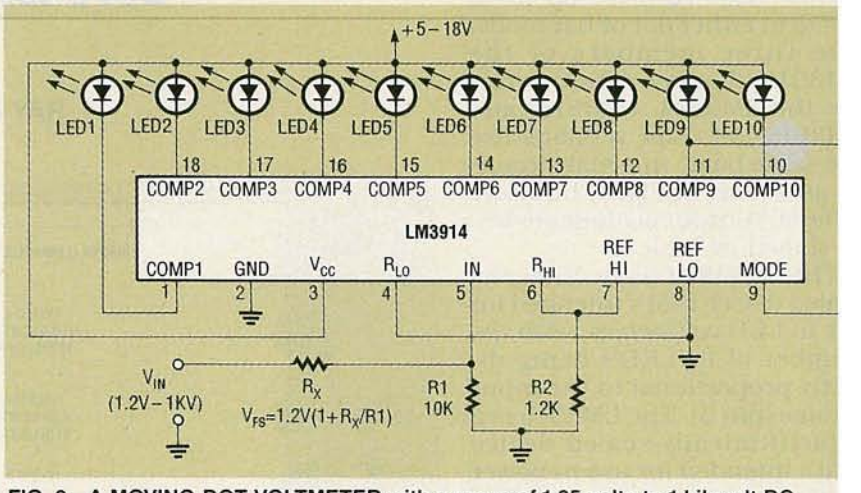


FIG. 2—A MOVING-DOT VOLTMETER with a range of 1.25 volts to 1 kilovolt DC.

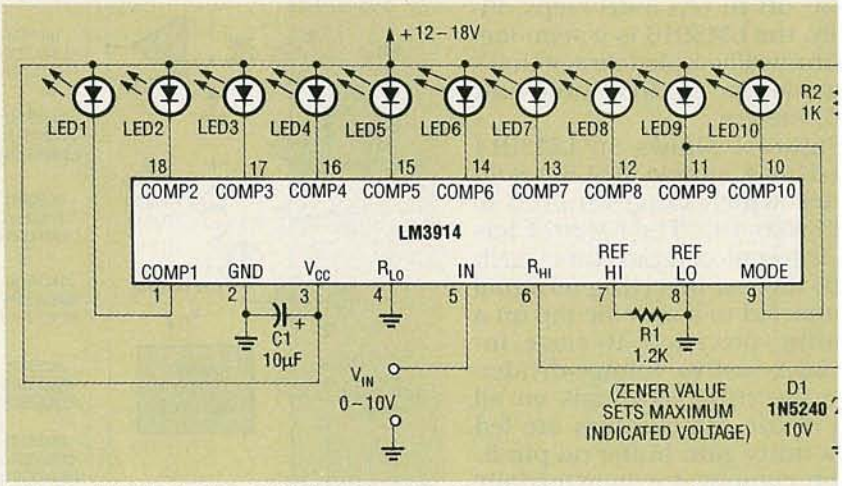
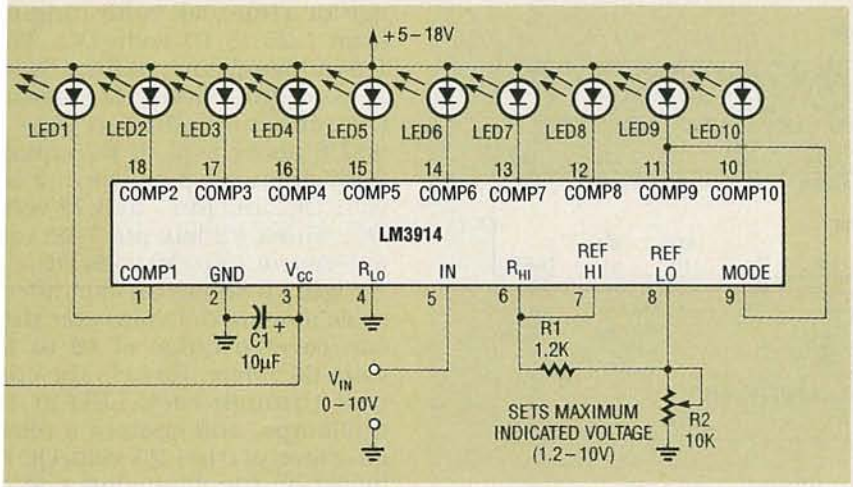
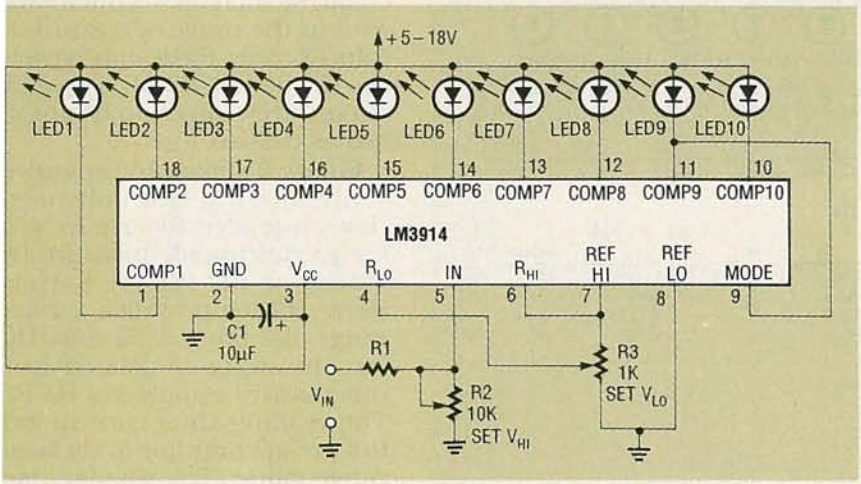


FIG. 3—A VOLTMETER RANGING from 0 to 10 volts DC using an external referenc



G. 4—AN ALTERNATE VARIABLE-RANGE voltmeter that can allow a variation in the aximum value of its range from +1.25 to 10 volts DC.



IG. 5—AN EXPANDED-SCALE MOVING-DOT voltmeter that ranges from 10 to 15 volts C.

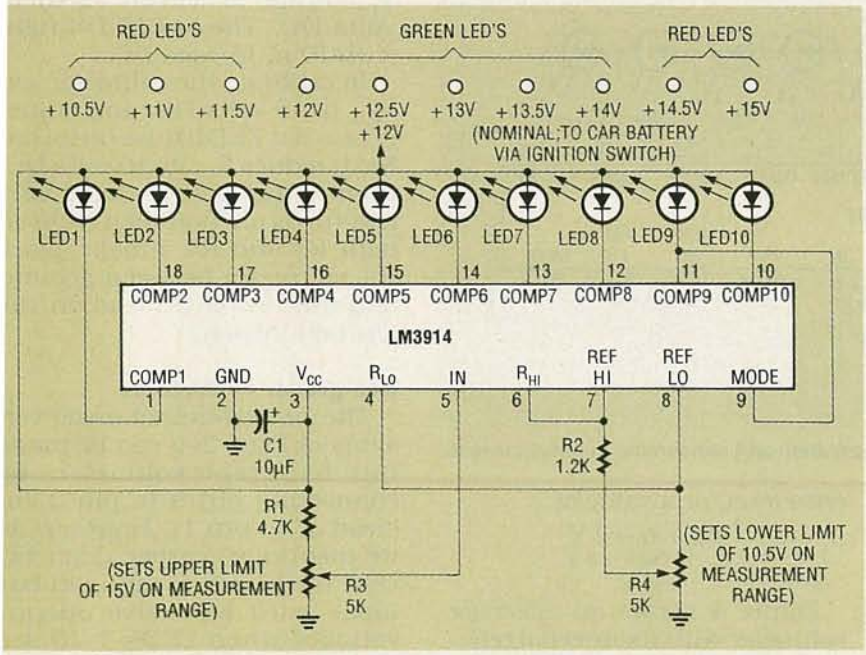


FIG. 6—AN EXPANDED-SCALE DOT-GRAPH voltmeter for use with a car battery.

versatility, and it can be powered by either the internal reference or an external source. If pin 6 is connected to 10 volts DC, then the LM3914 becomes a voltmeter ranging from 0 to +10-volts DC if pin 4 is grounded, or a restricted-range DC voltmeter ranging from 5 to 10 volts DC if pin 4 is connected to 5 volts DC.

The only constraint is that pin 4 cannot go more than 2 volts below V_{CC}. The input is fully protected against overloads up to ±35 volts DC.

As we mentioned earlier, the major difference between the three members of the LM391X family is in the weighting of the ten-stage internal voltage dividers. In the LM3914, the values are equal, producing a ten-step linear display. In the LM3915, the values are logarithmically-weighted, producing a log display spanning 30 dB in ten 3-dB steps. The values are semi-logarithmically weighted in the LM3916, producing a volume unit (VU) meter display. Let's now examine some LM391X applications, focusing on the LM3914.

Moving-dot voltmeters

Figures 2–6 show the LM3914 used in various 10-LED moving-dot voltmeters. In all of them, pin 9 is connected to pin 11, and a 10 µF capacitor is connected between pins 2 and 3 for stability.

Figure 2 shows a variable-range moving-dot voltmeter that can cover a range of 1.25 volts to 1 kilovolt DC. The low ends of the internal reference and the 10-stage internal voltage divider are grounded, while the top ends are joined. The voltmeter has a basic full-scale sensitivity of 1.25 volts DC, with variable ranging provided by voltage divider Rx-R1. When Rx equals 0 ohms, the full-scale value is 1.25 volts DC, and when Rx equals 90K, the full-scale value is 12.5 volts DC. Also, R2 is connected across the internal reference and sets the current through each LED at 10 milliamps, as before.

Figure 3 shows a fixed-range moving-dot voltmeter that can

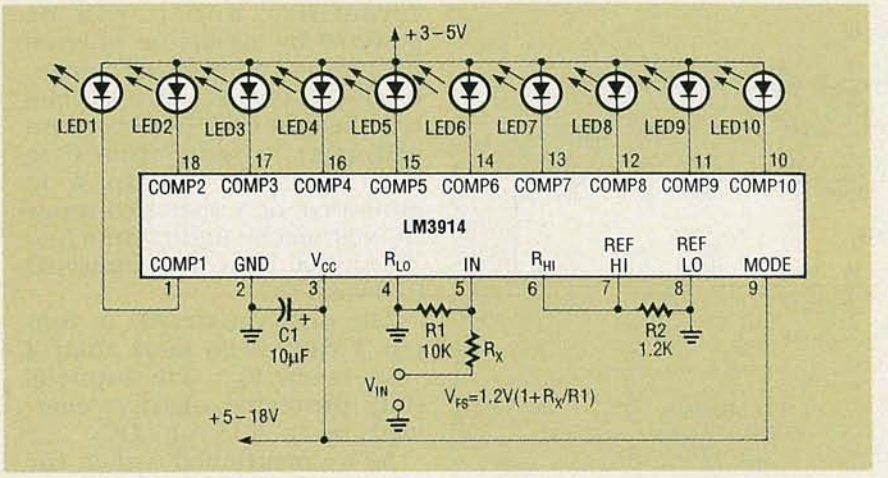


FIG. 7—A BAR-GRAPH VOLTMETER USING a separate supply for LED's 1–10.

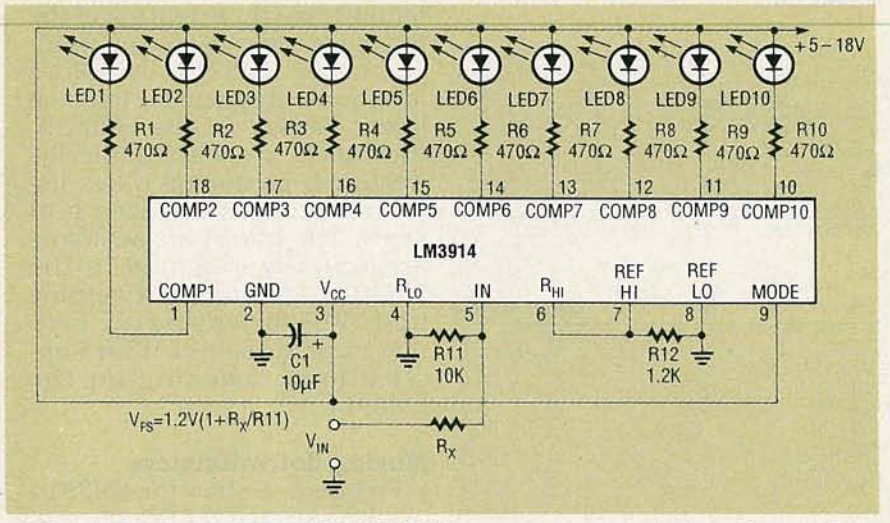


FIG. 8—A BAR-GRAPH VOLTMETER USING a common supply for both IC1 and LED's 1–10.

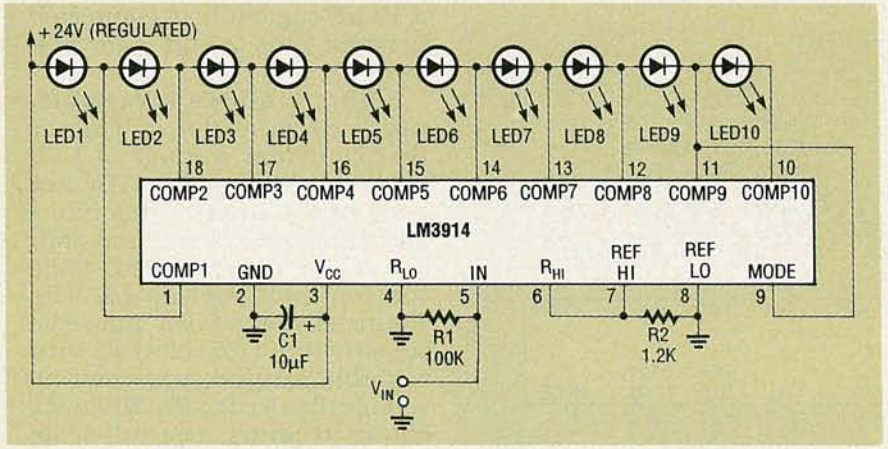


FIG. 9—A BAR-GRAPH USING dot-mode operation and consuming minimal current.

cover a range of 0 to 10 volts DC. It uses an external Zener diode reference D1 going to the top of the 10-stage internal voltage divider for a 10-volt DC reference. Also, the supply must be at least 2 volts DC above the Zener reference level, or a value of

$$V_{CC} = V_{D1} + 2\ V$$
$$= 10\ V + 2\ V,$$
$$= 12\ V.$$

Figure 4 shows an alternate voltmeter with its internal reference providing a variable voltage for a full-scale value rangi from 1.25 to 10 volts DC. T 1.2-milliamp current fixed by goes to ground via R2, raisi the reference value on pins and 8 above zero. If R2 equ 2.4K, then pin 8 will be at 2. volts DC, and pin 7 at 3.75 vo DC. Thus, R2 lets pin 7 be v ied from 1.25 to 10 volts DC.

Figure 5 shows an expand scale moving-dot voltmeter t can cover a range of 10 to volts DC. Here, R3 sets the c rent through each LED at milliamps, and enables a ref ence level of 0 to 1.25-volts DC be set on pin 4, the low end the 10-stage internal voltage vider. If R3 is set for 0.8 volts on pin 4, then the voltmeter read in the range of 0.8 to 1. volts DC only. By designing v age divider R1-R2 for a spec circuit, the range can be am fied as desired.

Figure 6 shows an expand scale moving-dot voltme that's intended for use in y car to continually measure status of its 12-volt batte Here, R2-R4 provides a ba range of 2.50 to 3.75 volts but the input is derived fr the positive supply via R1- The reading thus correspo to a pre-set multiple of the ba range value. The display u red and green LED's, with green LED's lighting when V_{CC} range is within 12 to volts DC. The red LED's li with 10 to 15 volts DC.

To calibrate the voltmeter, V_{CC} to 15 volts DC, and adj R3 so that LED10 just turns Next, reduce V_{CC} to 10 volts then adjust R4 so that LE just turns on, and then rech both R3 and R4. Finally, pl the voltmeter between grou and the 12-volt-DC lead on ignition switch.

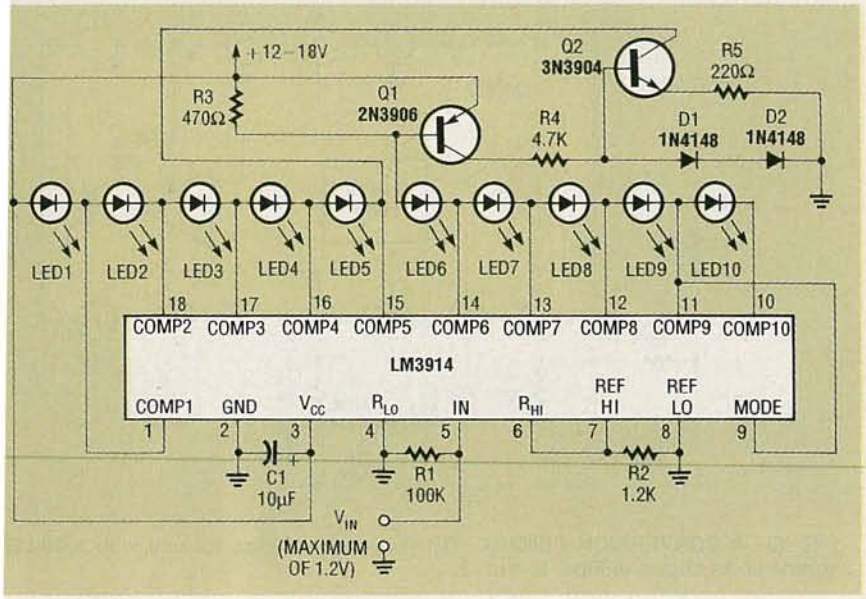
Bar-graph voltmeters

The moving-dot voltmeter sions of Figs. 2–6 can be m into bar-graph voltmeters connecting pin 9 to pin 3 stead of to pin 11. However we mentioned earlier, don't ceed the IC power rating in mode with excessive out voltages when LED's 1–10 on. Figure 7 is a bar-graph

eter that uses a separate supply for its ten LED's.

Most LED's drop about 2 volts when on, so one way around that problem is to use a separate 3 to 5-volt DC source for them, as shown in Fig. 7. Figure 8 is another variation of the bar-graph voltmeter using the same supply for the LM3914 and the ten LED's. If you use the same supply to operate both the IC and the LED's, then be sure to use a current-limiting resistor in series with each LED as shown in Fig. 8, so the IC output terminals saturate when they are lit.

Figure 9 shows another bar-graph display, one that doesn't exhibit excessive power loss. Here, LED's 1–10 are all in series, but each one is connected to an individual IC output, and the IC is in dot mode. Thus, if LED5 was on, its current would be drawn through LED's 1–4, so LED's 1–5 would also be on, creating a bar-graph display. In that case, the total current through all of the LED's is that of a single LED, so the total power dissipation is very low.



IG. 10—A MODIFICATION OF THE VERSION in Fig. 9, using an unregulated 12 to 18-olt DC supply.

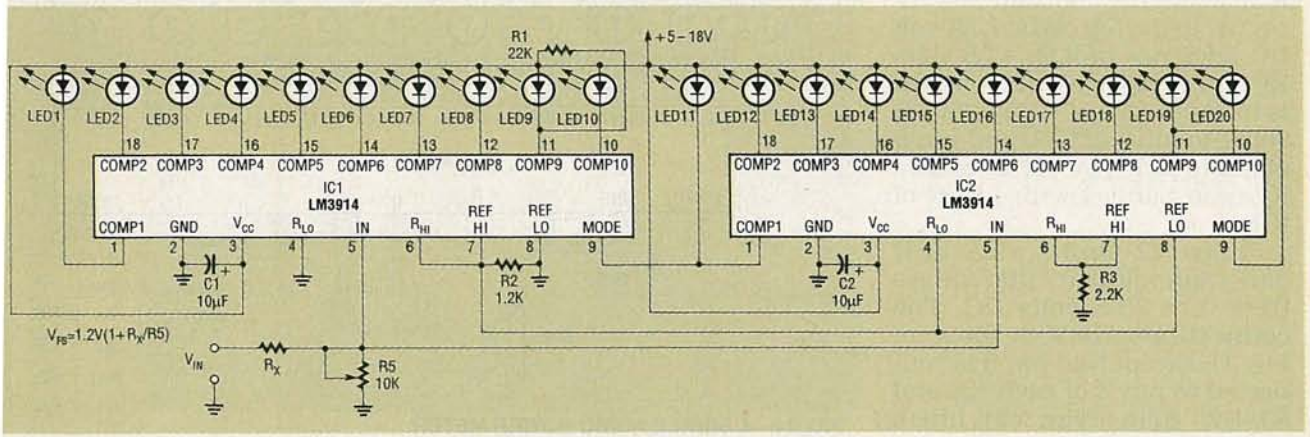


FIG. 11—A MOVING-DOT 20-LED VOLTMETER that ranges from 0 to 2.56 volts DC when Rx equals 0 ohms.

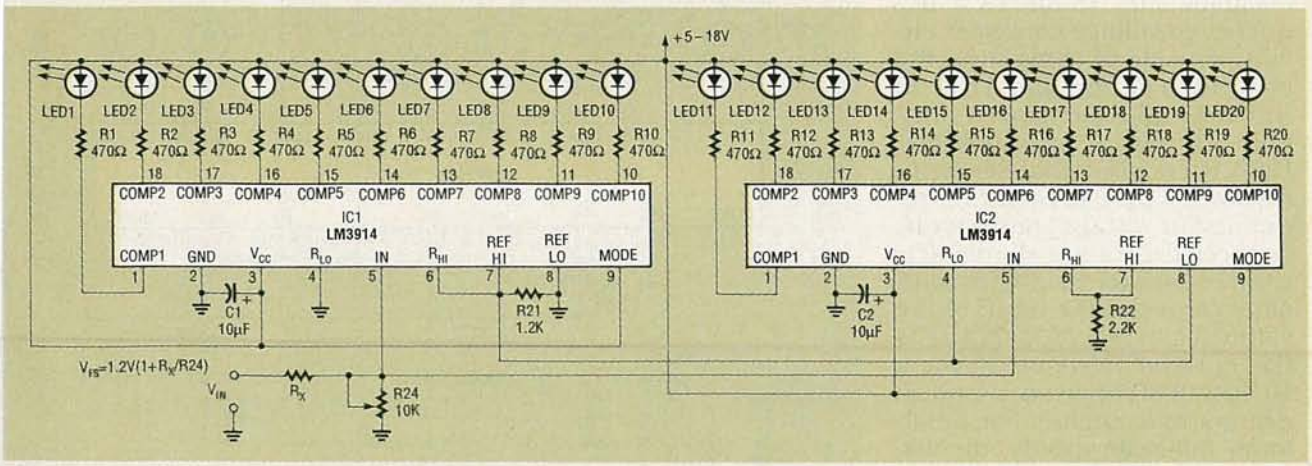


FIG. 12—A BAR-GRAPH 20-LED VOLTMETER that ranges from 0 to 2.56 volts DC when Rx equals 0 ohms.

The supply for the LED's has to be greater than the sum of the total drop with LED's 1–10 on, but within the voltage limits of the IC. Here the V_{CC} is a regulated value of 24 volts.

Figure 10 shows a modification of Fig. 9, using an unregulated V_{CC} ranging between 12 and 18 volts. In that case, LED's 1–10 are split into two chains, with Q1 and Q2 switching LED's 1–5 on when any of LED's 6–10 are active; the maximum total current through the LED's is twice that of a single LED.

The 20-LED voltmeter

The circuit in Fig. 11 uses two LM3914's in a 20-LED moving-dot voltmeter. The inputs of IC1 and IC2 go in parallel, but IC1 reads 0 to 1.25 volts DC, while IC2 reads 1.25 to 2.50 volts DC.

For the latter range, the low end of the 10-stage internal voltage divider in IC2 is connected to the 1.25-volt DC reference of IC1, while the top end is connected to the top of the 1.25-volt DC reference of IC2, 1.25 volts DC above that of IC1. The circuit is in dot mode, with pin 9 of IC1 going to pin 1 of IC2, and pin 9 of IC2 to pin 11 of IC2; note that R1 is in parallel with LED9 of IC1.

Figure 12 shows a 20-LED bar-graph voltmeter that ranges from 0 to 2.56 volts DC. The connections are like those of Fig. 11, except that pin 9 is connected to pin 3 of each IC, and R1–R20 go in series with LED's 1–20 to reduce power dissipation.

Finally, Fig. 13 shows a frequency-to-voltage converter circuit, capable of converting the circuits in either Figs. 11 or 12 into a 20-LED tachometer suitable for use in automobiles. Here, IC1 is a National Semiconductor LM2917 monolithic frequency-to-voltage converter IC connected between the vehicle contact-breaker points (used in older cars) and the input of the voltmeter. In Fig. 13, 0.022 μF is the optimal value of C2 for a 10,000-RPM range on a 4-cylinder, 4-stroke engine. For much lower full-scale speeds, the value of C2 might need to be changed for vehicles that have

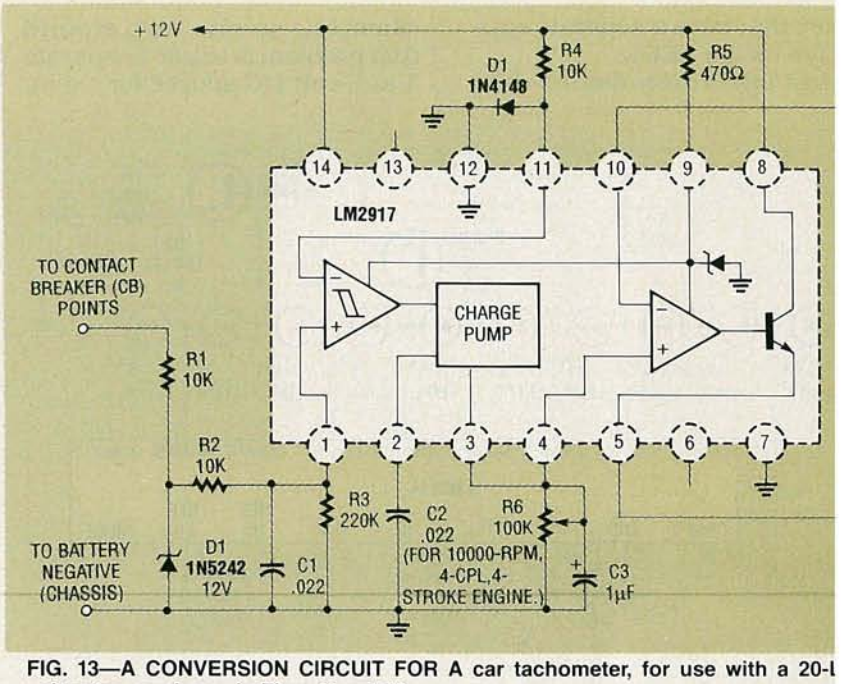


FIG. 13—A CONVERSION CIRCUIT FOR A car tachometer, for use with a 20-L voltmeter, as shown in Figs. 11 and 12.

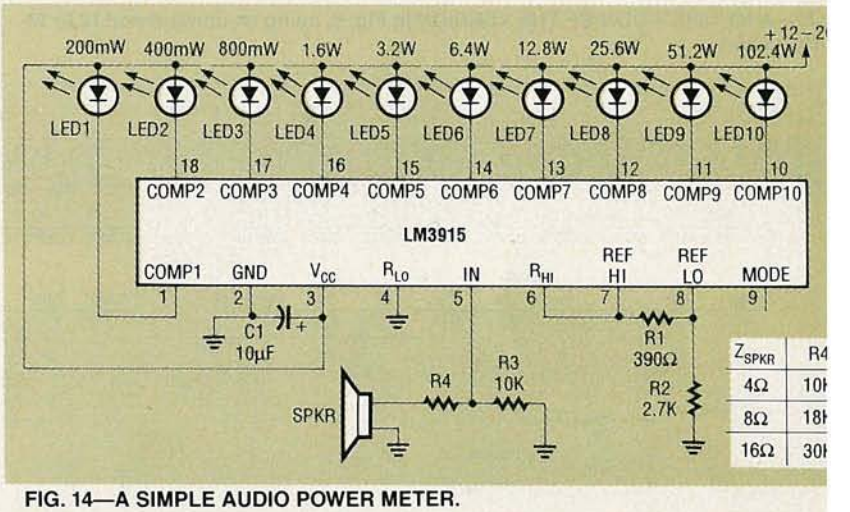


FIG. 14—A SIMPLE AUDIO POWER METER.

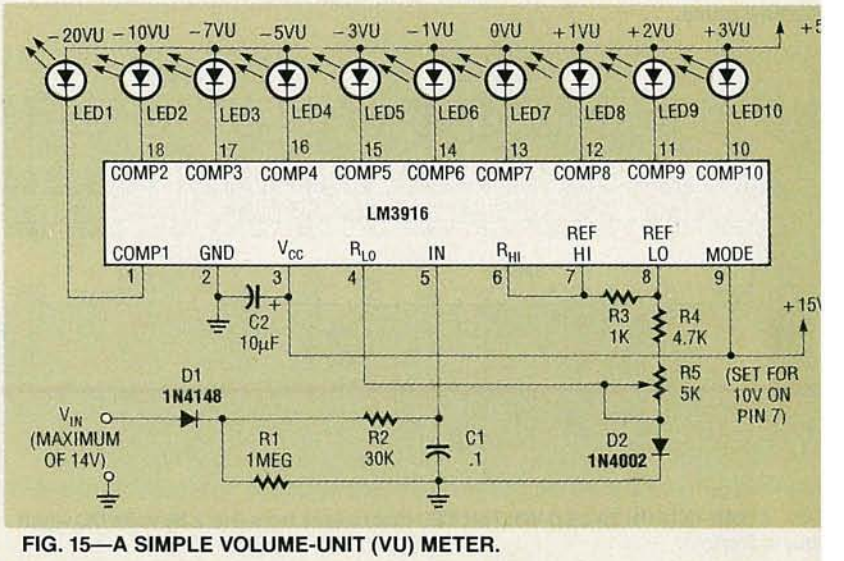


FIG. 15—A SIMPLE VOLUME-UNIT (VU) METER.

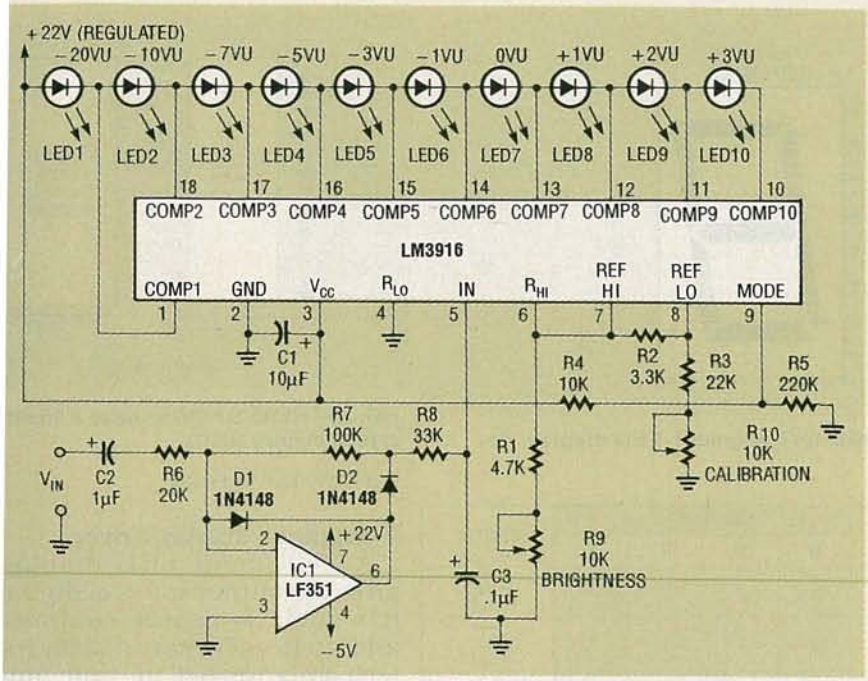


FIG. 16—A PRECISION VU METER with low current drain.

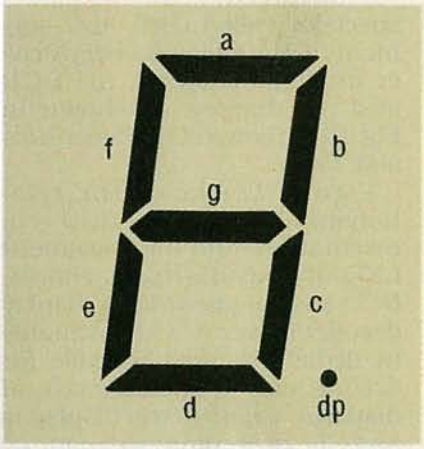


FIG. 17—THE STANDARD CONFIGURATION for a 7-segment LED display.

six or more cylinders.

LM3915 and LM3916 circuits

The LM3915 logarithmic and LM3916 semi-logarithmic versions basically work the same way as the LM3914, and can be directly substituted in most of the circuits shown in Figs. 2–12. The LM3915 and LM3916 will give an LED meter reading for an AC signal going to the input, and respond only to positive halves of the signal, with the number of LED's lit being proportional to the instantaneous peak value. The IC should be in dot mode, and set for 30 milliamps of LED drive.

Figure 14 shows an LM3915-based audio power meter. Pin 9 is left open for dot mode, and R1 equals 390 ohms, for an LED current of 30 milliamps. The range of the audio power meter is 200 milliwatts–100 watts. A better approach is to half-wave rectify the signal on the input and feed in the resulting DC, as shown in the VU-meter circuits of Figs. 15 and 16.

Figure 15, a simple volume-unit (VU) meter, uses an LM3915 in bar mode; the signal at the input is rectified by D1 and filtered by R1-R2-C1, with D2 compensating for the forward drop of D1. Figure 16, a precision VU meter offering low current drain, uses an LM3916, with the combination of IC1-D1-D2 acting as a precision half-wave rectifier.

Also, LED's 1–10 are in series, and IC2 is in dot mode, giving a low-power bar-graph display. To calibrate the audio power meter, adjust R10 for 10 volts DC on pin 7; R9 controls the level of display brightness.

The 7-segment LED display

Alphanumeric displays are used in electronics, in digital watches, pocket calculators, and in test equipment such as multimeters and frequency counters. The most common

SEGMENTS							DISPLAY	SEGMENTS							DISPLAY
a	b	c	d	e	f	g		a	b	c	d	e	f	g	
1	1	1	1	1	1	0	0	1	1	1	1	1	1	1	8
0	1	1	0	0	0	0	1	1	1	1	0	0	1	1	9
1	1	0	1	1	0	1	2	1	1	1	0	1	1	1	A
1	1	1	1	0	0	1	3	0	0	1	1	1	1	1	b
0	1	1	0	0	1	1	4	1	0	0	1	1	1	0	C
1	0	1	1	0	1	1	5	0	1	1	1	1	0	1	d
1	0	1	1	1	1	1	6	1	0	0	1	1	1	1	E
1	1	1	0	0	0	0	7	1	0	0	0	1	1	1	F

FIG. 18—THE TRUTH TABLE for a 7-segment LED display.

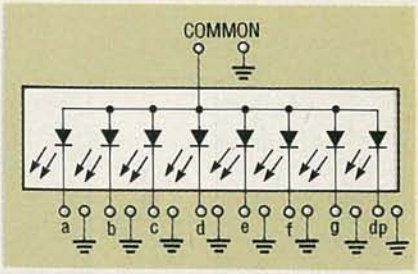


FIG. 19—THE SCHEMATIC OF a common-anode 7-segment LED display.

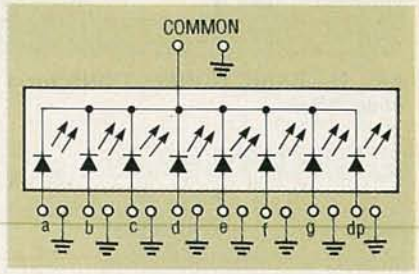


FIG. 20—THE SCHEMATIC OF a common-cathode 7-segment LED display.

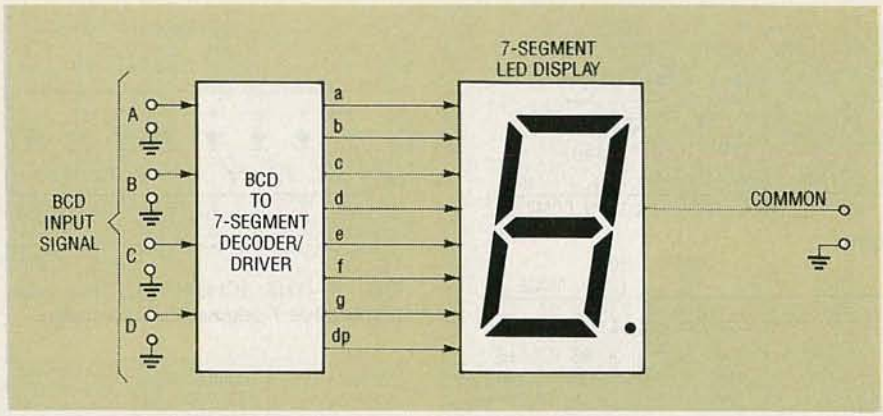


FIG. 21—BASIC CONNECTIONS for a BCD-to-7-segment LED-display decoder/driver.

BCD SIGNAL				DISPLAY	BCD SIGNAL				DISPLAY
D	C	B	A		D	C	B	A	
0	0	0	0		0	1	0	1	
0	0	0	1		0	1	1	0	
0	0	1	0		0	1	1	1	
0	0	1	1		1	0	0	0	
0	1	0	0		1	0	0	1	

FIG. 22—THE TRUTH TABLE of a BCD-to-7-segment LED-display decoder/driver.

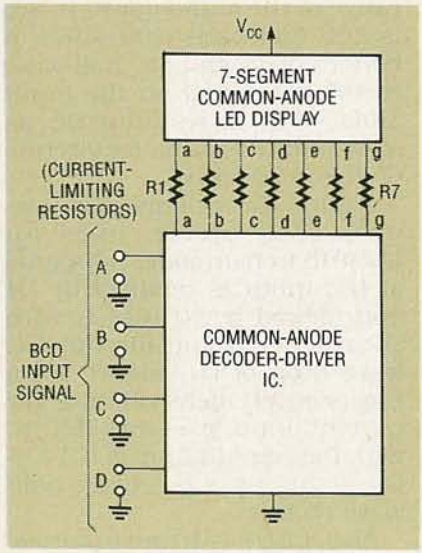


FIG. 23—HERE'S HOW to drive a common-anode 7-segment LED display.

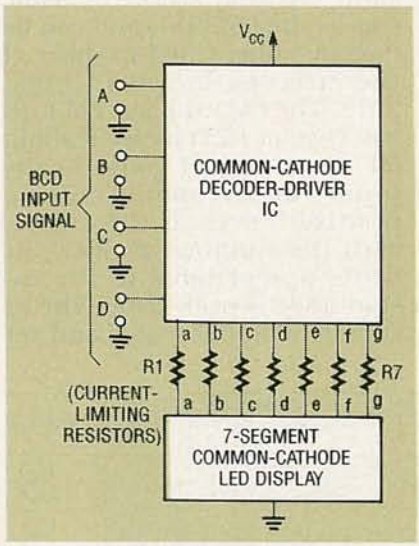


FIG. 24—HERE'S HOW to drive a common-cathode 7-segment LED display.

type of alphanumeric display is the 7-segment LED or LCD display, as shown in Fig. 17. The segments are labeled a–g, and the decimal point is labeled dp. You can display either the digits 0–9, or the letters A–F (a mixture of upper and lower case letters), as shown in Fig. 18.

Most 7-segment LED displays need at least nine external connections. Seven of those connections access the segments, one the decimal point, and the eighth is common. If the display is an LED type, the seven segments are arranged as shown in Figs. 19 and 20. A common-anode version (Fig. 19) has all LED anodes going to common, while a common-cathode version (Fig. 20) is configured in

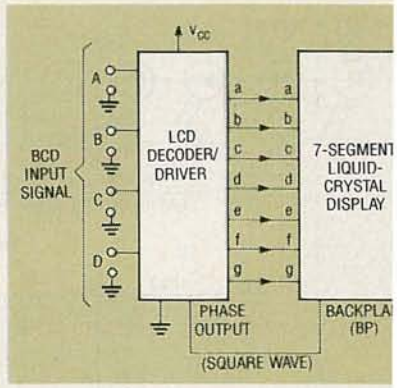


FIG. 25—HERE'S HOW to drive a liqu crystal display (LCD).

the reverse format.

7-segment display/driver

A 7-segment LED displ gives the output states of digi IC's such as decade counte and latches. They are usually i ternally arranged in 4-bit bi ary-coded decimal (BCD), a cannot directly drive a display. special IC called a BCD-to-7-se ment LED-display decoder/dr er must go between the BC and the display, as shown Fig. 21, to convert BCD to a su able form.

Figure 22 shows the rel tionship between the BCD re resentation, and the 7-segme LED-display digits. Normal BCD-to-7-segment LED-displ decoder/driver IC's are availal in dedicated form suitable f driving only a special class displays, whether the display an LCD, or a common-anode common-cathode LED displ Figures 23–25 show how su 7-segment LED displays a BCD-to-7-segment LED-displ decoder/driver IC's are co nected.

Figures 23 and 24 show h to drive common-anode a cathode 7-segment LED d plays. Note that if the BCD-to segment LED-display decod driver IC outputs are u protected, as is the case in m TTL IC's, a resistor in ser with each segment limits c rent; most CMOS IC's have su resistors internally. In Fig. you can see how to drie LCD. The common or backpl (BP) display terminal is dri with a symmetric square-wa which is derived from the ph output terminal.

HARDWARE HACKER

Using the IC Master; wavelets update; another caller-ID chip; musical note frequencies; and piano and organ resources.

DON LANCASTER

Several commercial products are starting to appear using that great *Rohm* BA-1404 FM stereo transmitter circuit. In particular, check out the *Pioneer* CD-FM-1 and the *Sony* XA7A CD to auto radio adapters. Dealer cost is in the $42 range.

What they do is let you play the output of a CD player through your existing car radio and audio system. The stereo channels are accepted by the BA-1404 IC and converted to a miniature but quite high-quality FM "broadcast" signal. You unplug your antenna, plug in your adapter, and then plug the antenna back into the adapter. Presto. Your CD audio now appears on the FM dial on your choice of one of two pushbutton-selected low-end channels.

As we've found out in the past, sloppily breadboarded BA-1404 chips tend to drift and mistune so much that they are unacceptable to most of the newer synthesized FM receivers that *demand* perfectly on-channel signals. While the ultimate way to stabilize an FM transmitter is to use a frequency-locked loop against a crystal reference, Pioneer and Sony both seem to have gone a simpler route.

Apparently they are just using a rigid and well-shielded design, tight supply regulation, and careful temperature compensation instead. They seem interested in a very low-level signal on a controlled cable, and they also do not see any antenna coupling or loading effects.

I will present more on those two beasties after I get a chance to test them. Either one of them should hack beautifully into a FM stereo wireless broadcaster circuit.

Wavelets update

We've had bunches of requests for lots more wavelet information. So, here is a summary of where we seem to be.

Wavelets are a stunning new set of math tools that are having a strong impact on just about every region of advanced scientific study. While the keenest interest in wavelets now lies in video compression, wavelets are being applied to everything from cardiology and seismology to animal vision—and everything in between.

Wavelets are a newer method of analyzing any complex set of signals and extracting useful information from those signals. Unlike the ancient *Fourier Transform*, wavelets have both *global* and *local* properties that let you selectively zoom in on signal portions of interest. For instance, good old Fourier is quite superb at working with the top and the bottom of a square wave. But the sides give it fits. Instead of Fourier's "one-size-fits-all," wavelets let you apply lots of detail only where needed.

Wavelets tend to work in a "log" manner rather than in that "linear" fashion of Fourier. This lets you pick up any fine details when wanted. Wavelets are also great at doing the "big lumps first." That becomes handy in decompressing pictures, where your crude (but complete) picture initially appears and detail gets added later. It also gives you the ability to select the amount of needed detail on the fly.

One detailed book on wavelets is *Wavelets and their Applications*, as published by *Jones and Bartlett*. The topics thoroughly covered include wavelet fundamentals, video compression, digital signal processing, numeric analysis, and a bunch of advanced subjects. Sadly, the volume is written by math freaks for math freaks. It tends to run roughshod over mere mortals. But it is there and certainly is the precise center of the emerging wavelet universe.

One tad less formidable wavelet summary tutorial and bibliography appears in *IEEE-SP* (Signal Processing) magazine for October 1991 on pages 14–38. Note that there are dozens of different monthly IEEE publications. Make sure you get the right one.

For a useful collection of freebie reprints on wavelets for video compression, hardware chips, and design software, contact the folks at *Aware*. Wavelets do video compression far simpler, far faster, and with far fewer artifacts than the older (and now largely obsolete) DCT (discrete cosine transform) compression transforms. Their hardware is also far cleaner and more likely to be standard.

Finally, I have posted some great IBM wavelet shareware on my *GEnie* PSRT as the file #365 WAVELET.PAK. You can call (800) 638-9636 for your connect information.

NEED HELP?

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

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

A new caller-ID circuit

Motorola has just introduced an exciting new phone-caller identification chip called the MC145447. Free samples are available. They also have a very convenient but somewhat overpriced $100 evaluation kit breadboard that gives you a full telephone-to-computer serial interface.

Figure 1 shows one of many possible circuits. This one is intended for continuous powering.

Compared to the earlier chips,

the MC145447 includes internal ring detection, and it apparently can be used without an expensive coupling transformer. It optionally strips off that ID header and provides only "real" message bits. That's the difference between their *raw* data output (the entire caller-ID byte sequence) and the *cooked* data (only the useful bytes) message strings.

Note that those two 500-pF input capacitors must be closely matched and rated to at least 1500 volts. A varistor and the normal part-68 interface should precede the circuit. The output levels are TTL- or CMOS-compatible, but have to be suitably translated to be sent over a RS-232 serial cable or data line.

The crystal used is the standard for colorburst frequency, available for under a dollar through several of our **Radio-Electronics** advertisers.

Naturally, your caller-ID service must already be provided by your phone company before either the chip or the evaluation kit will work. If the service is not yet available, suitable machine language emulation software can easily be written for nearly any computer. The game paddle port on an Apple IIe is absolutely ideal as a fake source of ID coding signals.

We'll be seeing much more on this chip and suitable emulation software after I get a better chance to test it more thoroughly. The obvious thing to do is to "steal" enough power off a computer's RS-232 interface lines to eliminate any need for a stand-alone power supply. Internal power-down features of the MC145447 can greatly simplify this task. Stay tuned for more details.

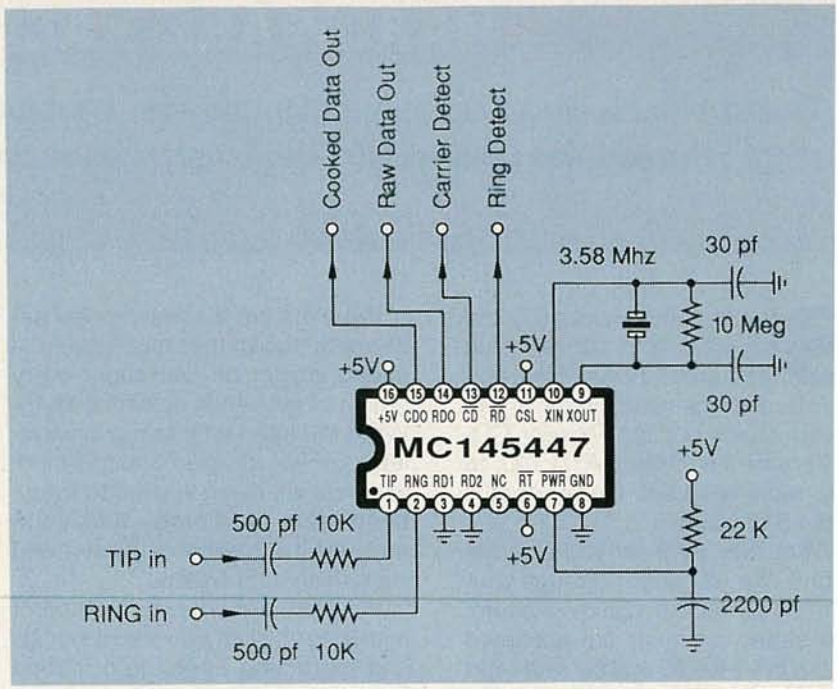


FIG. 1—ANOTHER CALLER ID CIRCUIT uses the brand new Motorola MC1454 Features include internal ring detection and data header stripping. Free samples available. The service has to be available from your local phone company before t chip can be used.

The IC Master

Identifying the maker of an integrated circuit from just the part number can be tricky, especially if you are mistakenly reading the date code instead. As you have probably found out on your own, *Radio Shack* has a useful *Semiconductor Reference Guide* available for $4.

We've already seen that the two leading sources of service, repair, and replacement semiconductors are *NTE* and *ECG*. Parts and training specific to *RCA* and *GE* produ are also available through *Thoms Consumer Electronics Publicatio* This is an extension of the old "S series of replacement parts.

But *the* place to go for inforr tion on integrated circuit part nu bers and cross references is three-volume set known as the *Master* which is published by thc *Hearst Business Communicatic* folks. The set is not cheap—it co $160.

Hearst also publishes the f *Electronic Products* magazine, p their *EEM (Electronic Engine Master Catalog)* directories. B of these are free to qualified s scribers. But note that *EEM* and *IC Master* are two totally differ and separate sets of references

Top-octave generators

This topic is more in the realn "whatever happened to..." tl anything else. But we still get lot helpline calls concerning *top-oct generators*, especially in *Mostek* MK50240 family. The l tom line: They're long out of d They also have recently become possibly difficult to get.

The traditional western mus scale is based upon twelve *equ*

NEW FROM
DON LANCASTER

HARDWARE HACKER STUFF

Hardware Hacker Reprints II or III	24.50
Midnight Engineering Reprints	16.50
Incredible Secret Money Machine	18.50
CMOS Cookbook	24.50
TTL Cookbook	24.50
Active Filter Cookbook	19.50
Micro Cookbook vol I or II	19.50
Lancaster Classics Library	109.50
AppleWriter Cookbook	19.50

POSTSCRIPT STUFF

Ask The Guru Reprints I, II or III	24.50
LaserWriter Secrets (IIe/Mac/PC)	29.50
PostScript Show & Tell	39.50
Intro to PostScript VHS Video	39.50
PostScript Beginner Stuff	39.50
PostScript Cookbook (Adobe)	16.50
PostScript Ref. Manual II (Adobe)	28.50
PostScript Program Design (Adobe)	22.50
Type I Font Format (Adobe)	15.50
LaserWriter Reference (Apple)	19.50
Real World Postscript (Roth)	22.50
PostScript Visual Approach (Smith)	22.50
Thinking in PostScript (Reid)	22.50
Undst PS Pgrmmg (Holtzgang)	26.50
The Whole Works (all PostScript)	349.50

BOOK-ON-DEMAND STUFF

Book-on-demand resource kit	39.50
GEnie PSRT sampler (IIe/Mac/PC)	39.50

FREE VOICE HELPLINE VISA/MC

SYNERGETICS
Box 809-RE
Thatcher, AZ 85552
(602) 428-4073

	octave 0	octave 1	octave 2	octave 3	octave 4	octave 5	octave 6	octave 7	octave 8
B	30.868	61.735	123.47	246.94	493.88	987.77	1975.5	3951.1	7902.1
A#	29.135	58.270	116.54	233.08	466.16	932.33	1864.7	3729.3	7458.6
A	27.500	55.000	110.00	220.00	440.00	880.00	1760.0	3520.0	7040.0
G#	25.957	51.913	103.83	207.65	415.30	830.61	1661.2	3322.4	6644.9
G	24.500	48.999	97.999	196.00	392.00	783.99	1568.0	3136.0	6271.9
F#	23.125	46.249	92.499	185.00	369.99	739.99	1480.0	2960.0	5919.9
F	21.827	43.654	87.307	174.61	349.23	698.46	1396.9	2793.8	5587.7
E	20.602	41.203	82.407	164.81	329.63	659.26	1318.5	2637.0	5274.0
D#	19.445	38.891	77.782	155.56	311.13	622.25	1244.5	2489.0	4978.0
D	18.354	36.708	73.416	146.83	293.66	587.33	1174.7	2349.3	4698.6
C#	17.324	34.648	69.296	138.59	277.18	554.37	1108.7	2217.5	4434.9
C	16.352	32.703	65.406	130.81	261.63	523.25	1046.5	2093.0	4186.0

FIG. 2—THE STANDARD FREQUENCIES of the Western 12-note equally tempered music scale. It applies to most electronic and conventional musical instruments EXCEPT the piano. Piano keyboards must be "stretched" because of a piano's non-harmonic overtones.

tempered notes per *octave*. (An octave is a 2:1 frequency interval.) Each note is related by the twelfth root of two, or 1.059 times the frequency of its neighbor.

The notes, of course, are lettered as C, C#, D, D#, E, F, F#, G, G#, A, A#, B, and back around to the next C, one octave higher. The traditional organ people number the octaves from zero up through eight. The usual "standard pitch" frequency reference sets note A4 to precisely 440.0 Hertz.

The usual twelve-note-per-octave equally tempered frequencies appear in Fig. 2.

Because all of the music note frequencies are irrational, they have to be approximated. One way to do that is to take a high-frequency clock and divide it down by magic numbers which can hit the needed accuracy. Musicians define the interval between notes as one *semitone*, and further define *one percent* of a semitone as a *cent*. A one-cent frequency error is approximately 0.06 percent.

Reasonably trained individuals usually can spot a three-cent frequency error, while the best of professional musicians can resolve a single cent. Thus, the relative frequency accuracy of all the notes

PIANO AND ORGAN RESOURCES

Devtronics
6101 Warehouse Way
Sacramento, CA 95826
(916) 381-6203
CIRCLE 301 ON FREE INFORMATION CARD

Jrnl Audio Engineering Soc
60 East 42nd Street, Rm 2520
New York City, NY 10165
(212) 661-2355
CIRCLE 302 ON FREE INFORMATION CARD

MIX Bookshelf
6400 Hollis Street, Ste 12
Emeryville, CA 94608
(800) 233-9604
CIRCLE 303 ON FREE INFORMATION CARD

PAIA Electronics
3200 Teakwood Lane
Edmond, OK 73013
(405) 340-6300
CIRCLE 304 ON FREE INFORMATION CARD

Player Piano Company
704 East Douglas
Wichita, KS 67202
(316) 263-3241
CIRCLE 305 ON FREE INFORMATION CARD

Tuners Supply
88-94 Wheatland Street
Somerville, MA 02145
(800) 247-0702
CIRCLE 306 ON FREE INFORMATION CARD

No Better Probe Ever at this Price!

Shown here
Model SP150 Switchable 1x-10x $49

Free probe guide shows economical replacements for Tektronix, H-P, Philips and all others

Risetime less than 1.5 nsec.

- **Universal**
  Works with all oscilloscopes
- **Rugged**
  Flexible cable lasts longer-
  Replaceable ground lead
- **Economical**
  Substantial savings compared to OEM probes
- **10 Day Return Policy**
  Guaranteed performance and quality

TEST PROBES, INC. TPI 9178 Brown Deer Road, San Diego, CA 92121
Toll Free 1-800-368-5719

CIRCLE 123 ON FREE INFORMATION CARD

NAMES AND NUMBERS

Aircraft Designs
25380 Boots Road
Monterey, CA 93940
(408) 649-6212
CIRCLE 307 ON FREE INFORMATION CARD

Antique Electronic Supply
6221 South Maple Avenue
Tempe, AZ 85283
(602) 820-5411
CIRCLE 308 ON FREE INFORMATION CARD

ARclad
PO Box 100
Glen Rock, PA 17327
(717) 235-7979
CIRCLE 309 ON FREE INFORMATION CARD

Astex
35 Cabot Road
Woburn, MA 01801
(617) 933-5560
CIRCLE 310 ON FREE INFORMATION CARD

Aware
One Memorial Drive
Cambridge, MA 02142
(617) 577-1700
CIRCLE 311 ON FREE INFORMATION CARD

ECG/Philips
PO Box 3277
Williamsport, PA 17701
(717) 323-4691
CIRCLE 312 ON FREE INFORMATION CARD

EMC Technology
PO Box D
Gainesville, VA 22065
(703) 347-0030
CIRCLE 313 ON FREE INFORMATION CARD

GEnie
401 North Washington Street
Rockville, MD 20850
(800) 638-9636
CIRCLE 314 ON FREE INFORMATION CARD

IC Master/Hearst
645 Stewart Avenue
Garden City, NY 11530
(516) 227-1300
CIRCLE 315 ON FREE INFORMATION CARD

IEEE/Signal Processing
445 Hoes Lane
Piscataway, NJ 08855
(908) 981-0060
CIRCLE 316 ON FREE INFORMATION CARD

ITW/Fastex
226 Gerry Drive
Wood Dale, IL 60191
(708) 350-8200
CIRCLE 317 ON FREE INFORMATION CARD

Jones & Bartlett
20 Park Plaza
Boston, MA 02116
(617) 482-3900
CIRCLE 318 ON FREE INFORMATION CARD

Media Magic
PO Box 507
Nicasio, CA 94946
(415) 662-2426
CIRCLE 319 ON FREE INFORMATION CARD

Motorola
PO Box 1466
Austin, TX 78767
(800) 521-6274
CIRCLE 320 ON FREE INFORMATION CARD

NTE Electronics
44 Farrand Street
Bloomfield, NJ 07003
(201) 748-5089
CIRCLE 321 ON FREE INFORMATION CARD

Rohm
PO Box 19681-631
Irvine, CA 92713
(714) 855-0819
CIRCLE 322 ON FREE INFORMATION CARD

Signetics/Philips
811 East Arques Avenue
Sunnyvale, CA 94088
(800) 227-1817
CIRCLE 323 ON FREE INFORMATION CARD

Synergetics
PO Box 809
Thatcher, AZ 85552
(602) 428-4073
CIRCLE 324 ON FREE INFORMATION CARD

Thomson Consumer Publictns
2000 Clements Bridge Road
Deptford, NJ 08096
(609) 853-2417
CIRCLE 325 ON FREE INFORMATION CARD

Voltek
100 Shepard Street
Lawrence, MA 01843
(508) 685-2557
CIRCLE 326 ON FREE INFORMATION CARD

should be better than 0.06 percent.

To get all of the notes to sound well together, well-chosen "magic" division ratios must be used. Figure 3 shows some detail. Of all the possible 8-bit divisor values, only the unique sequence of 116 123 ... 232 is good enough for a three-cent worst-case accuracy. If you have more bits available, then other sequences are also usable.

Figure 4 shows you how a top-

The 12 equally tempered musical keys repeat each **OCTAVE**, or **2:1** frequency interval.

This means each note is related to its neighbor by a geometric ratio of the **12th** root of two, or **1.05946:1**

Only this "magic" sequence of 8-b divisors is good enough to let all o the notes sound good together...

232 219 207 195 184 174 164 155 146 138 130 123 116

Here is the better 9-bit "magic" sequence used by the MK50240..

478 451 426 402 379 358 338 319 301 284 268 253 239

FIG. 3—EQUALLY TEMPERED NOT are irrational, so only this one "mag 8-bit sequence of division ratios can a good enough approximation.

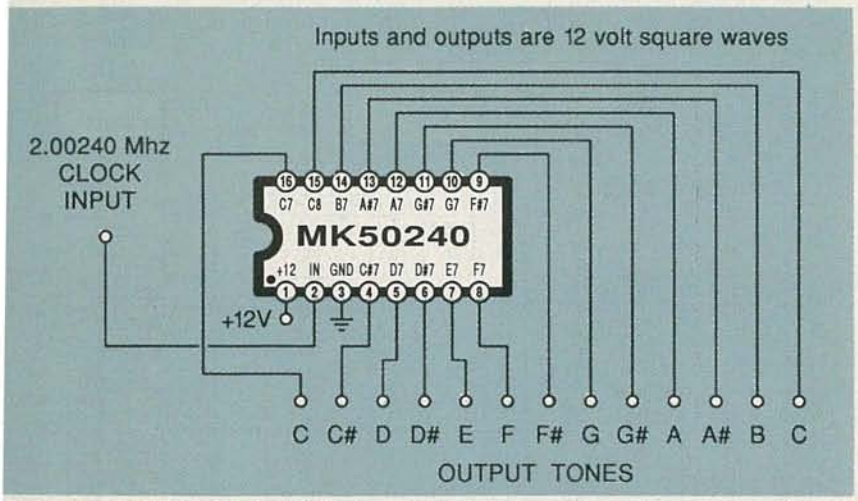
octave generator works. This is old N-channel integrated circuit t runs on a single 12-volt supply. input clock of 2.000240 MHz is quired. The clock can be obtai from a crystal for an absolute re ence, or it can be variable for pi blending or keyboard stretch variations. Thirteen outputs are p vided, giving you all the notes of highest octave, plus a spare C octave lower.

To generate lower notes, you either divide down the input cl for a single octave, or else add put dividers to generate the er music keyboard as shown in Fig

Hackers have long ago found of other exciting uses for top-oct generators, which include m cian's pitch references, piano tur aides, meditation, and musical t

Perhaps one of the most off- wall new-age uses involved Johr monton's *chord egg*. Polyph chords obtained from a lowe pitch top-octave generator w chosen at random and routed stereo headset. With suitable d and phasing techniques, the ap ent source of the stereo sounc forced *between* your ears, and chords literally bounce aro *inside* your head. A few chord e remain available through PAIA e tronics.

Assembly details for a traditi top-octave generator music mo system appeared long ago in June 1976 issue of *Popular E tronics*.



IG. 4—TOP OCTAVE GENERATOR integrated circuits produce all the needed notes of he musical scale. Input or output lines can be binarily divided for lower octaves. adly, these chips are getting hard to find.

There are several reasons why he top-octave generators are no onger popular. The "locked in" nature of octave-shifted notes sound as a single richer tone, rather han as a separate pair of chorused oices. Having all the notes sounding continuously in the background can lead to serious system noise problems. Zillions of wires are needed because the keyboard is usually non-scanned. The envelope and voicing opportunities are also severely limited.

But the main reason is that MIDI-based and all-digital sampled synthesizers do a much better job with a far cheaper, a far simpler, and far cleaner system architecture. Moreover, they are infinitely more flexible and sound much better than anything else.

At any rate, new sources of top-octave generators seem to be long gone. A very few of the original chips *may* remain available through *PAIA* or *Devtronix* on a catch-as-catch-can basis. It should also be possible to fake the top-octave generators with programmable gate array devices. The FPGA costs are dropping rapidly enough to make this possible.

Note that any pitch reference must be a nearly pure sine wave. Any higher harmonics will fool the ear and also cause potential tuning problems.

Finally, if any of you out there know of any secret stashes of this one-time great chip, be sure to let all of us know.

Try the

Radio Electronics

bulletin board system

(RE-BBS)
516-293-2283

The more you use it the more useful it becomes.

We support 1200 and 2400 baud operation.

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

Add yourself to our user files to increase your access.

Communicate with other R-E readers.

Leave your comments on R-E with the SYSOP.

RE-BBS
516-293-2283

Be an FCC LICENSED ELECTRONIC TECHNICIAN!

No costly school. No commuting to class. The Original Home-Study course prepares you for the "FCC Commercial Radiotelephone License." This valuable license is your professional "ticket" to thousands of exciting jobs in Communications, Radio-TV, Microwave, Maritime, Radar, Avionics and more...even start your own business! 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 _____

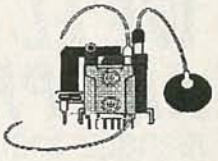
QUALITY TV & VCR PARTS

SEMICONDUCTORS

2SC1172B		STK0080	$16.95ea
2SD869	10/up $1.99ea	STK4273	$9.95ea (10min)
2SD1398		STR30120	$3.95ea
2SD1426			

REPLACEMENT FLYBACKS

154-074E	GOLDSTAR	$19.95ea
154-040A	GOLDSTAR	$19.95ea
FCC1415AL	SAMSUNG	$19.95ea
3214003	EMERSON	$24.50ea
TLF14423F	PANASONIC	$29.95ea
TLF14530F	PANASONIC	$29.95ea
2434391	HITACHI	$34.95ea



IDLERS

164113	RCA	$3.50ea (10min)
NPL Y0111GEZZ	SHARP	$10.95ea
NPLY0006GEZZ	REPLACEMENT	$2.95ea
143-0-4204-00400	REPLACEMENT	$4.95ea

POPULAR PARTS

526A	TRIPLER	$9.95ea
4-1164-031600	SANYO RF MODULATOR	$17.95ea
100M/50V	RADIAL	20/for $10.00
4.7M/250V	RADIAL	10/for $5.50
1000M/200V	SNAP-IN	5/for $12.50
47M/50V	RADIAL	10/for $4.50

FREE 56 PAGE CATALOG!!!

MAT ELECTRONICS
975 JAYMOR ROAD
SOUTHAMPTON, PA 18966

CALL TOLLFREE
1-800-628-1118
FAX# 215-364-8554

VISA MasterCard

CIRCLE 89 ON FREE INFORMATION CARD

SUPER LONG PLAY TAPE RECORDERS
12 Hour Model — USES 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 – 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. & handling. Phone Adapter & Vox $2.00 each. Recorders $5.00 each. Calif. Res. add tax. Mail order, VISA, M/C, COD's OK. Money Back Guarantee. Quantity discounts available. Dealer Inquiries invited. Free data.
AMC SALES INC. Dept. A 9335 Lubec Street
Box 928, Downey, CA 90241 1-800-926-2488
Phones (310) 869-8519 FAX (310) 923-1478
Mon-Fri 8-5 PAC. TIME

CIRCLE 108 ON FREE INFORMATION CARD

Save on cable rental fees!
CABLE TV DESCRAMBLERS
WE'LL BEAT ANY PRICE!
JERROLD-TOCOM-ZENITH
HAMLIN-OAK-PIONEER
SCIENTIFIC ATLANTA
• 24 HOUR SHIPMENTS!
• MONEY BACK GUARANTEE!
• QUANTITY DISCOUNTS!
MASTER CARD / AMEX / VISA / C.O.D.
Have make and model number of equipment used in your area ready
CALL TOLL-FREE
1-800-284-8432
CABLE WAREHOUSE
10117 West Oakland Park Blvd., Suite 515, Sunrise, FL 33351
NO FLORIDA SALES

CIRCLE 184 ON FREE INFORMATION CARD

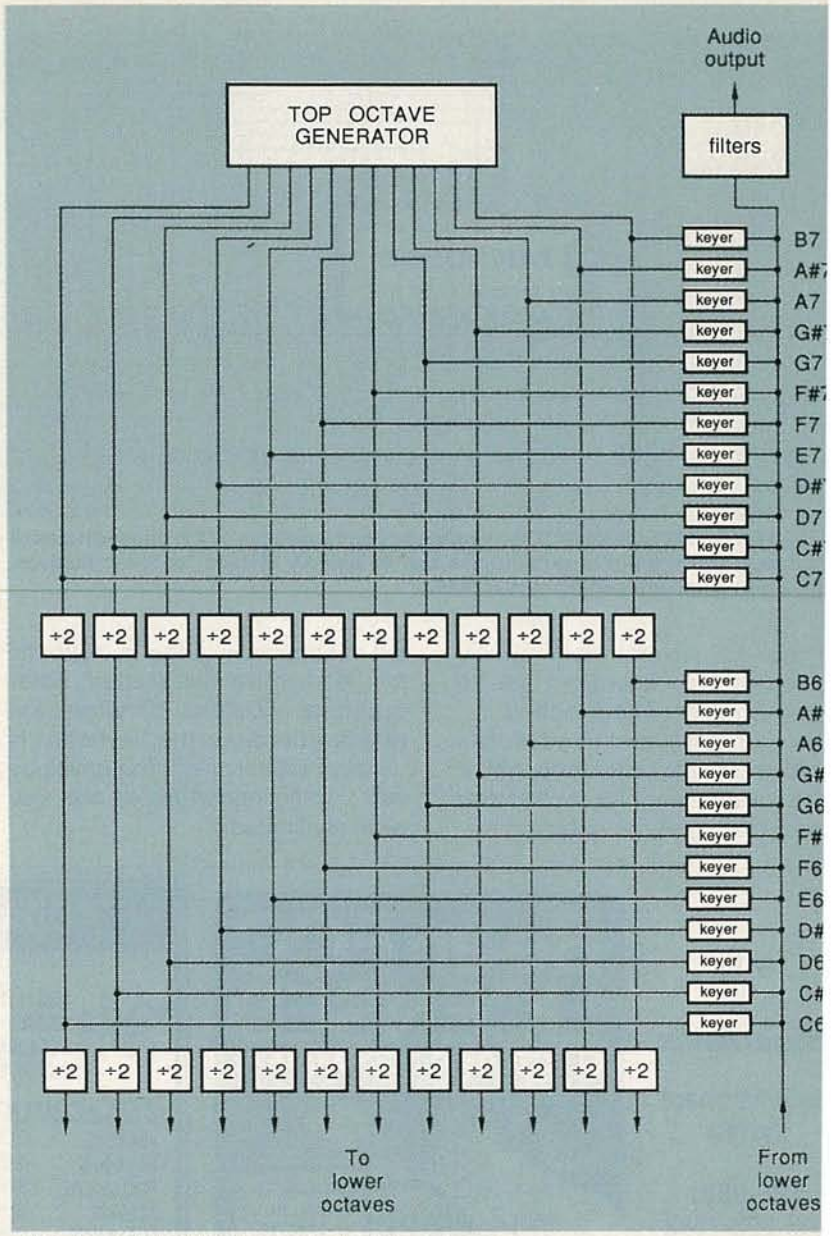


FIG. 5—A TRADITIONAL ELECTRONIC ORGAN architecture using top octave ge ators and dividers. Today's MIDI-based sampled synthesizer circuits can pro much better sound far simpler and in an infinitely wider variety.

Piano and organ resources

I thought I'd gather together some traditional music names and numbers for this month's resource sidebar. For piano tuning materials and supplies try *Tuner's Supply*, while the best source for antique instrument parts and data is the *Player Piano Company*. And a good horse's mouth book is *Piano Tuning and Allied Arts*.

Note that piano tuning is (1) a lot harder than it appears; (2) a minuscule, unprofitable, and rapidly declining market; and (3) an easy way to cause irreparable damage.

Note also that most piano k are *never* tuned to all their "corr frequencies. Instead, the keyb has to be "stretched" to allow the non-harmonic nature of world string overtones. Kee mind that it takes several *week* properly tune a piano!

One classic organ kit compar *Devtronix*, while a company ca *PAIA* offers a wide range of t tional to new age kits.

An excellent source for electr music titles is the *MIX* Books stocked by the folks that also lish the *Electronic Musician* m

ne. Fundamental synthesizer secrets can often show up first in the *Journal of the Audio Engineering Society.*

Some additional electronic music resources appear in my *Hardware Hacker II* reprints.

New tech lit

A great "gottahave" is the *Video Data Handbook* from *Signetics Philips*, which is chock-full of digital video-interface chips, RGB digitizers, multimedia chips, sync strippers, color decoding, and all of the usual A/D and D/A conversion chips and circuits.

Speaking of multimedia, the *Media Magic* people offer a *Computers in Science and Art* catalog full of good books, tapes, and software.

A free bibliography of papers on microwave plasma applications is offered by *Astex.*

From *Antique Electronic Supply*, a 1992 wholesale catalog of supplies, books, tubes, info, and parts for the electronic collector. We've had lots of calls from experimenters trying to find Fahnstock clips in this day and age. These folks are one of the few remaining suppliers.

Another trade journal on magnetic and electric shielding ideas is *EMC Technology*. And a wide selection of aircraft hacker books is available by way of *Aircraft Designs*.

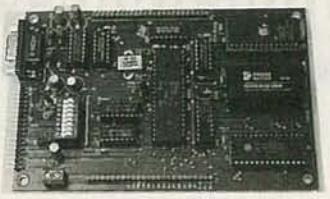
This month's freebie mechanical samples include foams, films, and foils from *ARclad*, a *Foam Specifier Kit* from *Voltek*, and some self-stick bumpers from *ITW/Fastex.*

A reminder that I have recently revised my *Incredible Secret Money Machine II* and have autographed copies on hand for you when you call or write. You can get the ISMM by itself or as a portion of my *Lancaster Classics Library.*

You can also reach me via *GEnie* PSRT (800) 638-9636 where you will find hundreds of downloadable files and tutorials on hardware hacking and also those midnight engineering topics.

Our usual reminder here that most of the products and services that have been mentioned appear either in the "Names and Numbers" or in the "Piano and Organ Resources" sidebars. **R-E**

Radio Electronics® mini-ADS



CREATE INTELLIGENT PROJECTS WITH THE VERSATILE Z8 PROGRAMMABLE MICROCOMPUTER. This powerful computer was designed for flexibility and can be used for various electronic projects. I/O Intensive. Up to 20MHz operation. Download programs or run EPROM code. Special hardware features included. Prices from **$125.00.** Battery-backed RAM, X-assembler, and other options available. CALL FOR FREE BROCHURE. **MJS DESIGNS, INC., 1438 W. Broadway Rd., Suite B185. Tempe, AZ 85282. (602) 966-8618.**

CIRCLE 178 ON FREE INFORMATION CARD

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

CIRCLE 115 ON FREE INFORMATION CARD

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

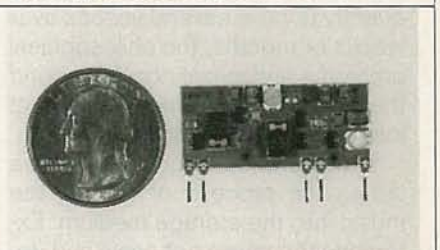
CIRCLE 185 ON FREE INFORMATION CARD

CABLE TV CONVERTERS AND DESCRAMBLERS 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

APPLIANCE REPAIR HANDBOOKS—13 volumes by service experts; easy-to-understand diagrams, illustrations. For major appliances (air conditioners, refrigerators, washers, dryers, microwaves, etc.), elec. housewares, personal-care appliances. Basics of solid state, setting up shop, test instruments. **$2.65 to $5.90 each.** Free brochure. **APPLIANCE SERVICE, PO Box 789, Lombard, IL 60148. 1-(312) 932-9550.**

CIRCLE 84 ON FREE INFORMATION CARD



TWO FOR THE PRICE OF ONE! 5 MINUTE ASSEMBLY! MONEYBACK GUARANTEE! Attach any 3V-12V battery and have the most stable, sensitive, powerful room transmitter you can buy. Or attach to telephone line. Hear all telephone conversations—crystal clear—over 1 mile away without batteries! Use any FM radio or wideband scanner. 80-130 MHZ. 100mW output! VT-75 microtransmitter chip **$49.95** + **1.50** S&H. VISA, MC, MO. COD's add **$4.00. DECO INDUSTRIES, Box 607, Bedford Hills, NY 10507. 1-800-759-5553.**

CIRCLE 127 ON FREE INFORMATION CARD

AUDIO UPDATE

AES: Audio Fact and Fantasy.

LARRY KLEIN

The theme of the recent 91st Audio Engineering Society Convention held in New York—"Audio Fact and Fantasy"—was one dear to my heart. I thoroughly enjoyed both the formal sessions and the lunches and hallway conversations with some of my old friends and new acquaintances.

As I've done in years past, I intend to discuss some of the more interesting papers. But first, I'd like to set the stage, so to speak, with a recapitulation of what I see to be some of the basic problems of high-fidelity reproduction—which is what the 91st Convention was all about.

What's the Problem?

In the very early days of hi-fi we kept talking about "concert-hall realism." Later, it came as a shock to many of the audio faithful to read that some new or rebuilt concert halls failed to achieve the "realism" supposedly inherent in live sound. In any case, how can the live listening experience ever be even approximately duplicated by scattering a dozen or more microphones throughout the ranks of a strangely grouped orchestra? And then when pop recording went multi-track, frequently done in several venues over weeks or months, the philosophical problems of duplicating a live sound that never was became intense—at least for the thinking listener.

Those and other questions arise during the process of getting the music into the storage medium. Extracting the music out again and delivering it to the ears of a listener in believable form is the other side of the coin. The success of a recording can only be judged during playback. But playback through what equipment, into what environment, and with what jury of listeners?

A recording of a live event entails a selected sampling of the sound field in the recording environment. The success of the sampling process—which basically involves the choice and placement of microphones—depends mostly on the talent of the recording engineer. If under reasonable playback conditions the recording can produce a plausible simulation of a live sonic event, it is deemed a success.

Be aware that this thumbnail input-output description of the audio process leaves many questions unanswered. Not unexpectedly, the input part of the recording process excites far fewer passions than the playback end of things. In playback, the audiophile gets involved obsessively exploring the real or imagined effects produced by each of a wide range of components. Objectively, most electronic equipment is really very good. Speaker quality, however, is somewhat variable from model to model and brand to brand. A third category of equipment, accessories, ranges from the sometimes helpful through the silly to the truly demented. (For further exploration of that last category, browse through virtually any issue of *The Stereophile* and *The Absolute Sound*.)

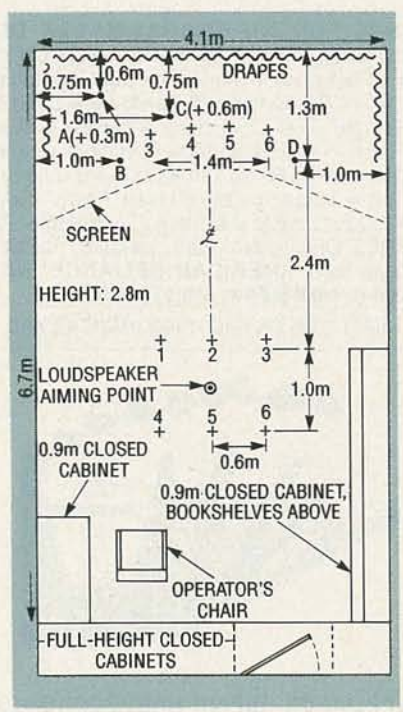


FIG. 1—THE FLOOR PLAN of the National Research Council of Canada's speaker listening room shows loudspeaker and listener locations. Loudspeakers were placed at positions 3, 4, 5, and 6 in monophonic tests, with listeners at positions 1, 3, and 5. In stereophonic tests, loudspeakers were at position B and D, and listeners at positions 2 and 5.

Loudspeakers

It seems to me that amplifiers are pretty much cut and dried in the sense that competent designers can give them any desired sort of quality. Although I find it strange that an engineer would deliberately introduce—or fail to eliminate—nonlinearities in an amplifier design I know for a fact that this has sometimes been done in the misguided pursuit of euphonic (ear-pleasing) effects. In any case, it's not that difficult to produce a virtually perfect amplifier, which is defined as one being free of audibly disturbing artifacts.

Loudspeakers are an altogether different ball game. Their complexities are reflected in the seeming endless series of technical papers, experiments, and products produced over the years. The recent AES Convention provided an excellent overview of the raging controversies and unsolved problems still besetting the world of loudspeakers. The essential question confronting the loudspeaker designer are: What should a loudspeaker do, and how can the designer determine when it's doing it correctly?

A comprehensive, if somewhat weighty, overview of those speaker evaluation problems was presented by M.R. Jason of National Public Radio. I'll discuss some of the issues raised by Mr. Jason.

The listener-preference approach as a means of evaluating loud-

eaker performance would seem the face of it to be an easy way to parate the good from the bad om the indifferent. But unless the aluations are based on *very* care- procedures and sophisticated atistical analysis, rather than sim- e listening tests, the results are ely to be misleading.

In fact, listener preference ap- ears to be so unreliable an evalua- on tool that a number of reputable ademic researchers have sug- ested that listener-preference sts be replaced by detectable-dif- rence tests. Those would test the ility of a listener to discriminate etween a test signal and a refer- nce signal. The thought seems to e that preference is determined by o many uncontrolled subjective ariables, while "detectability" at ast eliminates individual taste om the equation.

"Detectability" also eliminates ome of the problems of fast- ourier transform time-delay spec- ometry. One of the earliest users f the technique confided to me at ne point that while the displays ere undoubtedly impressive-look- g and contained lots of informa- on about what was happening uring the first several milliseconds f a pulse, the exact relevance to he music-reproductive abilities of ny particular speakers was, at est, unclear.

A Standard Listening Room

No one argues that loudspeaker erformance is independent of the oom in which it is playing. Even if ou had an ideal speaker—what- ver that is—the relative balance of he high and low frequencies, the evenness of the distribution of sound throughout the room, is strongly influenced, for better for worse, by the room size, propor- ions, wall treatments, furniture, speaker location(s), and listener po- sitions. All of those variable have to e standardized before evaluations can be meaningful to others who are working—or listening—with a dif- ferent set of conditions.

A major step toward standardiza- tion was taken in 1985, when the International Electrotechnical Com- mission (IEC) specified a standard listening room when it published its recommended practice for listening tests, *Listening Tests on Loud- speakers* publication 268-13. The standard room was not, as one might suppose, derived from some mathematically optimized ideal acoustic environment. It was based, instead, on a 22 × 13.5 × 9.2-foot room, shown in Fig. 1, used for lis- tening tests at the National Re- search Council of Canada in Ottawa. (The NRC roughly corre- sponds to the National Institute of Science and Technology in the U.S., but does far more practical research in support of various Ca- nadian industries. The NRC test and research facilities are largely re- sponsible for the general excel- lence of Canadian loudspeakers—but that's another story for another month.)

The room's acoustics were ad- justed somewhat with drapes and upholstered chairs. I visited the room shortly after it had been set up and I remarked on its acoustic nor- malcy. It was explained that it was intended to represent a good do- mestic listening environment typical of North America and Europe. Re- verberation time is 0.35 ± .085 seconds from 250 Hz to 4 kHz, ris- ing to 0.85 seconds at 40 Hz and falling to 0.25 seconds at 10 kHz.

Having a common reference en- vironment for speaker listening tests is a necessary tool, but cer- tainly only part of what needs to be done. Without going further into the complexities of speaker evaluation, let it suffice to say that it is no easy task—and certainly not as easy as most audio publications would have you believe. Floyd Toole, formerly of the NRC, has done significant work in correlating listener evaluations with measured performance. In the view of many experts, Toole's efforts have advanced audio art sig- nificantly toward the goal of "What you hear is what you measure—and vice versa."

Next month, I'll look at some ad- ditional AES papers that I think you'll find interesting. **R-E**

LEARN to CLEAN/ MAINTAIN/ REPAIR CAMCORDERS

HUGE EXPANDING MARKET!

Work from your home – part-time or full-time! No prior experience needed – Average mechanical ability only requirement for your success! Over *15 million* camcorders in use – Over *5 million* expected to be sold in 1991 alone!

It is a *fact* that the *vast majority* of camcorder malfunctions (just like VCRs!) are due to simple *mechanical* failure... We can show *you* how to *easily fix* those breakdowns and earn an average of $85.00/Hr. while working at home!

Get In Now – Soon camcorders will be like VCRs, i.e., one in almost every home.

For a camcorder cleaning job you can earn $65.00 for less than 30 minutes work.

For a camcorder repair job you can earn over $100.00.

FREE INFORMATION PACKAGE call or write:
Toll-Free 1-800-537-0589
Viejo Publications, Inc.
4470-107 Sunset Blvd. #600
Los Angeles, CA 90027, Dept. REC

CIRCLE 182 ON FREE INFORMATION CARD

Choose from 45 Career Opportunities!

Get Your Specialized Associate Degree or Career Diploma at Home in Spare Time

Now without attending college classes and with no previous experience, you can train for a money-making career...even get a Degree. Send for free facts and color brochure on employment opportunities in the field that interests you most. See how easy it is to train at home for a great career or advancement in your present job.

CALL TOLL FREE 1-800-234-9070 Ext. 489
CALL ANYTIME—24 hours a day, 7 days a week.
OR MAIL COUPON TODAY!

ICS SINCE 1890 International Correspondence Schools
Dept. ADES22S, 925 Oak Street, Scranton, PA 18515

Please send me free facts, color brochure and full information on how I can study at home for the career I have chosen. No obligation. CHECK ONE BOX ONLY!

ASSOCIATE IN SPECIALIZED BUSINESS DEGREE PROGRAMS
☐ Business Management
☐ Accounting
☐ Bus. Mgmt.—Finance Option
☐ Bus. Mgmt.—Marketing Option
☐ Applied Computer Science
☐ Hospitality Management

ASSOCIATE IN SPECIALIZED TECHNOLOGY DEGREE PROGRAMS
☐ Civil Engineering Technology
☐ Mechanical Engineering Technology
☐ Electrical Engineering Technology
☐ Industrial Engineering Technology
☐ Electronics Technology

CAREER DIPLOMA PROGRAMS
☐ High School
☐ Auto Mechanics
☐ Surveying and Mapping
☐ Drafting
☐ Air Conditioning & Refrigeration
☐ Wildlife/Forestry Conservation
☐ Police Sciences
☐ Private Security Officer
☐ Diesel Mechanics
☐ Electrician
☐ Small Business Management
☐ Gun Repair
☐ Electronics
☐ Microcomputer Repair
☐ Hotel/Restaurant Management
☐ Child Day Care
☐ Legal Assistant
☐ Interior Decorating
☐ Bookkeeping
☐ Art
☐ Motorcycle Repair
☐ Catering/Gourmet Cooking
☐ Computer Programming
☐ Computer Programming/COBOL
☐ Personal Computer Specialist
☐ Computer-Assisted Bookkeeping
☐ Fitness & Nutrition
☐ TV/VCR Repair
☐ Travel Agent
☐ Animal Care Specialist
☐ Photography
☐ Journalism/Short Story Writing
☐ Dressmaking and Design
☐ Florist

281XA

Name _____ Age _____
Address _____ Apt. # _____
City/State _____ Zip _____
Phone ( ) _____

DRAWING BOARD

Our oscilloscope is shaping up nicely.

ROBERT GROSSBLATT

If you're a regular reader of "Drawing Board," you know that the principles of design are just as important as the particulars of the circuit. Even though each series of columns winds up with a working gadget of one kind or other, the real idea behind all of it isn't to see how to design something in particular, but how to design anything in general. The real message is the method, not the minutiae.

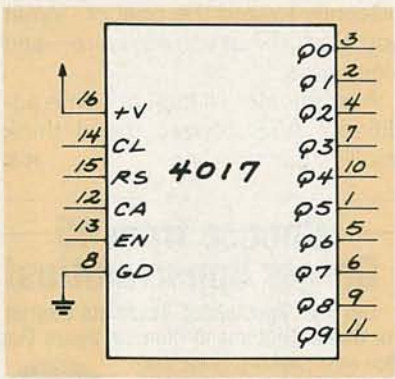


FIG. 1—THE 4017 DECADE COUNTER will be used to sequentially enable each of the LED columns at a rate chosen by the clock circuit we put together last month.

The reason for mentioning this is that we've come to the point where we're going to do the design of the horizontal driver circuit and there are lots of ways to get the job done. What we'll be doing together here is only one of them.

The job of this circuit is to sequentially enable each of the LED columns at a rate chosen by the clock circuit that we put together last month. Most small digital scopes (those with ten or less columns), use a 4017 decade counter to do this; that makes sense because it's exactly the kind of job the 4017 was designed to do. For scopes like ours where there are more than ten columns, the sequencing circuit generally gets more complex because there are no single-chip solutions to get the job done, and the 4017 wasn't really designed for sequential cascade counting. Decade counting is simply a matter of using the cascade output built into the chip, but doing sequential counting is something else altogether.

As you can see in Fig. 1, the chip has a limited number of control puts, and there's no easy way disable all the outputs. One outp will always be enabled no mat what you do to the control lines a whether or not the chip is getti clock pulses.

That's not to say, however, tha can't be done. After all, a 4017 is cheap, so available, and so perfe for the job, it would be a shame n to use it. All it takes is some logi glue and a bit of imaginative gati And that's what we're going to

I've been using various versio of this arrangement of 4017's years since it's a neat way to around the ten-count limit of 4017. As we all know, nothing is free and that goes here as w Since the 4017 will always have o of its outputs enabled, there's way we can string a bunch of th together sequentially and use ev output on every chip. That's the r son there are three 4017's be used in Fig. 2 even though we ne only twenty outputs. We lose last output of the first 4017 and t outputs from each of the others

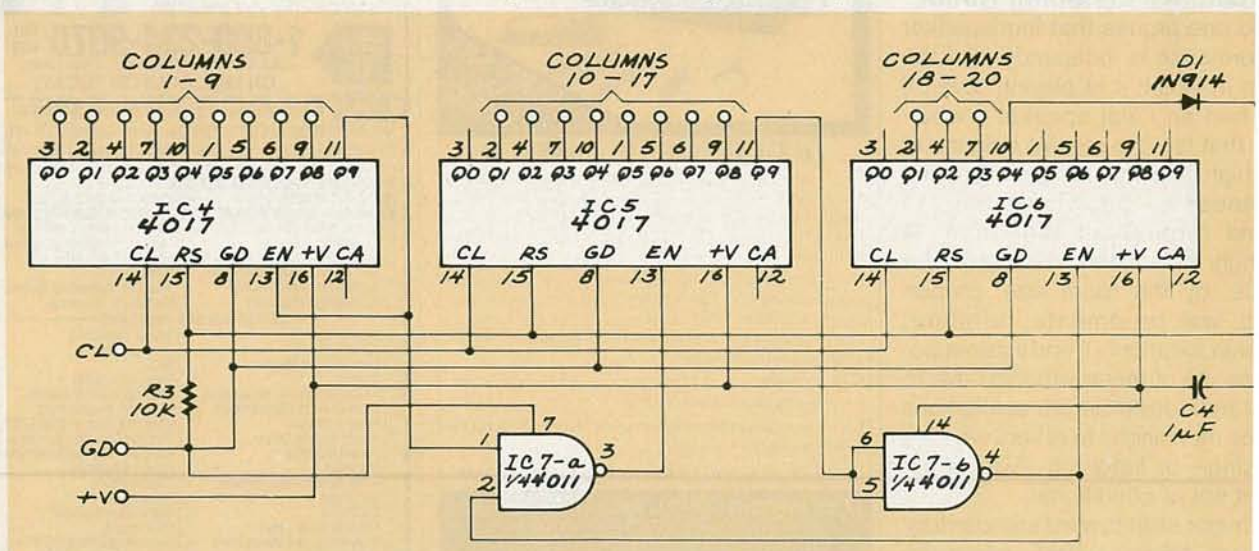


FIG. 2—BECAUSE ONE OUTPUT OF THE 4017 will always be enabled, we can't use every output on every chip. That's why there are three 4017's being used here even though we need only twenty outputs.

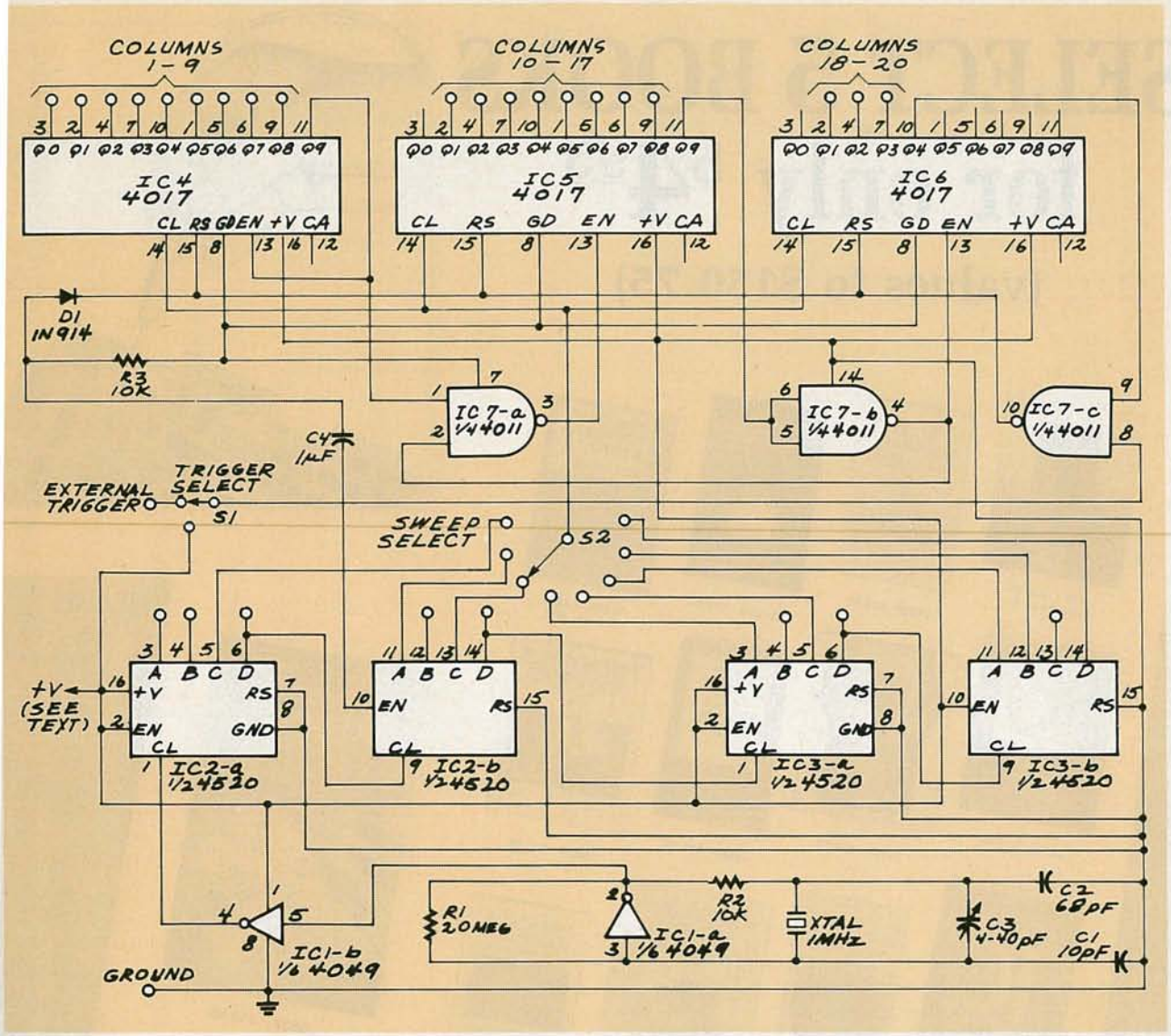


FIG. 3—HERE'S OUR OSCILLOSCOPE SO FAR. The NAND gate IC7-c is switched into the circuit in the triggered sweep mode. It resets when the trigger signal puts a high on the second leg of the NAND gate. If we want the scope to be free running, we switch the trigger leg of the gate to +V.

You should file this circuit away in our notebooks because it comes in handy when you least expect it. And for all you out there who were trained to eat absolutely everything on your plate, there are ways to reconfigure the circuit so you can use every single output of every single chip. Without going into the details, the problem is to create some sort of an external output enable control for the 4017. That can be done with buffers or transistors between the outputs of the 4017 and whatever the outputs are intended to control.

But I leave that to you. Any more of these asides and I'll wind up writing like Lawrence Sterne did in Tristram Shandy—digression upon digression upon digression.

By adding Fig. 2 to the stuff we did last month, we now have a working version of the horizontal circuit we defined at the outset of this design project. It does everything we specified and, if you wire it up on a breadboard, you'll see that the only other piece you have to add is an eight-position, single-pole rotary switch (a break-before-make type), so you can select the sweep speed being fed to the common clock inputs of the 4017's.

Before we leave the horizontal section of the scope, this is a good time to talk about how the scope is going to be triggered. If you're familiar with scopes, you know that most scopes offer you a choice of three basic ways to control the horizontal sweep: as a single shot, free-running, or triggered. Each of them is useful in different situations and, with the exception of free-running (most scopes refer to this as "normal"), the circuitry to make them happen needs some of the signals we'll be generating when we get to work on the design of our scope's vertical drive.

Any control of the horizontal sweep is directly translatable into what we do with the reset control lines of the 4017's. As you can see in Fig. 2, all the reset lines have been tied together and are controlled by

continued on page 98

SELECT 5 BOOKS for only $4.95

(values to $150.75)

3414 $39.95
Counts as 2

2883P $18.95

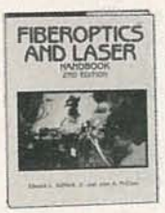
585120-2 $12.95

10024 $32.95
Counts as 2

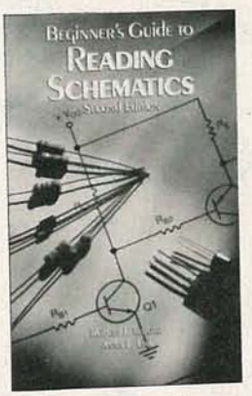
2613P $17.95

3107P $18.95

2980P $19.95



2981P $18.95



3632 $18.95

3550 $34.95
Counts as 2

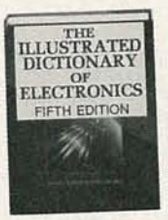
1367P $24.95

2800P $16.95

3321P $16.95

3672 $28.95

3145P $12.95



3345 $39.95

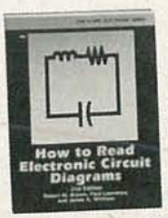
3576P $14.95

3270 $32.95
Counts as 2

3241P $16.95

3677 $34.95
Counts as 2

3122P $21.95



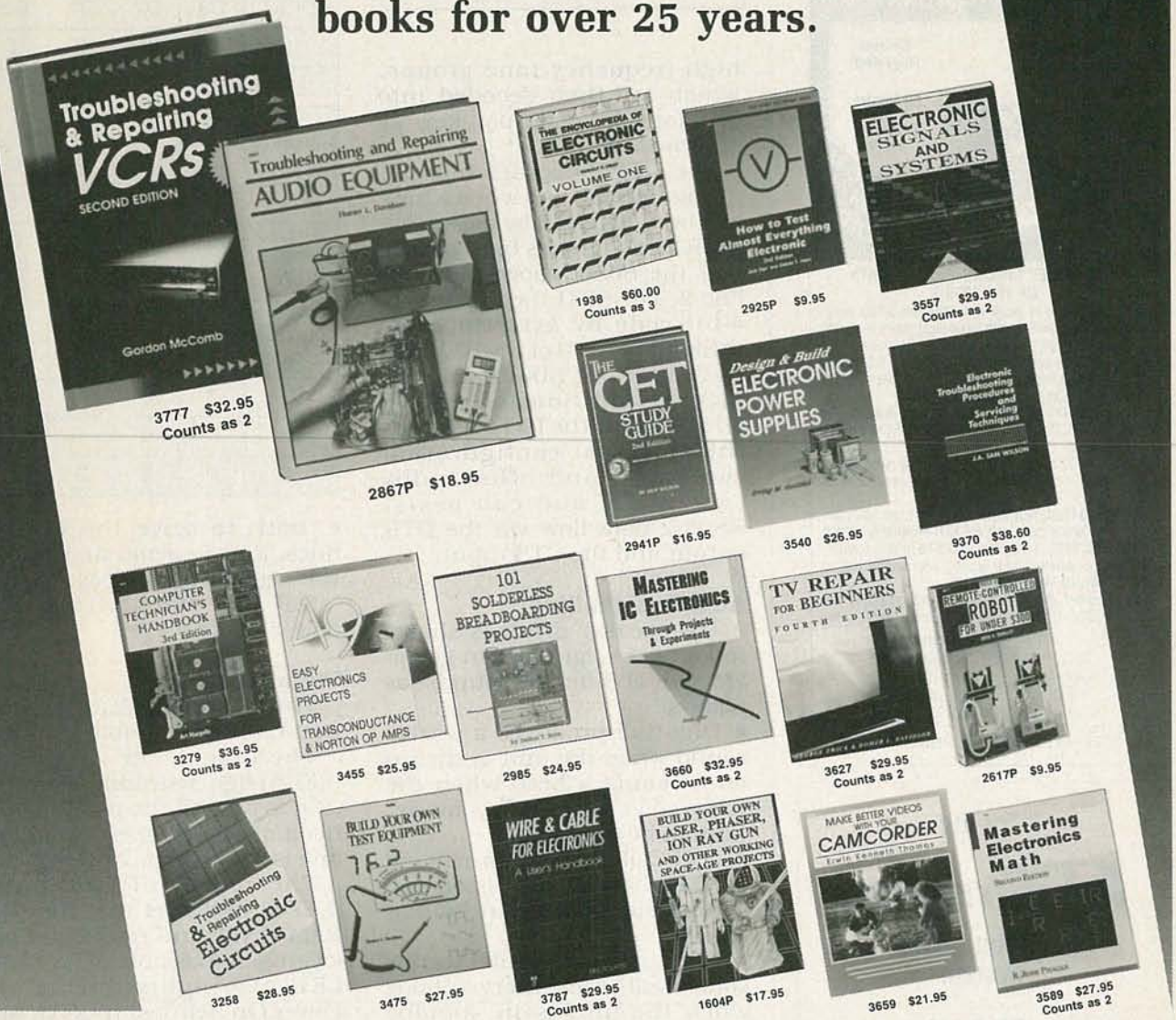
2880P $14.95

3804P $19.95

2947P $13.95

3778 $26.95

Your most complete source for electronics books for over 25 years.



3777 $32.95 Counts as 2

2867P $18.95

1938 $60.00 Counts as 3

2925P $9.95

3557 $29.95 Counts as 2

2941P $16.95

3540 $26.95

9370 $38.60 Counts as 2

3279 $36.95 Counts as 2

3455 $25.95

2985 $24.95

3660 $32.95 Counts as 2

3627 $29.95 Counts as 2

2617P $9.95

3258 $28.95

3475 $27.95

3787 $29.95 Counts as 2

1604P $17.95

3659 $21.95

3589 $27.95 Counts as 2

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 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. (Publishers' Prices Shown)

All books are hardcover unless number is followed by a "P" for paperback.
©1992 ELECTRONICS BOOK CLUB, Blue Ridge Summit, PA 17294-0810

ELECTRONICS BOOK CLUB

Blue Ridge Summit, PA 17294-0810

☐ YES! Please accept my membership in the Electronics Book Club and send the 5 volumes listed below, 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.

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.

RE392

LEARN VCR
CLEANING/MAINTENANCE/REPAIR
EARN UP TO $1000 A WEEK, WORKING PART TIME FROM YOUR OWN HOME!

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.
4470-107 Sunset Blvd., #600
Los Angeles, CA 90027, Dept. RE

CIRCLE 181 ON FREE INFORMATION CARD

Try the

Radio Electronics®

bulletin board system

(RE-BBS)
516-293-2283

The more you use it the more useful it becomes.

We support 1200 and 2400 baud operation.

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

Add yourself to our user files to increase your access.

Communicate with other R-E readers.

Leave your comments on R-E with the SYSOP.

RE-BBS
516-293-2283

PHONE-LINE MONITOR

continued from page 58

high-frequency tone groups, which are then decoded into one four-bit code per key, as shown in Table 3.

The DTMF decoder informs the microprocessor when a tone has been detected by asserting $\overline{\text{T-STB}}$, which drives bit 6 of port 1 of the 8031, shown back in Fig. 2. The 8031 then reads the 4-bit code by asserting T-OE through port C0 of the PIO, and reading bits PB0–PB3 of the PIO. In addition to reading DTMF codes, the PIO also reads the status of configuration switch S1 and off/standby switch S2, and can assist RS-232 data flow via the DTR output and the CTS input.

Audible signalling

The speaker driver is shown in Fig. 4-e. Digi-Call can generate several different sounds, as follows.

- Digi-Call produces a warble sound when the unit is turned on; it emits a beep when the user selects standby mode. Cannot be disabled.
- Digi-Call produces a ringing sound when the unit is on and the phone rings. Can be disabled.
- The turn-on reminder warble sound will chime every ¼ hour when the unit is in standby mode. Can be disabled.
- Power loss causes a short beep to be produced every minute. Cannot be disabled.
- A RAM-full condition causes an alarm to sound every minute until data is erased using the PC-based utility program. Cannot be disabled.
- Illegal configurations of S1 cause a continuous slow-going high-low beep. Cancel by choosing legal switch positions. We'll discuss S1 further next time.

The microprocessor has an internal serial interface that Digi-Call uses to transfer stored telephone data to the PC. However, the microprocessor's TTL levels are not compatible with standard RS-232 levels, so we use a MAX-232, shown in Fig. 4-e, both to drive the RS-2 lines, and to generate the ± volt signalling voltages. We a "steal" the −9-volt DC output power op-amp IC1.

TABLE 3—
DECODED DTMF OUTPUTS

DIGIT	D3	D2	D1	D0
1	0	0	0	1
2	0	0	1	0
3	0	0	1	1
4	0	1	0	0
5	0	1	0	1
6	0	1	1	0
7	0	1	1	1
8	1	0	0	0
9	1	0	0	1
0	1	0	1	0
*	1	0	1	1
#	1	1	0	0

Status indicators

Three status LED's indic Digi-Call's operational status

The green "On" indica (LED4) lights steadily when unit is on and the phone is hook; it blinks when the pho line is off-hook or ringing.

The red "Full" indica (LED3) indicates that the d RAM is full and no further logging is possible. The "F LED also lights during Power On Self Test (POST), during the diagnostics acce ble through the host PC s ware. Last, LED3 blinks slo if configuration switch S1 is to an illegal combination.

The Watch Dog indica (LED5) blinks slowly under mal circumstances, and rap if powered by the batteries.

The power supply, showr Fig. 5, is designed to ope even in the absence of AC po Blocking diode D9 isola back-up cells B1–B6 while power is present; resistor determines charge current the batteries. Digi-Call function with nonrechargea batteries, in which case should not be installed.

Next time we'll build the and get it up and running.

48 HOUR SHIPPING

ELENCO & HITACHI PRODUCTS AT DISCOUNT PRICES

TO ORDER CALL TOLL FREE 1-800-292-7711

Hitachi RSO Series

ortable Real-time Digital Storage Oscilloscopes)

/C-6023 - 20MHz, 20MS/s _____ $1,695
/C-6024 - 50MHz, 20MS/s _____ $1,995
/C-6025 - 50MHz, 20MS/s _____ $2,195
/C-6045 - 100MHz, 40MS/s _____ $2,995
/C-6145 - 100MHz, 100MS/s _____ $4,495

SO's from Hitachi feature roll mode, averaging, save emory, smoothing, interpolation, pretriggering, cursor easurements. These scopes enable more accurate, mplier observation of complex waveforms, in addition to uch functions as hardcopy via a plotter interface and aveform transfer via the RS-232C interface. Enjoy the omfort of analog and the power fo digital.

SPECIAL BUY

V-212 - 20MHz Scope $425

Hitachi Portable Scopes

DC to 50MHz, 2-Channel, DC offset function, Alternate magnifier function

V-525 - CRT Readout, Cursor Meas. $995
V-523 - Delayed Sweep _____ $975
V-522 - Basic Model _____ $875
V-422 - 40MHz _____ $775
V-223 - 20MHz delayed sweep _____ $695
V-222 - 20MHz deluxe _____ $625

HITACHI COMPACT SERIES SCOPES

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

V-660 - 60MHz, Dual Trace _____ $1,149
V-665A - 60MHz, DT, w/cursor _____ $1,345
V-1060 - 100MHz, Dual Trace _____ $1,395
V-1065A - 100MHz, DT, w/cursor ___ $1,649
V-1085 - 100MHz, QT, w/cursor ___ $1,995
V-1100A - 100MHz, Quad Trace ___ $2,195
V-1150 - 150MHz, Quad Trace _____ $2,695

5MHz Elenco Oscilloscope

$349
S-1325
• Dual Trace
• 1mV Sensitivity
• 6" CRT
• X-Y Operation
• TV Sync
• (2) 1x, 10x Probes included

PRICE BREAKTHRU

20MHz Digital Storage Oscilloscope

- Analog/Digital Scope
- 2K word per channel memory
- 10MS/s sampling rate
- State-of-art technology
- Includes probes

DS203
$795

Elenco 40MHz Dual Trace

Good to 50MHz
$495
S-1340
• High luminance 6" CRT
• 1mV Sensitivity
• 10KV Acceleration Voltage
• 17ns Rise Time
• X-Y Operation
• Includes (2) 1x, 10x Probes

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 opes. Call or write for complete specifications on these and many other fine oscilloscopes. **1x, 10x Scope Probes: P-1 65MHz $19.95, P-2 100MHz $26.95**

B + K TEST EQUIPMENT

All Models Available

Call for special price

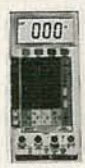
Digital Capacitance Meter

CM-1550B
$58.95
9 Ranges
.1pf-20,000ufd
.5% basic accy.
Zero control w/ Case
Big 1" Display

Digital LCR Meter

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

Multimeter with Capacitance & Transistor Tester



$55 CM-1500B
Reads Volts, Ohms Current, Capacitors, Transistors and Diodes / with case
Big 1" Display

FLUKE MULTIMETERS

All Models Available

Fluke 70-II ___ $65
Fluke 77-II ___ $145
Fluke 79-II ___ $169
Fluke 87 ____ $289
Call for special price

Quad Power Supply XP-580

$59.95
2-20V @ 2A
12V @ 1A
5V @ 3A
-5V @ .5A
Fully regulated and short circuit protected

Digital Triple Power Supply

XP-765
$269
0-20V @ 1A
0-20V @ 1A
5V @ 5A
Fully regulated, Short circuit protected with 2 limit control, 3 separate supplies
XP-660 with Analog Meters $195

AM/FM Transistor Radio Kit with Training Course

Model AM/FM 108
$26.95
14 Transistors • 5 Diodes
Makes a great school project

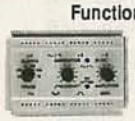
True RMS 4 1/2 Digit Multimeter

M-7000
$135
.05% DC Accuracy
.1% Resistance
with Freq. Counter and Deluxe Case

GF-8016 Function Generator with Freq. Counter

$249
Sine, Square, Triangle
Pulse, Ramp, .2 to 2MHz
Freq Counter .1 - 10MHz
Int/Ext operation
-8015 without Freq. Meter $179

Function Generator Blox



#9600
$28.95
Provides sine, triangle, square wave from 1Hz to 1MHz
AM or FM capability

Color Convergence Generator

SG-250
$79.95
Kit $59.95
Finest in the industry
10 rock steady patterns
RF & Video output

STANDARD AMATEUR RADIOS

Now available - The worlds finest amateur radios. Unsurpassed quality and features make STANDARD the worlds most popular line of amateur radios.

Mini Deluxe HTs:
C168A 2 meter
C468A 450MHz
CALL

Twin Band HTs
C228A 2M/220MHz
C528A 2M/440MHz
CALL

Twin Band Mobile
C5608DA 2M/440MHz CALL

We also have many accessories for these radios and most heath radios. Call for details.

Learn to Build and Program Computers with this Kit

Includes: All Parts, Assembly and Lesson Manual

Model MM-8000
$129.00

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.

Wide Band Signal Generators

SG-9000 $129
RF Freq 100K-450MHz AM Modulation of 1KHz Variable RF output
SG-9500 w/ Digital Display & 150 MHz built-in Counter $249

High Current Power Supply

XP-800
$295
Digital Volt/Amp Meters
Fully regulated, 0-122VAC @ 2A, 0-40VAC @ 10A or 0-30VDC @ 10A. Fully variable, Short circuit protected.

WE WILL NOT BE UNDERSOLD!
PS Shipping: 48 States 5%
$3 Min $10 Max) Shipping
L Res., 7.5% Tax FAX: 708-520-0085

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

VISA MasterCard

15 Day Money Back Guarantee
2 Year Warranty Prices Subject to Change
WRITE FOR FREE CATALOG

CIRCLE 109 ON FREE INFORMATION CARD

COMPUTER CONNECTIONS

Industry evolution

JEFF HOLTZMAN

IBM dominates the news this month. Since last time, Big Blue signed an historic accord with Intel, formed a trade group with Apple and Motorola, and commenced internal restructuring that, if successful, could point the way to survival for several major U.S. industries (not just the computer industry). If, however, that restructuring is unsuccessful, it may be a harbinger of how the computer industry will follow the automotive and steel industries down the tubes.

IBM + Intel

With the new-found friendship among IBM, Apple, and Motorola reached last summer, you may have wondered about IBM's commitment to the Intel platform. Well, wonder no longer. IBM and Intel signed a ten-year agreement under which they will collaborate on the design of new 80x86 IC's. About the significance of this deal, Intel's CEO Andrew Grove has said, "This is probably the biggest deal I have signed in my professional career."

The two companies will establish a 100-person development center composed of scientists and engineers from both IBM and Intel. Intel will contribute CPU designs; IBM will contribute systems-level expertise and semiconductor manufacturing technology. (It's not well known that IBM is one of the largest semiconductor manufacturers in the world.) It will take about two years to produce results, including highly integrated modules that incorporate CPU, cache memory, memory management, bus interface logic, disk controller, and graphics. The companies will develop these products jointly; IBM will have a four-month lead in commercializing systems, after which time Intel can sell IC's on the open market. IBM has had the right to build and enhance its own 386 CPU's since 1987. (An enhanced CPU would include the 386SLC, the "weird" CPU mentioned here last time as part of IBM's Ultimedia PC.) However, the new agreement precludes IBM from enhancing future 486-based CPU's.

IBM's four-month lead, as well the changing business climate, has competitors like Compaq deeply worried. For years Compaq was one of Intel's most loyal customers. Recently, however, the company has been warming up to AMD, which is expected to release a line of 486 clones sometime in 1992. Because AMD and Chips & Technologies have already successfully cloned the 386, Intel's marketing effort is focusing more and more on the 486 line. AMD is achieving great success with its 386 line by exceeding its own sales forecasts of 386 clones by 400% through 1991, for a total of about 20% of the 386 market. Intel also suffered a setback in the math coprocessor clone department; a judge in Texas has ruled that Cyrix may continue selling its FasMath clones until a combined antitrust/patent infringement case reaches trial in late summer 1992.

The good thing about all of this is that Intel is not content with trying to protect its prior accomplishments, and in the process leaving the fate of the company (not to mention the industry that depends on x86 chips) up to its lawyers. Rather, it is moving ahead and designing innovative new products, thereby staying a step or two ahead of the cloners. If the software industry followed this kind of model, we'd probably be much further along in the move toward graphical operating environments.

IBM + Apple + Motorola

Those three companies are forming a trade association, PowerOpen, dedicated to defining and promulgating software standa for the RISC-based PowerPC ar tecture announced as part of summer's historic Apple/IBM cord. These standards involve d ning the instruction set of PowerPC, a cross-platform bin compatibility layer called the plication Binary Interface (ABI), high-level programming interfac The intent of these technologie to provide a "universal" softw environment that will support fu Macintosh and OSF/Motif appl tions, as well as current Mac DOS applications (through e lators), and AIX applications. (A IBM's version of UNIX.) IBM Apple are also talking about m ing AIX and AU/X (Apple's vers over the next few years.

With both Motorola and Intel i hip pocket, IBM now stands po to build an incredible machine, that provides hardware-level port for the major operating tems of the 90's: Macintosh, D Windows, and standards-ba UNIX. 1993 will be an interes year for PC system architectu

IBM restructuring

IBM's restructuring may see be one of those ho-hum things the company seems to go thr with increasing frequency in re years. Don't bet on it. IBM is in trouble. Not only IBM the com but America's whole way of d business. If IBM fails, we're all g to be liable to significantly incre risk of domination by unfriendl eign vendors. There are people believe that this risk represer greater threat to our society way of life than the political and tary risks usually harped on b press, in Washington, and ir state and local governments. may not like IBM, but you'd b hope that it finds a way of resp

g competitively to the changes go-
g on in the world at large.

The most visible but probably
ast strategically important change
as the "reduction" of 20,000 jobs,
a one-time cost of $3 billion.
ore significant is the decision to
duce control over and grant in-
eased autonomy to IBM's major
visions (mainframe, AS/400,
S/6000, PC's, core technologies,
c.). Under this new scheme, each
vision will exert greater control
er its fate, thereby allowing faster
sponse time to rapidly changing
arket conditions. In recent years,
M has suffered increasingly at the
nds of smaller, more efficient,
ore integrated companies that
uld detect and rapidly respond to
me market need, be it portable
C's, engineering workstations, op-
ating systems, or what have you.
M suffered again and again be-
use its bureaucracy got in the way
responding to rapidly changing
stomer needs. In addition, the
mpany suffered from internal
ckering over product features and
arketing. In some cases, com-
etitors were able to commercialize
oducts before IBM could get out
the planning stage. Meanwhile,
e company's market share and
edibility dropped on a yearly basis,
chieving crisis level in the early part
f this decade.

It's still too early to tell whether
ese changes will provide the
eeded benefits. There are plenty of
keptics who say that A) the
hanges do not go far enough, and
) even if they did, they cannot be
nplemented in time.

I hope the nay-sayers are wrong.
he U.S. needs new models of
oing business on a very large
cale; IBM is poised to lead the way.
IBM fails, who, if anyone, will be
ble to show us how?

lews bits

Intel has leaked more details of
e **586,** which will contain 256K of
ache memory, a 64-bit data bus,
nd a 36-bit address bus. It will run
t speeds of 33-, 50-, 66-, and 100-
MHz, and it will execute common
nstructions at a rate of two per
lock cycle. By contrast, the 486
uns at a maximum of one instruc-
ion per cycle, and the 386 at two.

Phoenix Technologies (of clone BIOS fame) has created a reference design for a new class of device called a Companion PC. It will have a 6" × 10" footprint, a full keyboard, CGA graphics, long battery life, and software support (including DOS 5.0 in ROM) by Microsoft and Lotus. Sony, meanwhile, has shown a hand-held pen-based input device, currently sold only in Japan for about $500. The PTC-300 measures about 2.5" × 6" × 1", and has a large LCD used for both input and output. The device performs scheduling, database, and note-taking functions, appears to have a calculator-style keypad, and communicates with a docking station via infrared link. Apple is known to be working with Sony on some sort of miniaturized hand-held device, possibly CD-ROM based.

PRODUCTS AND VENDORS

- Adobe Type Manager ($99), Adobe Systems Incorporated, 1585 Charleston Road, P.O. Box 7900, Mountain View, CA 94039-7900. (800) 833-6687, (415) 961-4400.
  CIRCLE 41 ON FREE INFORMATION CARD

- CrossTalk for Windows 1.2 ($195), DCA, 1000 Alderman Drive, Alpharetta, GA 30201-4199. (404) 442-4000.
  CIRCLE 42 ON FREE INFORMATION CARD

- Designer 3.1 ($695), Micrografx, 1301 Arapaho, Richardson, TX 75081. (800) 733-3729, (214) 234-1769.
  CIRCLE 43 ON FREE INFORMATION CARD

- Word for Windows 2.0 ($495), Microsoft Corp., One Microsoft Way, Redmond, WA 98052-6399. (206) 882-8080.
  CIRCLE 44 ON FREE INFORMATION CARD

- *Multimedia Programmer's Reference* ($27.95), *Multimedia Authoring and Tools Guide* ($24.95), and *Multimedia Programmer's Reference* ($22.95), Microsoft Corp.
  CIRCLE 45 ON FREE INFORMATION CARD

- *The Programmer's PC Sourcebook* ($39.95), Microsoft Corp.
  CIRCLE 46 ON FREE INFORMATION CARD

- Lantastic 4.0 ($99/$50 upgrade), Lantastic for Windows ($299), Artisoft, Artisoft Plaza, 575 E. River Road, Tucson, AZ 85704. (602) 293-6363.
  CIRCLE 47 ON FREE INFORMATION CARD

Product watch

About twice a year or so I feel obligated to report on the software I'm currently using. Things have actually settled down in the past year and a half or so; I haven't switched a single major application in that time. Best Windows word processor: still Word for Windows, recently upgraded to version 2.0. It is unquestionably the most powerful and best integrated product for the Windows environment. Its desktop publishing features are still weaker than I'd like, but otherwise, I have few complaints. WW2 now has built-in drawing and charting packages, and a much more logical user interface. (If you install all the extras, you'll need about 15MB of disk space. I know it hurts, but this is a trend that seems likely to continue.) The program lists for $495, but just about anyone can obtain an "upgrade" for $129 by calling (800) 323-3577, Ext. W87. Drawing/illustration package: Designer 3.1, which boasts much increased speed compared with the previous version, text along a curve, batch printing, and more. Best Windows utility: Adobe Type Manager (ATM), version 2.0. Print any font on any Windows-supported printer, and see it accurately displayed on-screen. Best telecommunications program: Crosstalk for Windows, version 1.2. This version adds support for networked modems, icon-based session launching, dialing queues, and numerous small enhancements. I regularly transfer huge files in the background at 9600 bps with total reliability.

Best small-office network: LANtastic 4.0 The latest version adds speed and support for operating both servers and workstations under the 386-enhanced mode of Windows 3.0 (see Fig. 1). A new utility allows a dedicated server to devote all its resources to the network, greatly improving performance. LANtastic for Windows provides full

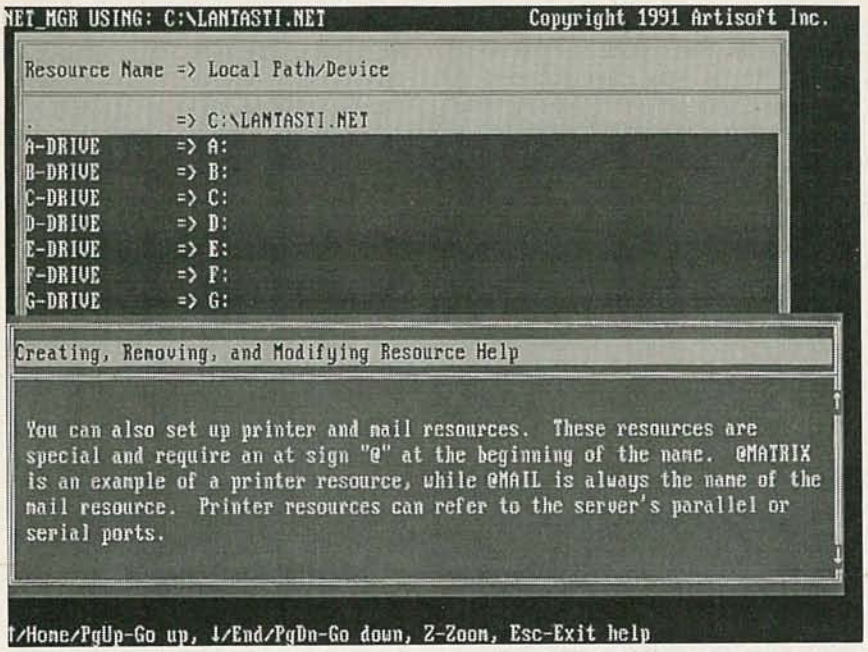


FIG. 1—LANTASTIC 4.0 provides greater speed and security, and full support for Windows 3.0. A separate Windows utility allows full access to all network and management functions.

Windows-based versions of the NET and NET—MGR programs which allow you to log on and off the network, administer network resources, etc. If you're in the market for a fully Windows-integrated, low-cost, DOS-based local area network, there's really no other choice.

Book nook

If you're interested in getting started with multimedia development under Windows, but don't have a clue about how to get started, check out these three volumes: *Multimedia Programmer's Reference*, *Multimedia Authoring and Tools Guide*, and *Multimedia Programmer's Reference*. All three a published by Microsoft; they a also included as part of Microso Multimedia Development Kit. T *Reference* details Windows syst calls, file formats, and data str tures; the *Workbook* describ sample applications; the *Gu* shows how to build multimedia plications. Another impressive crosoft volume is the secc edition of the *The Programmer's Sourcebook*, which contains ab 800 pages of tables covering j about everything you could poss want to know about the PC ar tecture, both hardware and s ware. Want to know how to cr wire a 9- to 25-pin RS-232 adapt No problem. How about the st ture of the boot sector of a flo disk? Easy. Maybe a listings o BIOS, DOS, and Windows func calls? Simple. May 8088/86/286/386/486 instruc sets? Piece of cake. Not to m tion: physical sizes and shape XT/AT/EISA/MicroChannel ex sion cards, expansion bus pino IC pinouts, etc., etc., etc. If you just one technical reference on PC architecture, this should be

Next time: An in-depth loo CompuAdd's Multimedia upgr components.

MESSAGING SYSTEM

continued from page 64

whenever A6 or A7, or both, are low at the time $\overline{CE}$ goes low. The ISD 1016's storage array is arranged in 160 segments of 0.1 second each. The segments are numbered 0–9Fh. They may be accessed randomly, however play and record operations will access them sequentially beginning with the address supplied by DIP switch S4 at A0–A7, until an EOM marker is encountered, or the operation is terminated by bringing $\overline{CE}$ high.

To determine the address to use to select a particular message, or to record a message at a specific point in memory, we will use a simple example. Suppose we want to hear a message we know starts at the 5-second point in memory. Each memory segment is 0.1-second long, so our message starts at segment 50 (5/0.1 = 50). Now we simply convert the decimal segment number into hex (50 decimal = 32 hex). Thus S4 switches 1–4 must be a binary "3" and switches 5–8 must be a binary "2," so switches 2, 5, and 6 would be open (bits 1, 4, and 5 high).

Configuration mode

If address bits 6 and 7 are both high (S4 switches 7 and 8 both open) at the time $\overline{CE}$ goes low, the ISD 1016 enters the "Configuration Mode," in which address bits A0–A5 (S4 switches 1–6) take on a different meaning. In this mode, those address bits no longer specify addresses. Instead, they select among the various options available as shown in Table 2.

To illustrate the use of Configuration mode, let's assume recorded a message using instructions given earlier, we would like to have it re continuously. (Make sure message is less than 16 seco long so the "overflow" condi won't disable the chip after first replay. Also, the Addres mode and Configuration m are mutually exclusive, so can have only one messag Configuration mode.) To the message back continuo we want to be in the Config tion mode; A3, A6, and A7 (open), and the rest of the dress switches closed. Now Power down/Up to the "up" tion, and set Disable/Enab the "enable" position. The sage that your recorded will repeat continuously until set to the "disable" positio of course, until your batt power gets used up).

BUYER'S MART

FOR SALE

STRICTED technical information: Electronic veillance, schematics, locksmithing, covert nces, hacking, etc. **Huge selection. Free chures. MENTOR-Z,** Drawer 1549, Asbury , NJ 07712.

FIBER optics kits, Experimenters $24.50, Datalink w/PCB $36.25, **HILL ELECTRONICS,** Box 47103, Phoenix, AZ 85068-7103.

CABLEBOX: Fully activate your Zenith ST5612, with no parts! Illustrated instruction manual $9.99. **JIM CHASE,** Box 148332, Nashville, TN 37214.

CLASSIFIED AD ORDER FORM

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

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

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

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

Special Category: $25.00

PLEASE PRINT EACH WORD SEPARATELY, IN BLOCK LETTERS.

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

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

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

Card Number _____ Expiration Date _____

Please Print Name _____ / Signature _____

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

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

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.

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

WIRELESS CABLE RECEIVERS 1.9 TO 2.7 GHz

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

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

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

VISA/MC/AMEX

ORDERS ONLY 1-800-484-4190 CODE 9793

CIRCUIT Boards — Complete printed circuit fabrication from single sided to production multilayers. Twenty-four hour turnaround available. **CIRCUIT CENTER,** PO Box 128, Addison, IL 60101. (708) 543-0671.

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

TEST equipment pre-owned now at affordable prices. Signal generators from $50.00, oscilloscopes from $50.00, other equipment, including manuals available. Send $2.00 U.S. for catalog, refunded on 1st order. **J.B. ELECTRONICS,** 3446 Dempster, Skokie, IL 60076. (708) 982-1973.

DESCRAMBLERS: Oak Sigma, Varisync, Hamlin, Scientific Atlanta, Jerrold, Pioneer, Sylvania. Catalog $5.00 moneyorder (credited first order), service manuals, schematics, **SURPLUS ELECTRONICS,** PO Box 10009, Colorado Springs, CO 80932.

CB RADIO OWNERS!

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

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

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

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

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

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

CABLE DESCRAMBLERS

Converters, Remote Controls, Descramblers, more

All major brands carried

*JERROLD, *TOCOM, *ZENITH
*GENERAL INSTRUMENTS
*SCIENTIFIC ATLANTA, *OAK
*HAMLIN, *EAGLE, *PIONEER

7th Year in business. Thank You
Member of Omaha Chamber of Commerce
1 Year warranty on new equipment
30 Day money back guarantee
Orders shipped from stock within 24 hours

CALL TODAY FOR A FREE CATALOG

1-800-624-1150

VISA MasterCard AMERICAN EXPRESS C.O.D.

M.D. ELECTRONICS
875 SO. 72nd St.
Omaha, NE 68114

CIRCLE 53 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 65 kits and over 1,400 unique, bargain priced, components in our catalog!

FREE CATALOG with OVER 1400 DIFFERENT ITEMS INCLUDING KITS! REQUEST YOUR COPY TODAY!

MACHO METER KIT
Five bright LEDS flash at random then reveal your rating. 9V battery not included.
C6362 $10.95

ROLLING DICE KIT
This kit will replace your ordinary dice and will "roll" your number for you. 9V battery not included.
C6412 $14.95

JUNGLE BIRD KIT
This kit produces the sounds of exotic jungle birds with 2 controls to adjust sound. 9V battery not included.
C6374 $6.25

FISH CALLER KIT
The clicking sound produced by this kit is said to attract fish! Give it a try! 9V battery not included.
C4566 $4.50

INSANITY ALARM KIT
In light it's silent, but when the lights go out, the alarm goes on! Lots of fun to use. 9V battery not included.
C6240 $6.95

FLASHING STOP SIGN KIT
Bright red and white stop sign with 22 ultra-bright red LEDS that flash. 9V battery not included.
C6458 $10.95

INEXPENSIVE GEIGER
Detects both Beta and Gamma Rays. 9V battery not included.
C6447 $39.95

INFRARED DETECTOR
Great for testing and verification of infrared output. 9V battery not included.
C6441 $5.95

MINIMUM ORDER: $10.00 plus $3.50 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 FAX ORDERS (602) 451-9495

CIRCLE 177 ON FREE INFORMATION CARD

SUBWOOFER design software. Design: por sealed, isobarik enclosures. Calculates optin box size, graphs performance any subwoofer. 5.25 disk: $19.95, **SUB-ENGINEERING,** 1236-R, Corvallis, OR 97330.

PAY TV AND SATELLITE DESCRAMBLING
ALL NEW 1992 EDITION ALL NEW

It's up to the minute. All new update on cable, wireless and satellite. Tur bypasses, circuits, chipping, bullets, bags, Dectec, Liberty One, ECM's Readers, programming, and lots more. Our best yet.Only $15.95. Other (ferent) editions 1991, 1989, Volume One (Basics) $15.95 each. MDS Han $9.95. Satellite systems under $600 $12.95.. Any 3/$29.95 or 6/$49.95. $29.95. Scrambling News Monthly $24.95/yr. Sample $3. All new catal Shipping costs included.

Scrambling News, 1552 Hertel Ave.,
Buffalo, NY, 14216. Voice/Fax (716) 874-2088
COD'S ARE OK. ADD $6

DESCRAMBLERS, M-35-B $19.00, RTC $69.00, Z-Tac $199.00, 5503 $199.00, SA $59.00, FTB $59.00, all brands in stock. **MO HOOD ELECTRONICS,** (206) 260-0107.

CABLE boxes. All brands and models. Full ranty, same day shipping, examples RT $69.00, 5503-VIP turn on chip $29.00, M-35 @ $14.00 ea. **S.A.C.,** 1 (800) 622-3799.

CABLE test chips. S-A 8550, S-A 8500 — 311, 320, 321 (specify) — $33.95. S-A 858C — $69.95. Tocom 5503/07 VIP — $33.95. **TI CODE,** PO Box 6426-RE, Yuma, AZ 85366-6

CABLE TV
DESCRAMBLER LIQUIDATI
FREE CATALOG!
Hamlin Combos $44, Oak M35B $60 (min. 5
WEST COAST ELECTRONI
For Information: 818-709-1758
Catalogs & Orders: 800-628-965

LAND/General mobile radios, CB's, scan radar detectors, auto alarms, marine t ceivers catalog $2.00, RAYS, Box 14862R Worth, TX 76117-0862.

TURN-ON kits for Starcom VII, $40.00; Sta VI, $30.00; Starcom DPBB, $50.00; Pio $75.00; Tocom VIP 5503/5507, $25.00, $30.00; Zenith, $25.00; Call **N.E. ENGIN ING,** (617) 770-3830.

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

LIFETIME WARRANTY

Quality Microwave TV Antennas
WIRELESS CABLE - IFTS - MMDS - Amateur TV
Ultra High Gain 50db(+) • Tuneable 1.9 to 2.7 Ghz.
• 36-Channel System Complete $149.95
• 12-Channel System Complete $114.95
• Call or write (SASE) for "FREE" Catalog
PHILLIPS-TECH ELECTRONICS
P.O. Box 8533 • Scottsdale, AZ 85252
(602) 947-7700 ($3.00 Credit all phone orders)
MasterCard • Visa • COD's • Quantity Pricing

FINALLY —A cross part database program for industry standard part numbers. Crosses industry standard part numbers to two manufacturers of replacement components. Gives the user technical information and allows the user to create a database of electronic components. (3) — 3 ½ disks. IBM PC/compatible. Send $38.00 to CPS SOFTWARE, PO Box 28, Blackwell, OK 74631.

IMPOSSIBLE cable systems. New user programmable units authorize any or all features of Pioneer or Jerrold descramblers. **TAKE CONTROL,** 1 (800) 968-4041.

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

PLANS AND KITS

FASCINATING electronic devices! Da Lasers! FM/AM/phone transmitters! Dete Kits/assembled! Catalog $2.00. **QUANTUM SEARCH,** 16645-113 Avenue, Edmonton T5M 2X2.

HOBBY/broadcasting/HAM/CB/surveill transmitters, amplifiers, cable TV, science, other great projects! Catalog $1.00. **PAN** Box 130-F3, Paradise, CA 95967.

PROJECTION TV... Convert your TV to prc 7-foot picture... Easy!... Results compara $2,500.00 projectors... **Plans and lens $2** Professional systems available... Illustratec log **free**... **MACROCOMA,** 15GG Main S Washington Crossing, PA 18977... Creditc ders 24hrs. 1 (800) 955-3979.

FREE CATALOG

FAMOUS "FIRESTIK" BRAND CB ANTENNAS AND ACCESSORIES. QUALITY PRODUCTS FOR THE SERIOUS CB'er. SINCE 1962

FIRESTIK ANTENNA COMPANY
2614 EAST ADAMS
PHOENIX, ARIZONA 85034

ELECTRONIC supermarket surplus prices! Transformer specials, railroaders, builders, engineers, experimenters, LSASE, **FERTIK'S,** 5400 Ella, Phila., PA 19120.

OUR monthly picture flyer lists quality surplus parts at low prices. Send today for yours. **STARTRONICS,** Box 683, McMinnville, OR 97128.

PHOTOFACT folders under #1400 $5.00. Others $7.00. Postpaid. **LOEB,** 414 Chestnut Lane, East Meadow, NY 11554. (516) 481-4380.

Advanced solid-state LASER

This incredible unit weighs less than 1/2 ounce. Only 1.125" long and 0.580" wide. With a range of more than 1000 yards, you are limited only by your imagination!

This is not a breakable glass tube but a state-of-the-art advanced solid-state laser with literally hundreds of applications!!

3mW only $149.00

5mW only $175.00

SPECIAL DEAL save 10% on two or more!

Low power, self-contained unit which will produce a visible red beam from a 5 - 10 volt power supply.

MC VISA DISCOVER COD

POLARIS Industries
141 W. Wieuca Rd., Suite 300-B
Atlanta, GA. 30342
Call Our Toll Free 24-Hour Order Line
1-800-222-5620

REMOTE CONTROL KEYCH

Complete w/mini-trans and +5 vdc RF re
Fully assembled including to build your own auto
Quantity discounts av
$24.95 Check,Visa Add $ 3 sh

VISITECT INC. Box 14158, Fremont, Ca
(510) 651-1425 Fax (510) 651-

REMOTE telephone recorder, $379.00, with room monitor, $479.00. Room monitor $175.00, Room & telephone $275.00. Catalog, $3.00, **LISTEN ELECTRONICS,** 603 Elgin, Muskogee, OK 74401. **(918) 683-9589.**

CB and schematic CAD. $195.00 IBM EGA CGA ultilayer, rubberband, autovia, NC drill, laser, dot atrix, plotter, library, Gerber, **AUTOSCENE,** 565 Bluebird St., Minneapolis, MN 55433. (612) 7-8584 free demo disk.

DECIPHER II/scanner/cable/satellite modiations books. Catalog — $3.00. **TELECODE,**) Box 6426-RE, Yuma, AZ 85366-6426.

ESCRAMBLER kits. Complete cable kit $44.95. omplete satellite kit $49.95. Add $5.00 shipping. ee brochure. No New York sales. **SUMMIT** RE, ox 489, Bronx, NY 10465.

URVEILLANCE transmitter kits tune from 65 305 MHz. Mains powered duplex, telephone, om, combination telephone/room. Catalog with **opular Communications, Popular Electonics and Radio-Electronics** book reviews of **Electronic Eavesdropping Equipment Design,"** $2.00. **SHEFFIELD ELECTRONICS,** 223 Stony Island Ave., Chicago, IL 60649-2806.

REDIT card encoding, standard explained in ain English. Illustrative examples included, send 5.00 **BSC,** Box 1841, Alexandria, VA 22314.

RED of breathing smoke from soldering? Plans build a smoke removal system, simple parts adily available, send S.A.S.E. and $3.95 to **LECTRONIC SERVICES,** PO Box 1733, Southate, MI 48195.

REMOVE LEAD VOCALS

From Records & CD's

Build this kit for under $60 which removes lead vocals from standard stereo records, CD's, tapes or FM broadcasts. Easily connects to any home component stereo. Perform live with the backgrounds. You can be the lead singer of your favorite band. Detailed Plans. $4.95

Weeder Technologies
14773 Lindsey Rd.
Mt. Orab, Ohio 45154

NOW build your own **regulated** 12VDC to 120VAC, 300W to 500W ***inverter.*** a **must** for campers or emergencies. Includes complete schematics, parts and manufacturers lists and **more!** Send $19.95 to **INVERTER SCIENTIFIC,** Box 778, Suffern, NY 10901.

DESCRAMBLING. New secret manual. Build your own descramblers for **cable and subscription TV.** Instructions, schematics for SSAVI, gated sync, Sinewave, (HBO, Cinemax, Showtime, UHF, Adult) $12.95, $2.00 postage. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

VHF amplifier plans 75-110 MHz, 15-25 watts. $8.95: **PROGRESSIVE CONCEPTS,** 1313 North Grand Ave., #291, Walnut, CA 91789.

CABLE TV DESCRAMBLERS!

CABLE KINGDOM!

JEROLD *OAK* *HAMLIN*
ZENITH *PIONEER*
SCIENTIFIC ATLANTA

IN STOCK

6 MONTH WARRANTY! WE SHIP COD!
ABSOLTLEY LOWEST
WHOLESALE/RETAIL PRICES!
******FREE CATALOG******

J.P. VIDEO
1470 OLD COUNTRY RD
SUITE 315
PLAINVIEW, NY 11803
NO N.Y. SALES
CALL NOW! 1 (800) 950-9145

PRINTED circuit boards for .70 square inch. Send artwork to **JM ELECTRONICS,** Box 150454, Altamonte Springs, FL 32715-0454. (407) 767-8196.

SATELLITE TV descrambler. Build your own. Easy to follow instructions, parts list, circuit board, wiring diagram, $9.95. **ABG ENTERPRISES,** 27081A, Halifax, NS, B3H-4M8.

PATENTS & INVENTIONS

INVENTORS! Your first step is important. For free advice, call **ADVANCED PATENT SERVICES,** Washington, DC, 1 (800) 458-0352.

NTIQUE RADIO CLASSIFIED

Free Sample!

Antique Radio's
rgest Circulation Monthly.
ticles, Ads & Classifieds.
-Month Trial: $15. 1-Yr: $27 ($40-1st Class).
.R.C., P.O. Box 802-L9, Carlisle, MA 01741

FREE CATALOG

• CABLE T.V. BOXES - ALL TYPES •
• LOW PRICES - DEALER PRICES •

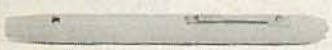
ACE PRODUCTS
1-800-234-0726

Triplet DMM

Large, easy to read 3-1/2 digit LCD display. Tests voltage in 5 ranges to 750VAC, resistance in 6 ranges to 20M plus diode test with audible continuity. 6 current ranges to 10A. Built-in battery test and LFE test for NPN and PNP transistors. Test leads, instructions and carrying case included.

#RD-390-140 **$47.00 Each**

Infrared Detector Pen



The world's first handheld, Battery powered, InfraRed Detector pen. Instantly recognizes infrared light from television, VCR, and stereo remote controls, VCR tape stop circuits, alarm perimeter detectors, and thousands of other IR controlled products. Allows you to confirm the presence of infrared in normal room lighting. Slim one hand operation makes it easy to reach IR emitters on crowed VCR tape mechanisms. A carrying case to protect and transport your B.I.R.D. is available for $3.95, order #390-201.

#RD-390-200 **$34.95 Each**

IC Protector Kit

Convenient assortment of 60 IC protectors for camcorders and VCRs. 5 each of 12 different protectors: ICP-F10, ICP-F15, ICP-F20, ICP-F25, ICP-F38, ICP-F50, ICP-F75, ICP-N5, ICP-N10, ICP-N15, ICP-N20 and ICP-N25. A $45.00 value.

#RD-070-545 **$29.95 Kit**

Audio/Video Cable Checker

Convenient tester checks cable for center conductor and shield continuity. Tests all BNC, "F", RCA, 3.5mm mini, N, UHF, and 1/4" phone cables. Operates on two AA batteries. Built-in battery test function.

#RD-390-250 **$21.50 Each**

3.5 Amp DC Power Supply

A quality, compact 12VDC power supply. Perfect for testing car stereos, CB equipment, radar detectors and other 12VDC items. Regulated 13.8VDC, 3.5 amp continuous, 6 amp surge. LED power indicator. Binding post outputs. Net weight: 4 lbs.

#RD-120-500 **$23.80 Each**

3-Way Bookshelf System

High quality, high power bookshelf speaker system. Black matte, diecast aluminum construction. Heavy duty wire mesh grille. 30 watts RMS, 50 watts max. 7" x 5" x 4". Sold in pairs with mounting hardware. Net weight: 8 lbs. per pair.

#RD-310-010 **$37.90 Pair**

Pressfit Speaker Terminal

Spring loaded, pushbutton speaker terminal in a round housing. No screws required to fasten; simply drill a hole, apply glue, and press into place.

#RD-260-295 **95¢ Each**

Norelco Type Boxes

Standard replacement plastic box for cassettes. Black base with clear lid. Made in the U.S.A.

#RD-200-060 **24¢ Each**

Pioneer 4-1/2" Full Range

This very popular woofer is perfect for making bookshelf speakers or for car stereo installations. Response: 70-15 KHz. fs= 70 Hz. 20 watts RMS, 35 watts max. SPL= 90 dB 1W/1M. 10 oz. magnet. 8 ohm impedance. Pioneer #A11EC80-02F. Net weight: 2 lbs.

#RD-290-010 **$9.90 Each**

18" Eminence Woofer

Bass reflex woofer with ribbed paper cone and treated cloth accordion surround. Giant 100 oz. magnet. 200 watts RMS, 300 watts max. 3", 2 layer voice coil. 8 ohm impedance (7.5 ohm DCR). Frequency response: 27-3,000 Hz. fs= 28.01 Hz.

#RD-290-200 **$99.80 Each**

12" Pioneer Subwoofer

12" super duty, dual voice coil subwoofer. 30 oz. magnet, 2" voice coil. 100 watts RMS, 145 watts max. 25 Hz resonant frequency. 6 ohm impedance (4 and 8 ohm compatible). Sensitivity: 94 dB 1W/1M. Response: 25-1,500 Hz. Pioneer #A30GU30-55D.

#RD-290-145 **$39.80 Each**

Parts Express
International Inc

340 E. First St., Dayton, Ohio 45402
Local: 1-513-222-0173
FAX: 513-222-4644

• 30 day money back guarantee • $20.00 minimum order • We accept Mastercard, Visa, Discover, and C. O. D. orders. • 24 hour shipping • Shipping charge = UPS chart rate + $1.00 ($3.50 minimum charge) • Hours 8:30 am - 7:00 pm EST, Monday - Friday • 9:00 am - 2:00 pm Saturday. Mail order customers, please call for shipping estimate on orders exceeding 5 lbs. • Foreign destination customers please send $5.00 U.S. funds for catalog postage •

CALL TOLL FREE
1-800-338-0531
FREE CATALOG

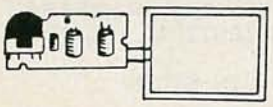
CIRCLE 56 ON FREE INFORMATION CARD

Courteous Service • Discount Prices • Fast Shipping

ALL ELECTRONICS

P.O. Box 567 • Van Nuys, CA 91408

Electroluminescent BACKLIGHTS



At last! A low cost electroluminescent glow strip and inverter. These brand-new units were designed to backlight small LCD TVs made by the Citizen Watch company. The inverter circuit changes 3 or 6 Vdc to approximately 100 Vac, the voltage required to light the glowstrip. Luminescent surface area is 1.7" X 2.25". The strip is a salmon color in its off state, and glows white when energized. The circuit board is 2.2" X 1". Glow strip and circuitry can be removed easily from plastic housing. Ideal for special lighting effects and backlighting. Two models available:

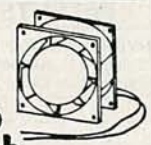
Citizen# 91TA operates on 3 Vdc **CAT# BLU-91**

Citizen# 92TA operates on 3-6 Vdc **CAT# BLU-92**

$3.50 each — ***LARGE QUANTITY AVAILABLE***

10 for $32.00 • 100 for $275.00

Special Deal 12 VDC COOLING FANS



Toyo Fan# TFD8012RXAL
12 VDC, 0.11A cooling fan.
3.175" square X
0.92" thick.
7 blade impeller.
11" long pigtail leads.
CAT# CF-124
10 for $50.00

$6 each

SUPER SMALL Surface Mount Green LED

Surface mount LED chip.
Clear when off, green when lit.
Very tiny - whole unit is 0.115"
X 0.055" X 0.05" thick. 1mm (0.04") lens diameter.
Gold-plated mounting surfaces for superior conductivity.
CAT# SMLED-2
100 for $18.00
1000 for $140.00

10 for $2

S.P.S.T. Pushbutton

SMK Manufacturing
0.47" square black pushbutton.
SPST normally open. 4 p.c. pins for mounting. Ideal for low current switching applications.
CAT# PB-29
100 for $15.00

5 for $1

PHOTORESISTOR

1K ohms bright light.16K ohms dark.
0.182" dia. X .08"high. 0.18" long leads.
CAT# PRE-7
100 for $45.00
1000 for $400.00

2 for $1

TOLL FREE ORDER LINES

1-800-826-5432

CHARGE ORDERS to Visa, MasterCard or Discover

TERMS: Minimum order $10.00. Shipping and handling for the 48 continental U.S.A. $3.50 per order. All others including AK, HI, PR or Canada must pay full shipping. All orders delivered in CALIFORNIA must include state sales tax (7 1/4%, 7 1/2%, 7 3/4%, 8 1/4 %). Quantities Limited. NO C.O.D. Prices subject to change w/out notice.

Call or Write For Our FREE 64 Page Catalog
(Outside The U.S.A. Send $2.00 Postage)

ALL ELECTRONICS CORP.
P.O. Box 567 • Van Nuys, CA • 91408

CIRCLE 107 ON FREE INFORMATION CARD

★★★★ PRESENTING ★★★★

CABLE TV DESCRAMBLERS

★★★★★ STARRING ★★★★★

JERROLD, HAMLIN, OAK
AND OTHER FAMOUS MANUFACTURERS

- FINEST WARRANTY PROGRAM AVAILABLE
- LOWEST RETAIL / WHOLESALE PRICES IN U.S.
- ORDERS SHIPPED FROM STOCK WITHIN 24 HRS.
- ALL MAJOR CREDIT CARDS ACCEPTED

FOR FREE CATALOG ONLY **1-800-345-8927**
FOR ALL INFORMATION **1-818-709-9937**

PACIFIC CABLE CO., INC.
7325½ Reseda Blvd., Dept. 2112
Reseda, CA 91335

SATELLITE TV

FREE catalog — Lowest prices worldwide. Satisfaction guarantee on everything sold — systems, upgrades, parts, all major brands factory fresh and warrantied. **SKYVISION,** 1012 Frontier, Fergus Falls, MN 56537. 1 (800) 334-6455. Outside US (218) 739-5231.

SATELLITE TV — Do it yourself — systems. Upgrades. Parts. Major brands discounted 40% — 60%. We'll beat everyone's price. **L.J.H. INC.,** call Larry (609) 596-0656.

VIDEOCIPHER II, descrambling manual. Schematics, video, and audio. Explains DES, Eprom, CloneMaster, 3Musketeer, Pay-per-view (HBO, Cinemax, Showtime, Adult, etc.) $16.95, $2.00 postage. Schematics for Videocypher Plus, $20.00. Schematics for Videocypher 032, $15.00. Collection of software to copy and alter Eprom codes, $25.00. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

ELECTECH

CABLE T.V. DESCRAMBLERS

• All quality brand names •
• All fully guaranteed • All the time •
Knowledgeable Sales Service Department
FOR FREE CATALOG 800-253-0099

EDUCATION & INSTRUCTION

F.C.C. Commercial General Radiotelephone license. Electronics home study. Fast, inexpensive! "Free" details. **COMMAND,** D-176, Box 2824, San Francisco, CA 94126.

Be a TV/VCR Repair Specialist

Now you can train at home in spare time for a money-making career as a TV/VCR Repair Specialist. No previous experience necessary. No need to quit your job or school. Everything is explained in easy-to-understand language with plenty of drawings, diagrams and photos. We show you how to troubleshoot and repair video-cassette recorders and TV sets, how to handle house calls and shop repairs for almost any make of television or VCR. Tools are included with your course so you can get "hands-on" practice as you follow your lessons step by step. Send for free facts about the exciting opportunities in TV/VCR Repair and find out how you can start making money in this great career. **MAIL COUPON TODAY** K03C

ICS SINCE 1890 **SCHOOL OF TV/VCR REPAIR,** Dept. ADE022S
925 Oak Street, Scranton, PA 18515

Please send me full information and color brochure on how I can learn TV/VCR Repair at home in my spare time. I understand there is no obligation and no salesman will visit me.

Name_____ Age____
Address_____ Apt. #____
City/State_____ Zip____
Phone ( )_____

ELECTRONIC engineering. 8 volumes complet $109.95. No prior knowledge required. Free br chure. **BANNER TECHNICAL BOOKS,** 12 Grant Avenue, Rockford, IL 61103.

VCR tapes by college instructor covering ele tronic topics. Send for free demo $3.50 P& **O.C.S.,** PO 292, Fort Mill, SC 29715.

NEW book, *Getting Started in Nuclear Physic* Easy to follow with illustrative footnotes and a vanced practical procedures. $19.95. **FARA FARAH,** PO Box 2464, Sarnia, Ontario, N7T 7 Canada.

CABLE TV DESCRAMBLERS

ALL TYPES 800-582-1114
FREE CATALO
M.K. ELECTRONICS • 7958 Pines Blv
Suite 276 • Pembroke Pines, FL 3302

BUSINESS OPPORTUNITIES

YOUR own radio station! Licensed/unlicens AM, FM, TV, cable. Information $1.00. **BROA CASTING,** Box 130-F3, Paradise, CA 95967.

LET the government finance your small busine Grants/loans to $500,000. Free recorded m sage: **(707) 449-8600.** (KS1).

EASY work! Excellent pay! Assemble products home. Call toll free **1 (800) 467-5566** Ext. 519

MAKE $$$! Become an American electron dealer! Profit opportunities since 1965. C **SCOTT PRUETT,** 1 (800) 872-1373.

HOME assembly work available! Guarante easy money! Free details! **HOMEWORK-R,** E 520, Danville, NH 03819.

MONEYMAKERS! Easy! One man CRT rebu ing machinery. $6,900.00 rebuilt. $15,900.00 n **CRT,** 1909 Louise, Crystalake, IL 60014. (8 459-0666. Fax (815) 477-7013.

CABLE TV DESCRAMBLE

BEST BUYS BEST SERVICE

BULLET PROOF TV TESTED
WANT TO BUY:
TOCOM, SA 8590,DPV7212
Must be reasonable price.
Call For Your Wholesale Catalog or Send $1.00 TO:

Dealers Wanted
Multi-Vision (402)331-3228 800-835-23
Electronics™ 2730 SO.123rd Ct.#126 Omaha, NE 68

WANTED

INVENTIONS/ new products/ideas wanted: **TLCI** for free information/inventors newslett (800) 468-7200 24 hours/day – USA/Canada

INVENTORS: We submit ideas to industry. out what we can do for you. **1 (800) 288-ID**

INVENTORS! Confused? Need help? Call **IMI** for free information kit. USA/CANADA: 1 (225-5800 (24 hours!).

MASTERCARD AND VISA are now acce for payment of your advertising. Sir complete the form on the first page o Market Center and we will bill.

THIS IS AN EXPANDED TYPE AD. N how it stands out on this page. To get yo set in this type style mark your classifie order, "Expanded-type ad," and calcu your cost at $4.70 per word.

UNICORN ELECTRONICS

10010 Canoga Ave., Unit B-8
Chatsworth, CA 91311

SINCE 1983 — YOUR I.C. SOURCE — AND MUCH MORE!!
NO SHIPPING CHARGES ON PRE-PAID ORDERS!*
NO CREDIT CARD SURCHARGE!
SCHOOL P.O.'s WELCOME!

LASER DIODES

CK #	MFG.	WAVE-LENGTH	OUTPUT POWER	OPER. CURR.	OPER. VOLT.	1-24	25-99	100+
220	TOSHIBA	660nm	3 mW	85 mA	2.5 V	129.99	123.49	111.14
200	TOSHIBA	670nm	3 mW	85 mA	2.3 V	49.99	47.99	43.19
201	TOSHIBA	670nm	5 mW	80 mA	2.4 V	59.99	56.99	51.29
211	TOSHIBA	670nm	5 mW	50 mA	2.3 V	69.99	66.49	59.84
215	TOSHIBA	670nm	10 mW	45 mA	2.4 V	109.99	104.49	94.04
200	NEC	670nm	3 mW	85 mA	2.2 V	59.99	56.99	51.29
22	SHARP	780nm	5 mW	65 mA	1.75 V	19.99	18.99	17.09
053	PHILLIPS	820nm	10 mW	90 mA	2.2 V	10.99	10.44	9.40

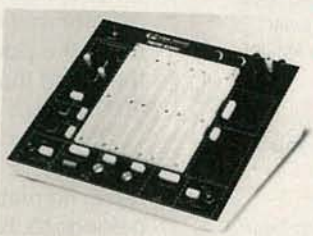
WAO II PROGRAMMABLE ROBOTIC KIT

The pen mechanism included with the robot allows it to draw. In addition to drawing straight lines, it can also accurately draw circles, and even draw out words and short phrases. WAO II comes with 128 x 4 bits RAM and 2K ROM, and is programmed directly via the keypad attached to it. With its built-in connector port, WAO II is ready to communicate with your computer. With the optional interface kit, you can connect WAO II to an Apple II, IIe, or II+ computer. Editing and transfering of any movement program, as well as saving and loading a program can be performed by the interface kit. The kit includes software, cable, card, and instructions. The programming language is BASIC.

Power Source – 3 AA batteries (not included)

CK #	DESCRIPTION	1-9	10-24	25+
/961	*WAO II Programmable Robotic Kit*	79.99	75.99	68.39
IIAP	*Interface Kit For Apple II, IIE, II+*	39.99	37.99	34.19

PROTOBOARD DESIGN STATION



- The total design workstation – including expanded instrumentation, breadboard and power supply.
- Ideal for analog, digital and microprocessor circuits
- 8 logic probe circuits
- Function generator with continuously variable size, square, triangle wave forms, plus TTL pulses
- Triple power supply offers fixed 5 VDC supply plus 2 variable outputs – +5 - 15 VDC and -5 - 15 VDC
- 8 TTL compatible LED indicators, switches
- Pulsers
- Potentiometers
- Audio experimentation speaker
- Multiple features in one complete test instrument saves hundreds of dollars needed for individual units
- Unlimited lifetime guarantee on breadboard sockets
- **Fixed DC output**
  +5 VDC @ 1.0 amp, ripple – 5 mV
- **Variable DC output**
  +5 – to +15 VDC @ 0.5 amp, ripple – 5 mV
- **Variable DC output**
  -5 – to -15 VDC @ 0.5 amp, ripple – 5 mV
- **Frequency generator**
  frequency range: 0.1 Hz to 100 KHz in 6 ranges
  output voltage: 0 to ± 10V (20 Vp-p)
  output impedance: 600 (except TTL)
  output current: 10mA max., short circuit protected
  output waveforms: sine, square, triange, TTL
  sine wave: distortion 3% (10 Hz to 100 KHz)
  TTL pulse: rise and fall time 25ns
  drive 20 TTL loads
  Square wave: rise and fall time ± 1.5 s
- **Logic indicators**
  8 LED's, active high, 1.4 volt (nominal) threshold, inputs protected to ± 20 volts
- **Debounced pushbuttons (pulsers)**
  2 push-button operated, open-collector output pulsers, each with 1 normally-open, 1 normally-closed output. Each output can sink up to 250 mA
- **Potentiometers**
  1 – 1K , 1 10K , all leads available and uncommitted
- **BNC connectors**
  2 BNC connectors pin available and uncommitted shell connected to ground
- **Speaker**
  0.25 W, 8 Ω
- **Breadboarding area**
  2520 uncommitted tie points
- **Dimensions**
  11.5" long x 16" wide x 6.5" high
- **Input**
  3 wire AC line input (117 V, 60 Hz typical)
- **Weight**
  7 lbs.

STOCK #	DESCRIPTION	1-9	10-24	25+
PB503	*Protoboard Design Station*	299.99	284.99	256.49

IDC BENCH ASSEMBLY PRESS

The Panavise PV505 1/4 ton manual IDC bench assembly press is a rugged, practical installation tool designed for low volume, mass termination of various IDC connectors on flat ribbon cable.

- Assembly base & standard platen included
- Base plate & platen may be rotated 90° for maximum versatility
- Base plates & cutting accessories are quickly changed without any tools required
- Additional accessories below
- Size – 10" W x 8.75" D x 9" H
- Weight – 5.5 lbs.

CK #	DESCRIPTION	1-9	10-24	25+
505	*Panavise Bench Assembly Press*	149.99	142.49	128.24

COLLIMATING PEN

A low power collimator pen containing a MOVPE grown gain GaAlAs laser. This collimator pen delivers a maximum CW output power of 2.5 mW at 820 nm.

The operating voltage of 2.2-2.5v @ 90-150mA is designed for lower power applications such as data retrieval, telemetry, alignment, etc.

The non-hermetic stainless steel case is specifically designed for easy alignment in an optical read or write system, and consists of a lens and a laser diode. The lens system collimates the diverging laser light .18 mrad. The wavefront quality is diffraction limited.

The housing is circular and precision manufactured measuring 11.0 mm in diameter and 27.0 mm long. Data sheet included.

As with all special buy items, quantity is limited to stock on hand.

STOCK #	DESCRIPTION	1-9	10-24	25+
SB1052	*Infra-Red Collimator Pen*	49.99	47.49	42.74

LASER DIODE MODULE

The LDM 135 integrated assembly consisting of a laser diode, collimating optics and drive electronics within a single compact housing. Produces a bright red dot at 660-685 nm. It is supplied complete with leads for connection to a DC power supply from 3 to 5.25 V.

Though pre-set to produce a parallel beam, the focal length can readily be adjusted to focus the beam to a spot.

Sturdy, small and self-contained, the LDM135 is a precision device designed for a wide range of applications. 0.64" diam. x 2" long.

STOCK #	DESCRIPTION	1-9	10-24	25+
LDM135-.5	*.5 mW Laser Diode Module*	179.99	170.99	153.89
LDM135-1	*1 mW Laser Diode Module*	189.99	180.49	162.44
LDM135-2	*2 mW Laser Diode Module*	199.99	189.99	170.99
LDM135-3	*3 mW Laser Diode Module*	209.99	199.49	179.54

COLLIMATING LENS

This economical collimating lens assembly consists of a black anodized aluminum barrel that acts as a heat sink, and a glass lens with a focal point of 7.5 mm. Designed to fit standard 9mm laser diodes, this assembly will fit all the above laser diodes. Simply place diode in the lens assembly, adjust beam to desired focus, then set with adhesive.

CK #	DESCRIPTION	1-9	10-24	25+
ENS	*Collimating Lens Assembly*	24.99	23.74	21.37

DUAL MODE LASER POINTER

New slimline laser pointer is only ½" in diameter x 6¼" long and weighs under 2 oz., 670 nm @ less than 1 mW produces a 6 mm beam. 2 switches, one for continuous mode, and one for pulse mode (red dot flashes rapidly). 2 AAA batteries provide 8+ hours of use. 1 year warranty.

STOCK #	DESCRIPTION	1-9	10-24	25+
LP35	*Dual Mode Laser Pointer*	199.99	189.99	170.99

He-Ne TUBES

New, tested 632nm He-Ne laser tubes ranging from .5mW to 3mW (our choice). Perfect for hobbyists for home projects. Because of the variety we purchase, we cannot guarantee specific outputs will be available at time of order. All units are new, tested, and guaranteed to function at manufacturers specifications.

STOCK #	DESCRIPTION	1-9	10-24	25+
LT1001	*He-He Laser Tube*	69.99	66.49	59.84

POWER SUPPLY

- Input: 115/230V
- Output: +5v @ 3.75A
  +12v @ 1.5A
  -12v @ .4A
- Size: 7" L x 5¼" W x 2½" H

STOCK #	PRICE
PS1003	$19.99

ROBOTIC ARM KIT

Robots were once confined to science fiction movies. Today, whether they're performing dangerous tasks or putting together complex products, robotics are finding their way into more and more industries. The Robotic Arm Kit is an educational kit that teaches basic robotic arm fundamentals as well as testing your own motor skills. Command it to perform simple tasks.

STOCK #	PRICE
YO1	$43.99

AVOIDER ROBOT KIT

An intelligent robot that knows how to avoid hitting walls. This robot emits an infra-red beam which detects an obstacle in front and then automatically turns left and continues on.

STOCK #	PRICE
MV912	$43.99

ORDER LINE — (800) 824-3432 • INTERNATIONAL ORDERS — (818) 341-8833
FAX ORDERS — (818) 998-7975 • TECHNICAL SUPPORT — (818) 341-8833

• 15.00 MINIMUM ORDER • UPS BLUE, RED & FEDERAL EXPRESS SHIPPING AVAILABLE • OPEN MON-FRI 9:00 AM - 6:00 PM, SAT 10:00 AM - 3:00 PM PDT
• CA RESIDENTS ADD 8¼% SALES TAX • CALL FOR QUANTITY DISCOUNTS • CALL FOR FREE CATALOG (FOR 1ST CLASS DELIVERY OR CATALOGS DELIVERED OUTSIDE THE U.S. — SEND $2.00) • WE CARRY A COMPLETE LINE OF ELECTRONIC COMPONENTS
*NO SHIPPING CHARGES ON PRE-PAID ORDERS DELIVERED IN THE CONTINENTAL U.S.

CIRCLE 191 ON FREE INFORMATION CARD

Shortwave Listening Guidebook

by Harry Helms

The world is talking on shortwave radio, and here's the book that tells you how to listen in! In direct, nontechnical language, Harry explains how to get the most from your shortwave radio. Its 320 heavily illustrated pages are filled with practical advice on:

- **antennas**
- **when and where to tune**
- **selecting the right radio for you**
- **accessories**
- **reception techniques**

Learn how to hear the BBC, Radio Moscow, ham radio operators, ships at sea, even Air Force One! Includes hundreds of frequencies for stations around the world and the times you can hear them.

Only $16.95 plus $3.00 shipping (CA residents please include sales tax).

HighText Publications, Inc.
7128 Miramar Road
Suite 15L, San Diego, CA 92121

ADMIT ONE

Your Ticket To SUCCESS

Over 28,000 technicians have gained admittance worldwide as certified professionals. **Let your ticket start opening doors for you.**

ISCET offers Journeyman certification in Consumer Electronics, Industrial, Medical, Communications, Radar, Computer and Video. For more information, contact the **International Society of Certified Electronics Technicians, 2708 West Berry Street. Fort Worth, TX 76109; (817) 921-9101.**

Name_____

Address_____

City_____

State_____ Zip_____

____ Send material about ISCET and becoming certified.

____ Send one "Study Guide for the Associate Level CET Test." Enclosed is $10 (inc. postage).

DRAWING BOARD

continued from page 83

the last output being used on the last 4017 in the circuit. The only other things on the reset line are the resistor and capacitor pair that generate the power-up reset pulse and the diode that isolates the last used 4017 output from that pulse.

The reset pulse at power-up, by the way, is needed because the 4017, no matter which logic family it belongs to, has a nasty habit of waking up stupid and putting a completely illegal state at its outputs. That can be either no outputs active or, worse than that, more than one active.

By having the reset lines configured as shown in Fig. 2, the circuit is essentially free running. Each successive horizontal sweep will immediately follow the previous one and, since we can control the sweep speed only in discreet steps, most waveforms will creep horizontally across the display. That can be cut to a minimum if you have a variable clock available as an alternative to drive the horizontal section (another good idea to look at later), but using one makes it difficult to estimate frequencies on the display since you never know exactly what the sweep speed is.

A much better way to steady the displayed waveform is to have a circuit that starts each horizontal sweep at the same reference point on the test signal. That's known as "triggered sweep" and it's one of the most powerful features we can add to the design we're working on. Since the trigger signal has to come from the test signal being sent to the vertical section of the scope, we have to wait until we work on that section before we can get into the details of the design. But we can make allowances for it now.

Adding triggered sweep to the circuit means we want the ability to control the situation that makes the horizontal section reset the display to the first column. You might think that all we have to do is pick off some voltage level on the test signal and have that make the display return to the first LED column. If you think that, you should think again.

Under that sort of arrangem things would get really strange i trigger occurred more often t the time it took to sweep the dis across all twenty LED columns the display. If, for example, sweep speed was set to 2 mil conds, it would take 40 millisecc for each complete horizo sweep. And if the trigger level the input occurred every 10 mi conds, the display would be on LED columns wide.

That complication doesn't a on conventional scopes beca they have a CRT for the display the hardware controlling the zontal action of the electron b will always let it finish a horiz sweep before zipping it back t left hand side of the screen fo start of the next sweep. Since v dealing with discrete LED colu we have to add circuitry that the same thing.

In our scope, when we wa triggered sweep, we have to the trigger signal with an indic that the old sweep is finishec the circuit is ready to start the one. The way to accomplish th shown in Fig. 3, the schema the scope so far. The NAND gate c is switched into the circuit we set the scope to trigg sweep. When the last LED co has been displayed, the Q4 o of IC6 will go high, but the c won't reset and begin a new s until the trigger signal puts a hi the second leg of the NAND ga we want the scope to be free ning, all we have to do is switc trigger leg of the gate to +V the 4017-based horizontal se will reset as soon as the old s has been finished.

Get the circuit shown in I working so we can get to wo the vertical section next month keep a list of any ideas you come up with to add goodies final scope design. One thin might consider is that, since dealing with an LED disp shouldn't take much to be a freeze the display and mak selves an LED storage scope

But that's my idea, so ex those gray cells, come up with of your own, and let me know they are.

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
NAS/TRANS-WORLD CABLE CO.
3958 North Lake Blvd. ● Suite 255
Lake Park, Florida 33403
1-800-442-9333
1-800-848-3997

CABLE TV DESCRAMBLERS ★CONVERTERS★ and ACCESSORIES.

SAVE MONEY. DON'T RENT!

PANASONIC, JERROLD, OAK, PIONEER, SCIENTIFIC ATLANTA AND MORE. LOWEST PRICES. FREE CATALOG.
CABLE READY COMPANY **(800) 234-1006**

DESCRAMBLERS
CABLE TV EQUIPMENT

CALL TOLL FREE
1-800-228-7404
FREE CATALOG
C.O.D
30 DAY MONEY BACK GUARANTY
OUR PRODUCTS ARE **BULLET PROOF**
YOU WON'T FIND ANY HOLES IN OUR WARRANTIES
WE CARRY ALL MAJOR BRANDS
BEST PRICE BEST SERVICE
MAKE THE CONNECTION
NU-TEK ELECTRONICS
FOR MORE INFORMATION CALL OR WRITE
1-512-250-5031 NU-TEK ELECTRONICS 8114 BALCONES WOOD DR. #307 DEP. 296 AUSTIN TEXAS 78759

INVENTORS

VENTORS! Can you patent and profit from your a? Call **AMERICAN INVENTORS CORP.** for e information. Serving inventors since 1975. 1 0) 338-5656.

SURFACE MOUNT PARTS

' last! Small quantities of common SMT capaci- rs and resistors delivered fast. Call for ormation. **TECHNICAL SOLUTIONS,** 1 (800) 2-1019.

S IS AN EXPANDED-TYPE AD WITH A T SCREEN. See how it jumps out on the e. To order your ad in this format calcu- the cost at $5.90 per word for the ex- ded-type and the tint background.

FREE CATALOG!
1-800-648-7938
JERROLD HAMLIN OAK ETC
CABLE TV DESCRAMBLERS

- *Special Dealer Prices!*
- *Compare our Low Retail Prices!*
- *Guaranteed Prices & Warranties!*
- *Orders Shipped Immediately!*

REPUBLIC CABLE PRODUCTS, INC.
4080 Paradise Rd. #15, Dept RE392
Las Vegas, NV 89109
For all other information (702) 362-9026

TODAY'S THE DAY
Stop Smoking.
American Heart Association

MARK V ELECTRONICS, INC.
Competitive Pricing * Fast Shipping Since 1985

IN CA 1-800-521-MARK (orders only)
OUTSIDE CA 1-800-423-FIVE (orders only)
ORDER BY FAX (213) 888-6868
CATALOG & INFORMATION (213) 888-8988

▲ indicates the level of difficulty in the assembling of our Products. ▲ Beginner ▲▲ intermediate ▲▲▲ Advanced ★ Fully Assembled

Special offer will be given to the purchase of Amplifier + Metal Cabinet + Power Transformer!

AMPLIFIERS

MODEL	DESCRIPTION	KIT	ASSEMB.
TA-28MK2	Digital Voice Memo ▲▲	$ 30.00	
TA-50A / B	Multi-Purpose Melody Generator ▲	12.84	17.20
TA-50C	Multi-Purpose Melody (Happy Birthday, Wedding March, etc.) Generator ▲	13.65	18.71
TA-120MK2	35W Class 'A' Main Power Mono Amp ▲▲	31.50	42.80
TA-300	30W Multi-Purpose Single Channel Amp ▲	20.00	29.00
SM-302	60W + 60W Stereo Power Amplifier (with Mic. input)▲▲	73.00	85.00
TA-323A	30W X 2 Stereo Pre-main Amp ▲	31.50	42.80
TA-377A	State of the Art Fully Complementary Symmetrical FET Pre-Amp ▲▲▲	59.95	75.00
TA-400	40W Solid State Mono Amp ▲	28.00	34.93
TA-477	120W Mosfet Power Mono Amp ▲▲	68.00	85.00
SM-720	120W + 120W AC/DC Stereo Hi-Fi & Pre-Main Amp ▲▲	75.00	89.00
TA-800MK2	120W + 120W Low Tim Pre-Main Stereo Power Amp ▲▲	63.92	
TA-802	80W + 80W Pure DC Stereo Main Power Amp ▲▲	45.94	59.72
TA-1000A	100W Dynamic Class 'A' Main Power Mono Amp ▲▲	50.00	65.00
TA-1500	100W X 2 Class 'A' DC Stereo Pre-Main Amp ▲▲▲	73.70	95.81
TA-2200	DC Fet Super Class 'A' DC Pre-Amp ▲▲▲	47.70	58.24
TA-2500	HQ Pre-Amp w/10 band graphic equalizer ★		78.00
TA-2800	BI-FET IC Pre-Amp w/3 way tone control ▲▲	48.90	63.57
TA-3000	Stereo Simulator (For Mono TV or Any Mono Source) ▲▲	27.00	38.50
TA-3600	300W HQ Hi-Fi Power Mono Amp ▲▲▲	85.00	110.00
SM-222	7 Band HI-FI Graphic Equalizer ▲▲▲	26.80	38.80
SM-333	Audio/Video Surround Sound Processor ▲▲▲★	65.00	75.00
SM-666	Dynamic Naise Reduction ▲	26.00	34.00
SM-888	Universal Audio/Video KARAOKE Mixer, Pre-Amp ★		155.00

DIGITAL METERS AND COUNTER

		KIT	ASSEMB.
SM-43	3½ Multi-Functional Led D.P.M. (w/ABS plastic case)▲▲	$ 34.50	$ 43.00
SM-48	4½ Hi-Precision D.P.M ▲▲▲	38.00	48.00
SM-48A	4½ Hi-Precision D.P.M. (w/ABS plastic case)▲▲▲	41.20	52.00
SM-49	3½ Multi-Functional LCD D.M.P. (w/Hold Function)▲▲	36.00	44.50
SM-100	150MC Digital Frequency Counter▲▲▲	79.00	90.00

MISCELLANEOUS

MODEL	DESCRIPTION	KIT	ASSEMB.
TY-23B	3 Channel Color Light Controller ★	$	$ 65.00
TY-25	Stereo Loudspeaker Protector ▲	14.85	20.85
TY-35	FM Wireless Microphone ▲	11.25	
TY-36	AC/DC Quartz Digital Clock ▲	19.00	26.20
TY-38	Sound / Touch Control Switch ▲	12.00	
TY-41MK V	Infrared Remote Control Unit (w/Case) ▲▲▲	22.00	35.00
TY-42	Bar / Dot Level Meter ▲▲	24.15	33.81
TY-43	3½ 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
016	10,000 uf 80V DC Capacitor (TA-3600, TA-477, TA-1000A, TA-802)		23.00
017	8,200 uf 50V DC Capacitor (TA-802, TA-120MK2)		13.00
021	Nobel Resistor-Single Vol. Control (TA-3600, TA-477, TA-1000A, TA-120MK2)		12.00
022	Alps Resistor - Dual Vol. Control (TA-377A, TA-802, TA-2200)		22.00

REGULATORS

TR-355A	0-15V 5A Regulated DC Power Supply (no case & x'former) ▲	$15.65	$ 21.76
TR-355B	0-30V 3A Regulated DC Power Supply (no case & x'former) ▲	15.65	21.76
TR-503	0-50V 3A Regulated DC Power Supply (no case & x'former) ▲▲	16.75	23.65

METAL CABINETS WITH ALUMINUM PANEL

MODEL	H" x W" x D"	MATCHING	PRICE
LG-1273	3" 12" 7"	TA-2800, TA-377A, TA-2200	$ 23.85
LG-1684	4" 16" 8"	TA-323A, TA-377A, TA-2200	28.50
LG-1924	4" 19" 11½	TA-802, TA-1500,TA-120MK 2, TA-800 MK2, TA-1000A	34.50
LG-1925	5" 19" 11½	TA-477, TA-800 MK2, TA-1500, TA-1000A, TA-3600	38.00
LG-1983	2¾" 19" 8"	TA-377A, TA-2800, TA-2200, TA-120MK 2	30.50

POWER TRANSFORMERS

MODEL	DESCRIPTION	MATCHING	PRICE
001	28V x 2.6A to 30V x 2.6A	TA-800 MK2, TA-802, TA-1000A, TA-1500	$ 28.00
002	36V x 2.3A	TR-503, TA-323A, TA-400, TA-300, TA-377A	23.00
003	40V x 2.6A	TA-477	30.00
004	24V x 2.6A	TA-120 MK 2	23.00
005	26V x 2.3A	TR-355B	17.00
006	18V x 2.5A	TR-355A	17.00
007	53V x 2.8A	TA-3600	45.00

We accept major Credit Cards, Money Orders, Checks and C.O.D. Orders. C.O.D. fee is $6.50. Minimum order is $20.00. • We ship by UPS ground inside US (min. $4.00) and ship by US mail outside US. Please call our sales department for orders over 2 lbs. or foreign orders. • All assembled units have a 30 days warranty. • Quality or Volume discount available upon request. • Residents of CA please add sales tax 8.25%. • Prepaid Order for faster Shipment. Prices are subject to change without prior notice. We are not responsible for typographical errors.

Business & Showroom hours: (Pacific Time)
Mon. thru Fri. 9:30 am to 5:00 pm
Sat. 10:00 am to 5:00 pm

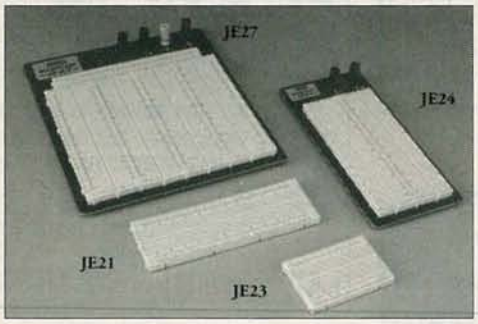
MARK V ELECTRONICS, INC. – 8019 E. Slauson Ave, Montebello, CA 90640

CIRCLE 93 ON FREE INFORMATION CARD

Your Natural Resource for Wid

Test/Measurement and Prototype Equipment

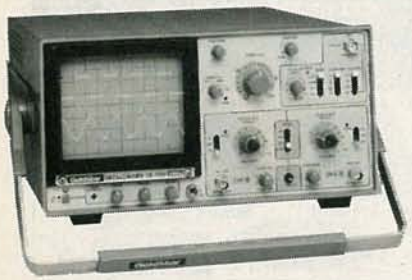
Jameco Solderless Breadboards



Jameco's long-lasting breadboards feature screen-printed color coordinates and are suitable for many kinds of prototyping and circuit design. Larger models feature a heavy-duty aluminum backing with voltage and grounding posts.

Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price	Part No.	Dim. L" x W"	Contact Points	Binding Posts	Price
JE21	3.25 x 2.125	400	0	$4.95	JE25	6.500 x 4.25	1.660	3	$17.95
JE23	6.50 x 2.125	830	0	6.95	JE26	6.875 x 5.75	2.390	4	22.95
JE24	6.50 x 3.125	1.360	2	12.95	JE27	7.250 x 7.50	3.220	4	31.95

GoldStar 20MHz Dual Trace Oscilloscope



The perfect unit for today's testing and measurement needs! Features include a 6" CRT display, and bandwidth from DC to 20 MHz. The GoldStar Oscilloscope comes with two 40MHz probes, two fuses, power cord, operation manual, schematics and block and wiring diagram. It's lightweight and portable with a two-year warranty.

GS7020.....$399.95

BNC Cable Assemblies for GS7020

BNC1 BNC(M) to BNC(M) RG58 A/U (39"L) $3.95

BNC2 BNC(M) to Micro Hook RG174 39"L).....3.95

BNC3 BNC(M) to Macro Hook RG174 (39"L).....3.95

Miniature RS232 Breakout Box

Design new interfaces or modify old ones quickly and easily. Completely self-contained, these boxes include (25) 22AWG wire jumpers and machine tool sockets so you are sure to have a good connection.

BBMF.....$9.95

RS232 Interface Check Tester

Helps avoid expensive repair calls by showing you simple interface problems. In seconds the CT232 will target the status of line 2, 3, 4, 5, 6, 8, 11, 19 and 20. The CT232 includes male to female DB25 connectors.

CT232.....$14.95

JAMECO®
ELECTRONIC COMPONENTS
COMPUTER PRODUCTS

24 Hour Toll-Free Order Hotline
1•800•831-4242

VISA MMC MasterCard

Please refer to Mail Key 2 when ordering

Metex Digital Multimeters

- Handheld, high accuracy • AC/DC voltage, AC/DC current, resistance, diodes, continuity, transistor hFE (except M3900)
- Manual ranging w/overload protection
- Comes with probes, batteries, case and manual

M3650 & M4650 only:
- Also measures frequency and capacitance

M3800 3.5 Digit Multimeter $39.95
M3610 3.5 Digit Multimeter $59.95
M3900 3.5 Digit Multimeter with Tach/Dwell $59.95
M3650 3.5 Digit Multimeter w/Frequency & Capacitance $74.95
M4650 4.5 Digit w/Frequency & Capacitance & Data Hold Switch.....$99.95

24 Hour Toll-Free Order Hotline! 1•800•831-4247

Jameco Logic Pulser

- Compatible with TTL, DTL, RTL, HTL, HNIL, MOS and CMOS ICs
- 1MΩ Sync input impedance • Pulser mode output current: 10mA • Square wave current output: 5mA • Audible tone

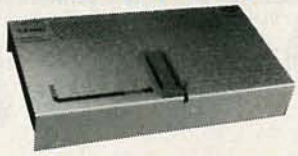
LP540.....$16.95

Jameco Logic Prob

- Max Frequency 80MHz • Minimum detectable pulse: 10ns • 120KΩ input impedance • Max. supply voltage: ±25
- TTL threshold: (Lo)+0.8V ±0.1V, (H +2.3V ±0.2V • CMOS threshold: (Lo) VCC ±10%, (Hi) 70%VCC±10%

MS104.....$2

E(E)PROM Programmer 1 Socket 16K-1Meg



- Built-in Normal, Intelligent I&II, and Quick-pulse algorithms • XP6000A needed for operation • Software included

XP6001 .....$119.95
XP6000A Adapter Card $29.95

UVP EPROM Erase

- Erases all EPROM's • Erases 1 chip 15 minutes and 8 chips in 21 min
- UV intensity: 6800 UW/CM²

DE4.....$

EPROMs - for your programming needs

Part No.	Price	Part No.	Price	Part No.	
TMS2516	$4.25	2764-20	$3.95	27256OTP	
TMS2532A	6.95	2764-25	3.75	27256-15	
TMS2564	5.95	2764A-20	3.75	27256-20	
TMS2716	5.95	2764A-25	3.19	27256-25	
1702A	3.95	27C64-15	3.95	27C256-15	
2708	4.75	27C64-25	3.25	27C256-20	
2716	3.39	27128OTP	2.49	27C256-25	
2716-1	3.75	27128-20	7.95	27512OTP	
27C16	4.25	27128-25	7.75	27512-20	
2732	4.95	27128A-15	4.95	27512-25	
2732A-20	4.49	27128A-20	4.49	27C512-15	
2732A-25	3.49	27128A-25	3.75	27C512-20	
2732A-45	2.95	27C128-15	5.75	27C512-25	
27C32	4.75	27C128-25	7.95	27C010-15	
				68766-35	

• Partial Listing • Over 4000 Electronic and Computer Components in Stock!

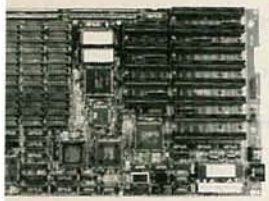
CIRCLE 114 ON FREE INFORMATION CARD

Selection & Competitive Prices

Computer Upgrade Products and Electronic Components

Upgrade your existing computer system! Jameco will help you upgrade easily and economically.

Jameco 80386SX Motherboard



- 16MHz processing speed
- Baby motherboard (8.5"x13")
- Zero or one wait state operation
- Supports up to 8MB of RAM
- Intel 80387SX/compatible math coprocessor socket
- AMI BIOS
- Six 16-bit and two 8-bit expansion bus slots
- One-year Warranty

JE3516SN.....$299.95

Fujitsu 101-Key Enhanced Keyboard

This keyboard features 12 function keys, separate cursor and numeric keys.

- IBM PC/XT/AT and compatible computers
- Automatically switches between XT or AT
- LED Indicators for Num Lock, Caps Lock, and Scroll Lock
- Tactile Feedback
- Manual included • One-year Warranty

FKB4700.....$79.95

Conner IDE Hard Drives

is series of high-performance Conner disk drives is designed for large rage capacity.

P3000	40MB 3.5" Low Profile	$249.95
P30084	80MB 3.5"Low Profile	$399.95
P30104	120MB 3.5" Low Profile	$479.95
P3204	200MB 3.5" HH	$699.95
DP20	16-bit Host Adapter	$29.95

Additional host adapters available!

Many more Upgrade Products available!

Toshiba 1.44MB 3.5" Internal Floppy Disk Drive

- IBM PC/XT/AT and compatibles
- Compatible with DOS versions 3.3 or higher
- Includes all necessary installation hardware
- 1.44MB formatted high density mode
- 720KB formatted low density mode
- Size: 1"H x 4"W x 5.9"D (actual drive size)
- One-year Manufacturer's Warranty

356KU.....$99.95

Integrated Circuits*

Part No.	1-9	10+
00	$.29	$.19
02	.29	.19
04	.29	.19
06	.35	.25
07	.35	.25
08	.35	.25
10	.29	.19
17	.35	.25
20	.29	.19
32	.35	.25
47	.89	.79
74	.39	.29
76	.45	.35
86	.45	.35
89	2.95	2.75
90	.59	.49
121	.49	.39
192	.79	.69
193	.79	.69

Linear ICs*

Part No.	1-9	10+
082CP	$.59	$.49
M317T	.65	.55
M324N	.35	.29
M336Z	1.05	.95
M339N	.39	.35
E555V	.29	.25
M556N	.49	.39
M723CN	.49	.39
M741CN	.29	.25
M1458N	.35	.29
M1488N	.45	.39
M1489N	.45	.39
LN2003A	.69	.59
M3914N	1.95	1.75
E5532	1.19	1.09
305T	.45	.41
312T	.45	.41

** Call for a complete listing of ICs*

Memory

Part No.	Function		Price
41256-120	256K DIP	120ns	$1.79
41256-150	256K DIP	150ns	1.69
511000P-80	1MB DIP	80ns	5.99
511000P-10	1MB DIP	100ns	5.49
41256A9A-10	256K SIPP	100ns	18.95
41256A9B-80	256K SIMM	80ns	20.95
421000A9A-80	1MB SIPP	80ns	59.95
421000A9B-80	1MB SIMM	80ns	64.95

Miscellaneous Components*

Potentiometers

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

43PXX	3/4 Watt,15 Turn	$.99
63PXX	1/2 Watt, 1 Turn	.89

Transistors And Diodes

PN2222	$.12	1N751	$.15
PN2907	.12	C106B1	.65
1N4004	.10	2N4401	.15
2N2222A	.25	1N4148	.07
1N4735	.25	2N3055	.69
2N3904	.12	1N270	.25

Switches

JMT123	SPDT, On-On (Toggle)	$1.15
206-8	SPST, 16-pin (DIP)	1.09
MPC121	SPDT, On-Off-On (Toggle)	1.19
MS102	SPST, Momentary (Push-Button)	.39

**Additional components available*

Connectors

Part No.	Description	Price
DB25P	Male, 25-pin	$.65
DB25S	Female, 25-pin	.75
DB25H	Hood	.39
DB25MH	Metal Hood	1.35

LEDs

XC209R	T1, (Red)	$.14
XC556G	T1 3/4, (Green)	.16
XC556R	T1 3/4, (Red)	.12
XC556Y	T1 3/4, (Yellow)	.16

IC Sockets

Low Profile		Wire Wrap(Gold)	Level #2
8LP	$.10	8WW	$.49
14LP	.11	14WW	.69
16LP	.12	16WW	.79
24LP	.19	24WW	1.15
28LP	.22	28WW	1.39
40LP	.28	40WW	1.89

Soldertail Standard and Header Plug Sockets Also Available

24-Hour Toll-Free Order Hotline:

1•800•831-4242

Call or Write for a

FREE 90-Page 1992 Catalog!

$30.00 Minimum Order • Data Sheets - 50¢ each

JAMECO®
ELECTRONIC COMPONENTS
COMPUTER PRODUCTS

1355 Shoreway Road
Belmont, CA 94002
FAX: 1•800•237-6948
BBS Support: 415-637-9025

International Sales • Customer Service • Technical Assistance • Credit Department • All Other Inquiries: 415-592-8097 • 7AM - 5PM P.S.T.

© 1992 Jameco 3/92

CA Residents Add 7.25%, 7.75%, 8.25% or 8.5% Sales Tax

Shipping, handling and insurance are additional.

Terms: Prices subject to change without notice. Items subject to availability and prior sale. Complete list of terms/warranties is available upon request.

Cable TV Descrambler Kits

Universal Kit.....$55.00
Includes all parts and PC Board. Not included is the ac adaptor or enclosure.

Tri-Mode Kit.....$39.00
Includes all parts, PC Board and AC Adaptor. Not included is the enclosure.

SB-3 Kit.....$29.00
Includes all parts, PC Board and AC Adaptor. Not included is the enclosure.

Universal Tutorial.....$9.95
Includes an in depth study of the techonology used and has troubleshooting hints.

Tri-Mode Tutorial.....$9.95
Includes a gate by gate study of the circuit and has troubleshooting hints.

Snooper Stopper.....$39.00
Protect yourself from descrambler detection and stop the "bullet".

Call Toll Free 1-800-258-1134

Visa, MasterCard & COD

M & G Electronics, Inc.
301 Westminister Street
Providence, RI. 02903

CIRCLE 190 ON FREE INFORMATION CARD

Worldwide Cable

CABLE TV DESCRAMBLERS

THE MOST ADVANCED TECHNOLOGY IN CABLE EQUIPMENT:

- BASE BAND
- JERROLD
- PIONEER
- TOCOM
- HAMLIN
- ZENITH
- SCIENTIFIC ATLANTA
- OAK

For out of this world prices call
WORLDWIDE CABLE
1 800-772-3233
FREE CATALOG AVAILABLE

7491 C-5 N. FEDERAL HWY., SUITE 142
BOCA RATON, FL 33487

MC / COD / VISA NO FLORIDA SALES

CIRCLE 189 ON FREE INFORMATION CARD

ADVERTISING INDEX

RADIO-ELECTRONICS does not assume any responsibility for errors that may ap in the index below.

Free Information Number		Page
108	AMC Sales	78
75	Ace Products	97
107	All Electronics	96
185	American Reliance Inc.	79
84	Appliance Service	79
77	B&K Precision	15
109	C & S Sales	89
—	CIE	8, 40
184	Cable Warehouse	78
—	Command Productions	77
127	Deco Industries	79
177	Electronic Goldmine	94
—	Electronics Book Club	23, 84
121	Fluke Manufacturing	CV2
186	Global Specialties	25
—	Grantham College	45
86	Heathkit	13
192	Hewlett Packard	7
—	ICS Computer Training	81
114	Jameco	100, 101
115	Jensen Tools	79
190	M&G Electronics	102
89	MAT Electronics	77
53	MD Electronics	94
178	MJS Design	79
93	Mark V. Electronics	99
—	NRI Schools	21, 32
180	Optoelectronics	29
56	Parts Express	95
183	People's College	27
78	Radio Shack	3
187	SCO Electronics	52

Free Information Number		
—	Science Probe	
92,179	Tektronix	
123	Test Probes	
—	The School of VCR Repair	
191	Unicorn	
188	U.S. Cable	
181,182	Viejo Publications	8
189	Worldwide Cable	

ADVERTISING SALES OFFIC

Gernsback Publications, Inc.
500-B Bi-County Blvd.
Farmingdale, NY 11735
1-(516) 293-3000
President: **Larry Steckler**

For Advertising ONLY
516-293-3000
Fax 1-516-293-3115
Larry Steckler
publisher
Christina Estrada
assistant to the President
Arline Fishman
advertising director
Denise Haven
advertising assistant
Kelly McQuade
credit manager
Subscriber Customer Service
1-800-288-0652
Order Entry for New Subscribers
1-800-999-7139
7:00 AM - 6:00 PM M-F MST

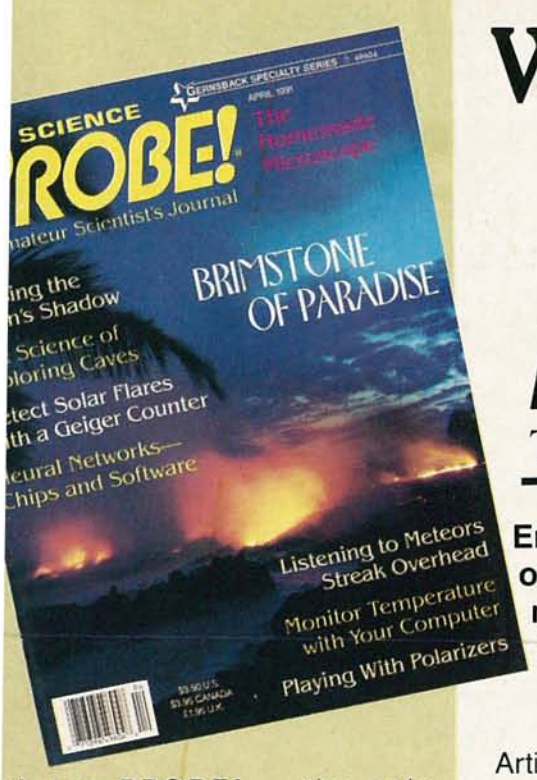
SALES OFFICES

EAST/SOUTHEAST
Stanley Levitan, Eastern Sales Man
Radio-Electronics
1 Overlook Ave.
Great Neck, NY 11021
1-516-487-9357, 1-516-293-3000
Fax 1-516-487-8402

MIDWEST/Texas/Arkansas/Okla
Ralph Bergen, Midwest Sales Mana
Radio-Electronics
One Northfield Plaza, Suite 300
Northfield, IL 60093-1214
1-708-446-1444
Fax 1-708-559-0562

PACIFIC COAST/Mountain State
Marvin Green, Pacific Sales Manag
Radio-Electronics
5430 Van Nuys Blvd. Suite 316
Sherman Oaks, CA 91401
1-818-986-2001
Fax 1-818-986-2009

RE Shopper
Joe Shere, National Representative
P.O. Box 169
Idyllwild, CA 92549
1-714-659-9743
Fax 1-714-659-2469



Welcome to. . .

SCIENCE PROBE!®

The Amateur Scientist's Journal

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

cience PROBE! — the *only* agazine devoted entirely to Amateur cientists! If you are fascinated by sci- nce in all its many forms . . . if you can't ay away from a microscope, tele- cope, calipers, or test tube — we in- te you to share the wonders in every sue of **Science PROBE!** You will join community of Amateur and Student cientists who enthusiastically seek cientific knowledge or follow scientific ursuits for their own sakes and not nerely as a profession.

btain your next issue of **Science ROBE!** by visiting a quality News- tand, Convenience Store, or Super- narket or by reserving your personal opy through the mail by completing ne coupon below.

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

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

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

How an Amateur Mapped the Milky Way
Make your own Seismometer
Operate a Solar-powered Weather Station
Grow Crystals Automatically
Experiment with a Saltwater Aquarium
How to Keep a Science Notebook

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

7RC27

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

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

☐ Next Issue Only ☐ Next Four Issues (1 Year)
Offers valid in the U.S.A. and Canada only. No foreign orders.
Name _____
Address _____
City _____ State _____ ZIP _____
All Orders payable in U.S.A. Funds only.

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

You Can Always Spot The Technician Who Doesn't Use Tektronix.

If you're sending technicians and FSEs into the field with equipment other than Tektron

don't be surprised to discover some unusual tools in their service kits.

Signal flares, for instance. On the other hand, portable test gear from Tek gets technicians to the root of

the problem long before the problem gets to them. Everything from oscilloscopes and spectrum analyzers to handheld DM

As a result, your customers will be back on their feet

in what'll seem like no time at all. They'l

happy for that. Not to mention a whole lot nicer to work with. For your employees' sake, g

touch with a Tektronix representative today. Or keep an eye peeled for signs of distress. **TALK TO TEK/1-800-426-2**

Tektronix

Test and Measurement

03W-188149 Copyright© 1991, Tektronix, Inc.

CIRCLE 179 ON FREE INFORMATION CARD