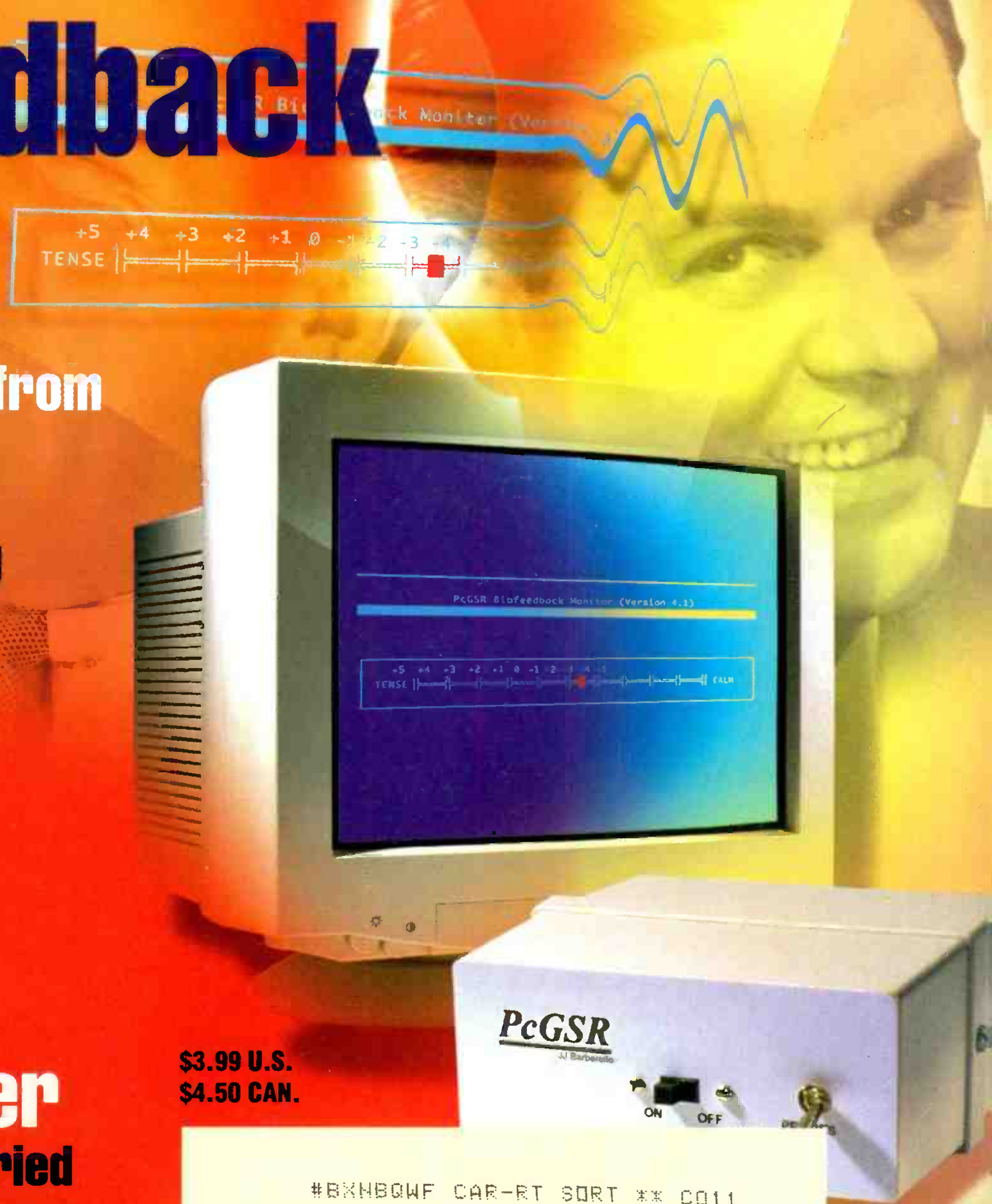
WHAT'S NEW IN COMPUTER TECHNOLOGY

Electronics NOW®

DECEMBER 1996

Build a Biofeedback Monitor

Use it to remove stress and strain from your daily life



Reduce your heating bills with an Automatic Fan Control for your furnace

Build a Cable Reflectometer

Test cables—even buried ones—for opens, shorts, mismatches, and more

$3.99 U.S.
$4.50 CAN.

#BXNBQWF CAR-RT SORT ** C011
#BRKS0418090 6#303178 OAP50
JUN 97
CHRIS BARKER 12EN
[redacted]

A GERNSBACK PUBLICATION

Electronics NOW®

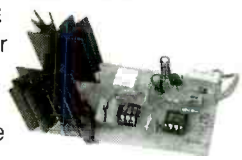
Vol. 67 No. 12

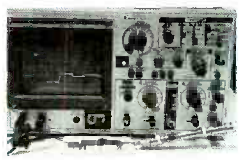
CONTENTS

DECEMBER 1996

ON THE COVER

BUILD THIS





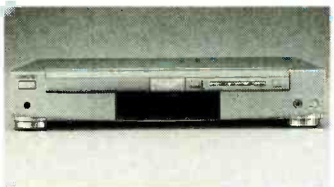
ELECTRONICS NOW, (ISSN 1067-9294) December 1996. Published monthly by Gernsback Publications, Inc., 500 Bi-County Boulevard, Farmingdale, NY 11735-3931. Second-Class Postage paid at Farmingdale, NY and additional mailing offices. Canada Post IPM Agreement No. 334103, authorized at Mississauga, Canada. One-year subscription rate U.S.A. and possessions $19.97, Canada $27.79 (Includes G.S.T. Canadian Goods and Services Tax, Registration No. R125166280), all other countries $28.97. All subscription orders payable in U.S.A. funds only, via international postal money order or check drawn on a U.S.A. bank. Single copies $3.50. © 1996 by Gernsback Publications, Inc. All rights reserved. Printed in U.S.A.

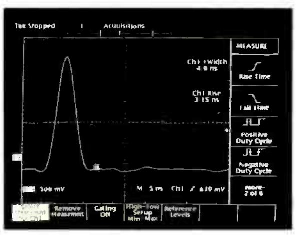
POSTMASTER: Please send address changes to ELECTRONICS NOW, Subscription Dept., Box 55115, Boulder, CO 80321-5115.

DECEMBER 1996

TECHNOLOGY

DEPARTMENTS





AND MORE

Electronics NOW®

Hugo Gernsback (1884-1967) founder

LARRY STECKLER, EHF, CET,
Editor-in-chief and publisher

EDITORIAL DEPARTMENT
CARL LARON, editor
JOSEPH J. SUDA, associate technical editor
JULIAN S. MARTIN, associate editor
TERI SCADUTO, assistant editor
MICHAEL A. COVINGTON, N4TMI contributing editor
JEFFREY K. HOLTZMAN, computer editor
LARRY KLEIN, audio editor
DAVID LACHENBRUCH, contributing editor
DON LANCASTER, contributing editor
EVELYN ROSE, editorial assistant

ART DEPARTMENT
ANDRE DUZANT, art director
RUSSELL C. TRUELSON, illustrator

PRODUCTION DEPARTMENT
RUBY M. YEE, production director
KATHRYN R. CAMPBELL, production assistant
KEN COREN, desktop production director
LISA BAYNON, desktop production

CIRCULATION DEPARTMENT
JACQUELINE P. CHEESEBORO, circulation director
THERESA LOMBARDO, circulation assistant

REPRINT DEPARTMENT
MICHELE TORRILLO, reprint bookstore

Typography by Mates Graphics
Cover design by David Loewy

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

Advertising Sales Offices listed on page 126.

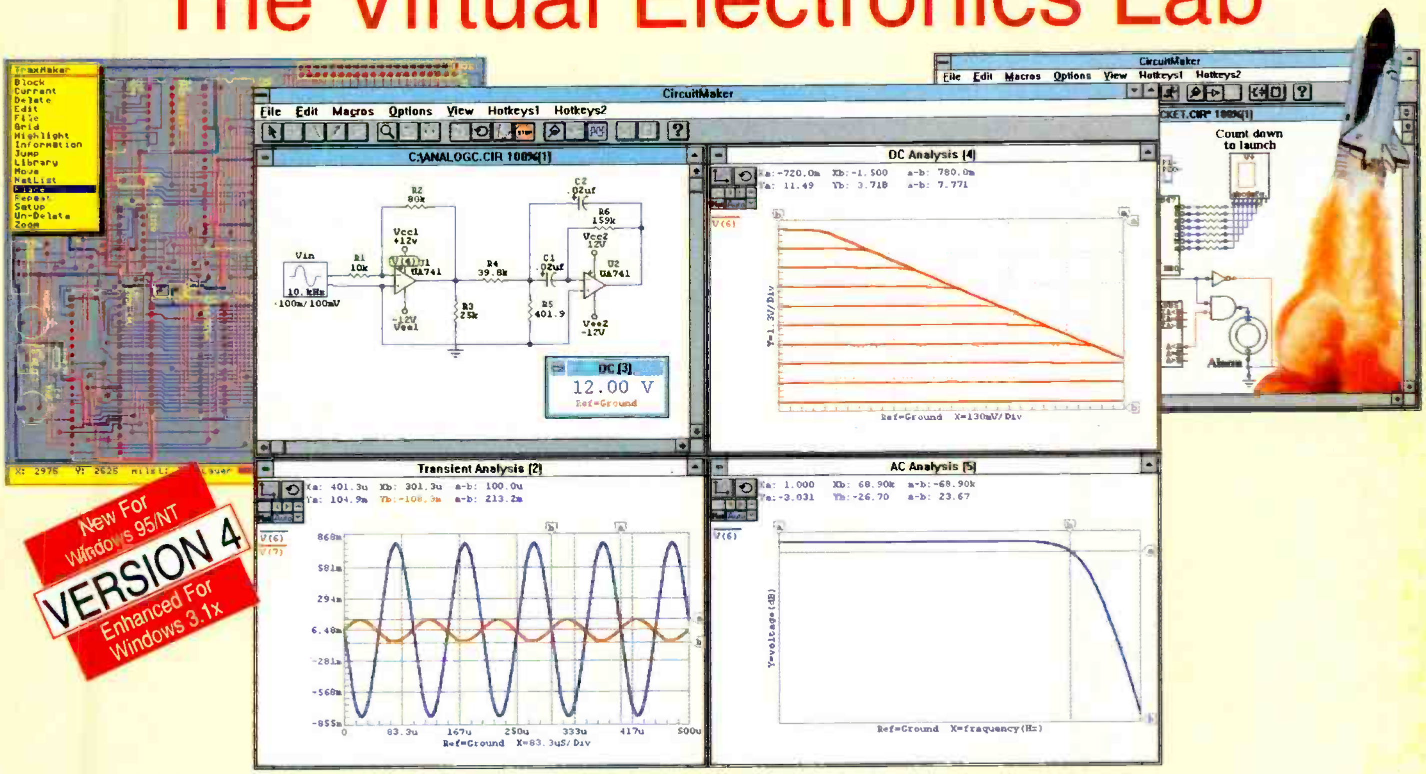
Electronics Now Executive and Administrative Offices
1-516-293-3000.

Subscriber Customer Service:
1-800-999-7139.
7:00 AM–6:00 PM Monday–Friday MST

Audit Bureau of Circulations
Member

CircuitMaker®

The Virtual Electronics Lab™



Professional Schematic Layout

CircuitMaker's schematic capabilities are unmatched and include many advanced editing features not found in similar programs. These powerful features minimize the time and task associated with drawing a schematic and insure a professional looking final product. Printout and export options are numerous and results are of the highest quality. But that's what people have come to expect from CircuitMaker.

Unlimited, Indestructible Devices

CircuitMaker ships with over 1500 devices. That's more (at no additional cost) than any competing product. If you need a device that is not included, CircuitMaker provides industry standard SPICE import and a powerful macro capability. These indestructible devices accurately emulate actual devices and enable the user to try all those "what if" scenarios with no risk and at no additional cost.

Accurate Simulation & Advanced Analysis

CircuitMaker features analog, digital and mixed-mode simulation. Obviously, simulation is of no value if the results are not accurate. CircuitMaker's simulation engine is based on Berkeley SPICE3, which is renowned for it's accuracy. That's why we can factually state that CircuitMaker provides it's user with the most accurate simulation available. Furthermore, CircuitMaker provides a wealth of analysis capabilities not found in other products in it's class. No other product offers this much simulation muscle at such a reasonable price.

Printed Circuit Board Output

CircuitMaker's PCB output capability helps you complete your design cycle, by generating a netlist that can be imported into any compatible PCB program. This is not a costly "add-on module", it comes standard with every copy of CircuitMaker. MicroCode Engineering also offers TraxMaker, a professional level, PCB layout and autorouting program for just $299. Used in conjunction with CircuitMaker, TraxMaker completes a powerful end-to-end circuit design system.

	Schematic Capture	Advanced Schematic Features	Digital, Analog, and Mixed-Mode Simulation	Full SPICE Compatibility	SPICE Export/Import	PCB Export	Retail Price
CircuitMaker	YES	YES	YES	YES	YES	YES	$299
Electronics Workbench version 4	YES	NO	YES	NO	NO	NO	$299
Electronics Workbench Engineer's Pack	YES	NO	YES	NO	YES	YES	$599

"CircuitMaker Shocks The Competition, With An Unbeatable Bottom-line"

Total Customer Satisfaction

At MicroCode Engineering we are committed to total customer satisfaction. When you purchase CircuitMaker you have the confidence of knowing that a trained staff of professionals is available to serve you after the sale. Our free unlimited customer service is second to none! Whether you have general or technical questions they will be answered promptly by a knowledgeable representative.

FREE Functional Demo

A free functional demo is available on the Internet at http://www.microcode.com, on CompuServe (GO MICROCODE) and on America Online by doing a file search for CircuitMaker.

Call now to order or request additional information

800-419-4242

MicroCode Engineering Inc. • 573 W 1830 N Suite 4 Orem UT 84057-2030 USA • Phone 801-226-4470 Fax 801-226-6532 • Internet http://www.microcode.com

CIRCLE 128 ON FREE INFORMATION CARD

EDITORIAL

Questions, Answers, Promises, and Wishes

Back in my first editorial (**Electronics Now,** September 1996), I asked for your help in determining the future course of this magazine. The answers I received were interesting, gratifying, and somewhat overwhelming.

To start with, I want to thank each and every one who took the time to respond. It is that kind of feedback that helps keep **Electronics Now** on course. If you see something wrong or right, or have an opinion and don't share it with us, it is sort of like not voting and then complaining afterward about the results of an election.

Anyway, as to the responses, they offered a wide gamut of specific likes and dislikes, but most had one unifying theme: Keep the spirit and tone of the magazine right where it is. I promise that is one thing that will happen. For those who would like to see what your fellow readers think, a few selected letters appear in this month's Letters column. A few others might appear in future columns.

And, please, keep on writing! Your opinions and suggestions count for a lot. While the demands of publishing a monthly magazine prevents me from answering each and every letter individually, each and every one is read and appreciated.

Let me close this month by wishing all our readers, advertisers, staff, and their families a joyous holiday season and a happy New Year.

Carl Laron
Editor

WHAT'S NEWS

A REVIEW OF THE LATEST HAPPENINGS IN ELECTRONICS

FCC Approves Digital Wireless Cable

The FCC last summer approved a petition from the Wireless Cable Association International (WCA) to allow wireless cable operators to implement digital-compression technology. The ruling allows wireless-cable operators to move from 33 analog channels to a digital system with more than 100 channels of programming. Tests and trials of the digital technology have proven successful, but the FCC action was needed before widespread deployment could begin.

In a letter to WCA president Richard Alston, FCC chairman Reed E. Hundt wrote: "From this day forward, the Commission will routinely grant wireless cable and ITFS applications proposing to transmit digitally on a non-interfering basis. Through the magic of digital technology, wireless cable operators now will be able to increase the carrying capacity of their wireless cable spectrum to well over 100 channels—a veritable gold mine for video-programming distributors."

"This clears the way for dramatic growth in the wireless cable industry," said Alston. "Wireless cable operators can now invest with confidence in digital technology, greatly expanding services and reach to new customers."

The drive to receive FCC approval was led by major system operators such as American Telecasting and People's Choice TV Corporation. American Telecasting plans to begin its conversion to digital technology in 1997.

ISCET To Share Test Administration

The International Society of Certified Electronics Technicians (ISCET) has decided to make the ISCET testing program available to all interested associations. Other associations are encouraged to choose their own test administrators and to allow the ISCET-issued test and certificate to bear the logo and name of the participating association. A portion of the test fee will go to the certifying organization.

ISCET has also agreed to accept the Electronics Technicians Association (ETA) Associate Test in lieu of the ISCET Associate Test requirement. Those who pass the ETA exam will qualify to take any one of the ISCET Journeyman exams. ISCET remains open to continuing negotiations with the ETA to develop a common Associate exam pool. Leaders from the National Electronics Service Dealers Association (NESDA), the National Association of Service Dealers (NASD), and the National Independent Appliance Servicers (NIAS) have agreed to support ISCET's efforts to unify national technician certification.

ISCET has certified more than 41,000 electronics and appliance technicians, most of whom hold Associate certification. Based in Fort Worth, Texas, ISCET is recognized as the leading electronics- and appliance-technician certification agency.

First HDTV Station On Air

On July 30, WHD-TV became the first commercial station to broadcast and receive live HDTV signals. Based in Washington, D.C., WHD-TV is operated by WRC-TV, which is owned and operated by NBC. The model HDTV station is funded by equipment manufacturers and some 250 television stations nationwide. The broadcasts used the Grand Alliance system on which the proposed FCC digital-television standard is based.

The first public, on-air demonstration of the broadcast and reception of live and taped digital signals occurred on August 1. A taped segment of Lawrence of Arabia, transmitted using progressive scan and in its original aspect ratio, was shown in subsequent demonstrations.

WHD-TV has obtained an experimental license from the FCC to operate on channels 27, 30, and 34. Its purpose is to provide broadcasters and equipment manufacturers hands-on experience with the design, operation, and evaluation of the equipment needed to smoothly carry out the transition from the analog NTSC broadcast system to the digital era. The Model HDTV Station Project is sponsored by the Association for Maximum Service Television (MSTV) and the Consumer Electronics Manufacturers Association (CEMA). The project is being implemented by the David Sarnoff Research Center.

"We are delighted that both the broadcast and reception of a Grand Alliance HDTV signal were successful and ahead of schedule," said Jim McKinney, Model HDTV Station Project director. "Both video and audio signals were broadcast, as were data signals. Full high-definition television pictures and digital audio signals were received, decoded, and displayed as part of the first transmissions."

CEMA president Gary Shapiro added, "This is a great step forward for HDTV. AS soon as the digital HDTV standard, recommended by the FCC Advisory Committee, is adopted by the FCC, HDTV will become a reality."

FCC Eases Dish Restrictions

An FCC order issued in August allows people to install satellite dishes or other antennas, even when local governments or homeowners' associations have passed restrictions against them. As long as the equipment is installed on private property, meets certain aesthetic guide-

continued on page 18


Call for your FREE catalog!
Your One Stop Component & Computer Source
Special Prices for Electronics Now Readers. Please mention VIP #DR6!
8031 Embedded Applications Proto PC Board
• 32KB of SRAM • 8031 CPU
• 32KB of monitor EPROM
• 14 screw-type terminal blocks connected to general purpose digital input/output ports
• 40-pin header for all system signals
• Two 23-pin headers for demultiplexed data, address, control, and I/O signals
• Size: 4.0"W x 7.0"L • Weight: 1.3 lbs.
SPECIAL
Part No. Description Price
119546 8031 proto board... Special $99.95
Modem Technical Guide
MICRO HOUSE
Great tool for beginners and experienced modem users and includes a bonus CD-ROM! Includes modem primer, set-up information, hardware configuration settings and diagrams for many of the most popular models on the market.
• Detailed summaries of standard and proprietary commands • 625 pages
THE MODEM
Part No. Description 1-4 5-9
133794 Modem Tech. Guide $49.95 $44.95
Electronic Temp-Control Soldering Station
XYTRONIC
• Temperature control: 500°–800°F
• Circuit protects voltage and current sensitive ICs from voltage spikes
• Power consumption: 45W at 650°
• Includes one P/N 35115, 1/16" tip
SPECIAL
Part No. Description Price
129058 Soldering station..... Special $59.95
Benchtop PC Board Solder Station
• Holds PC boards up to 13" wide
• Can be adjusted by using press release and sliding support arm to hold desired size board
• Right hand soldering iron holder
• Size: 19.5"W x 8.8"D x 8.8"H
NEW
Part No. Description Price
133065 PC board solder stat. $49.95
Jameco Clamp Vise
• Lightweight, sturdy construction
• Nylon jaws open 2"
• Ball cup allows vise to adjust to any angle
• No tools needed – finger turn to tighten
• Size: 10.0"H x 2.5"W • Weight: 2.0 lbs.
Part No. Description 1-4 5-9
127167 Clamp vise............$19.95 $17.95
LOGICAL DEVICES, INC. CUPL Software
CUPL Software is one of the world's most popular and comprehensive PLD/FPGA design software systems, with over 20,000 users. CUPL is a very versatile and powerful logic compiler that can be used to create simple or even very sophisticated logic designs for PLD's and FPGA's. CUPL runs either in DOS or in a DOS prompt within the Microsoft® Windows® environment.
132871 132880
132871: CUPL Starter Kit
Supports 10 of the most popular PAL & GAL architectures.
132880: PAL Expert
Supports 75 of the most popular PAL, GAL and PROM architectures.
Part No. Description 1-4 5-9
132871 CUPL starter kit.....$89.95 $79.95
132880 PAL expert............349.95 329.95
CircuitMaker® Software
Professional quality schematics made quick and easy!
• Accurate analog, digital and mixed-mode simulation
• Powerful interactive circuit analysis capabilities
• 1000+ devices and models included
• SPICE compatible import/export
• Improve your skills w/ many troubleshooting features
• Optional PCB layout and autorouting
Part No. Description Price
125591 CircuitMaker SW............... $279.95
Jameco 51 Piece Tool Kit
An assortment of the most essential tools for maintenance and repair jobs. Black vinyl-covered case features removable pallets, a combination lock and a cushioned, black plastic handle. • Weight: 11.0 lbs.
• Size: 12.5"L x 17.5"W x 3.5"H
Part No. Description Price
26681 51 piece tool kit................$109.95
SL WABER Surge Protectors
SurgeSentry 6 outlet
• Ultimate 3-stage protection
• No limit connected equipment guarantee
• 62,525 amp spike suppression; 880 joules
SPECIAL
133090
DataGard 7 Outlet
• $1000 connected equipment guarantee
• Standard 1-stage protection
• 13,000 amp spike suppression; 520 joules
133081
Part No. Description Price
133090 SurgeSentry 6-outlet Special $24.95
133081 DataGard 7-outlet .. Special 9.95
Encyclopedia of Electronic Circuits on CD-ROM
Tab/McGraw Hill
Electrical engineers can turn to this new CD-ROM for an interactive, electronic version of the Encyclopedia of Electronic Circuits. It features 1,000 circuitry drawings from the 5-volume set, plus an easy-to-use schematic editor, SuperCAD, from Mental Automation. This valuable tool allows engineers to locate specific circuits, and then review, modify, print, or combine them with other circuits.
Part No. Description 1-4 5-9
130500 Encyclo. CD-ROM ...$99.95 $89.95
JAMECO 3½-Digit Pocket Multimeter
• Measures: AC/DC voltage, A DC, HFE and resistance
• DC voltage: 200mV, 2V, 20V, 200V, 1000V
• AC voltage: 200V, 750V
• Resistance: 200Ω, 2kΩ, 20kΩ, 200kΩ, 2MΩ
• DC current: 200mA, 2mA, 20mA, 200mA, 10A • Diode test • Transistor HFE
• Removable test leads
Part No. Description Price
119212 Pocket meter w/ test.............$17.95
Power Leap Upgrade Adapter
For 486SX/DX/DX2 to 586-100/120
• Supports 5V 486 motherboards
• 586-XXX chip not included
• Supports 64-bit X86 compatible processor with 16KB write-back cache
• 100 and 120MHz core speeds with 33, 40 and 50MHz bus options (BIOS written before 1995, will only work with AMD CPUs)
• Includes manual and 3.5" utility/test disk
Part No. Description Price
131941 Upgrade adapter.................$49.95
Jameco E(E)PROM Programmer
• Programs EPROMs, EEPROMs
• Programs 16Kbits to 512Kbits EPROMs
• Programming speeds/algorithms: normal, intelligent, and quick pulse
Part No. Description 1-4 5-9
101400 1 socket 16Kbits-512Kbits E(E)PROM prog. $129.95 $119.95
ABS Speedy Box and Board
18913: Speedy Box
• Size: 4.9"L x 2.5"W x 1.5"D
• Weight: 3.4 oz.
105128: PC Board
• Number of holes: 671
• Size: 4.4"L x 2.0"W
18913
105128
Part No. Description 1-9 10-49 50-99
18913 Speedy box.....$2.49 $2.25 $1.79
105128 PC board..........4.95 4.49 3.95
BOCA 9600S/4800R bps Fax and 2400 bps Modem
• Easy to use menu-driven fax and data communications software
SPECIAL
• Auto-install utility and external COM1-COM4 select
• Weight: 1.2 lbs. • Five-year warranty
Part No. Description Price
132417 Internal fax/modem Special $24.95
2.5" High 6-Digit Clock Kit
• Bright 2.5" high 6-digit displays (red)
• Can be viewed from over 50' away
• 12 hour or 24 hour display switch
• Fast and slow set switches
• Time hold control switch
• Safe low input voltage: 9VAC
• Kit PC board size: 17.5"L x 3.5"W
HOT!
Part No. Description Price
105507 Digital clock kit...................$59.95
Video Transmitter Station
This powerful new device transmits from a source location to any number of remote locations through TVs. Excellent for security surveillance!
• Transmit/receive: channels 7-13
• Use with a camcorder for stereo audio sound • Includes audio & video cables
Part No. Description 1-4 5-9
131828 Video transmitter $49.95 $44.95
Jameco Electronic Component Cabinet Kits
Kits include the most popular components with extra space for your customized expansion. Each kit includes a 20 drawer component cabinet.
More kits available – call for details!
Part No. Description Price
84953 330 pc. 7400 series IC kit........$169.95
84961 420 pc. 74LS series IC kit..........149.95
84970 300 pc. CD4000 series IC kit.......99.95
84988 385 pc. Linear series IC kit........179.95
108329 540 pc. 1/8 watt Resistor kit........29.95
81832 540 pc. 1/4 watt Resistor kit........28.95
107879 540 pc. 1/2 watt Resistor kit........31.95
108433 2200 pc. Electr. Hardware kit.......39.95
81867 110 pc. Radial Capacitor kit.........34.95
81859 320 pc. Ceramic Capacitor kit......29.95
81883 160 pc. Mylar Capacitor kit..........34.95
81841 129 pc. Tantalum Capac. kit........49.95
82587 270 pc. Diode kit.........................39.95
82595 180 pc. Transistor kit...................49.95
Jameco Solderless Breadboards
• Low static plastic body – CMOS safe
• Nickel plated clips designed to withstand up to 5,000 insertion cycles
20773
Part Number Contact Points Size L x W Pricing 1-9 10-49
94457 100 6.5 x 0.4......$2.49 $2.25
20600 400 3.3 x 2.1........4.95 4.49
20669 630 6.5 x 1.4.........5.95 5.35
20722 830 6.5 x 2.1..... SALE 6.95
20757 1,360 6.5 x 3.1..... SALE 11.95
20773 1,660 6.5 x 4.3......16.95 14.95
20790 2,390 6.9 x 5.8......21.95 19.95
20811 3,220 7.3 x 7.5......29.95 27.95
JAMECO® ELECTRONIC COMPONENTS COMPUTER PRODUCTS
© 1996 Jameco 12/96
Ordering Hours: 5:30am - 5:30pm PST
1355 Shoreway Road
Belmont, CA 94002-4100
FAX: 1•800•237•6948 (Domestic)
FAX: 415•592•2503 (International)
E-mail: info@jameco.com
http://www.jameco.com
Call for your FREE catalog!
VISA MasterCard DISCOVER FedEx. UPS
Mention V.I.P.# DR6
Call 1-800-831-4242 to order today!

WHATS NEW IN THE FAST-CHANGING VIDEO INDUSTRY

BY DAVID LACHENBRUCH

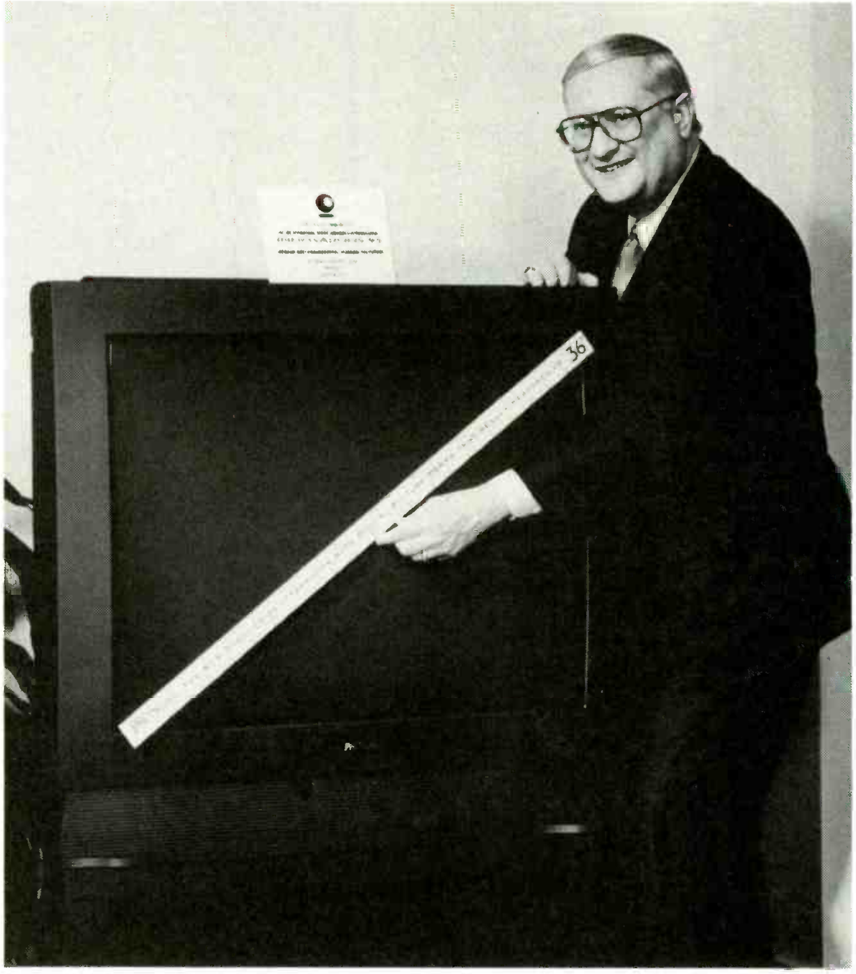
Satellite Receivers—$199

Digital satellite receivers were selling as recently as last summer at $599 to $699. Suddenly, the starting price is $199—and in some cases as low as $99. The secret is the tie-in sale of service, presumably patterned on the giveaway prices of cellular phones and pagers.

Virtually all direct-to-home satellite equipment manufacturers have now joined in the orgy of price slashing at the instigation of the satellite programming services. The big one—Digital Satellite System (DSS), which has the majority of subscribers—made it complete. Here's how it works: Programmers such as DirecTV will subsidize the receiver manufacturers at $1 to $1.50 monthly per unit sold over the next five years, in return for which manufacturers are expected to bring their hardware price down to $399. The ultimate buyer of the unit then receives a rebate of $200 from the programmer if he or she subscribes to a specific program package, such as DirecTV Total Choice, at $359 for a year. That brings the total price of the hardware to the buyer down to $199.

There are several variations of this program. AT&T, for example, gives added discounts and rebates to customers of its long-distance service, charging only $155 for a year's prepaid subscription to Total Choice, and adding no-interest financing through its credit-card subsidiary. Some dealers have knocked another hundred bucks off the price of the receiver gear because they get a cut of the program subscription. The actual manufacturing cost of a DSS receiver is estimated to be about $270.

Some dealer advertising for the receivers verges on the deceptive, however. Ads mentioning the lowball price rarely also add the other conditions, including the necessity to buy a year's subscription to a programming service. Of course, the satellite receivers are no good without the programming, which is by subscription only. Regardless, however, the new promotional pricing has given a big spur to the growth of the small-dish service.



THOMSON EXECUTIVE VICE PRESIDENT JOSEPH P. CLAYTON shows off a 36-inch diagonal ProScan TV.

MPEG Disc Camcorder

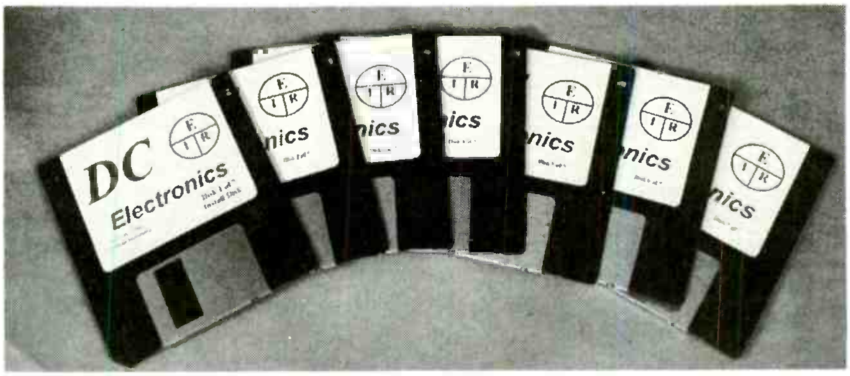
Hitachi promises that a revolutionary new type of camcorder will be on the world market as early as next year. As demonstrated in prototype form, it's about the size of a small hand-held remote-control or an electric shaver, and has a lens and pickup at one end and a 1.8-inch LCD monitor screen at the other. In the middle is a little slot to accommodate a standard 1.8-inch hard-disk drive of the type used in notebook computers. The camcorder can record for up to 30 minutes on the tiny magnetic disc, which can be played back directly through the built-in monitor or a TV set; it can also be removed and inserted in a PC for playback.

In motion video, the camcorder, as demonstrated recently in Tokyo, had picture quality that was better than

continued on page 18

Discover DC Electronics

17-Module Course -- Only $49.95



Contains everything you ever needed to know about DC electronics. Whether you are a professional working in electronics and you want a review of the basics, or a student or hobbyist new to this field and need a good self-paced course, this is the perfect way to get started.

The course starts with basics and assumes you know nothing about electronics. It teaches the required math, how to use a scientific calculator. and the metric notation system. Each module has been written by an electronics instructor, and will directly from a floppy or from a menu-driven system on your hard drive. Every module includes a review, summary, quiz, and a final exam that can be printed out. Important points are animated to make the explanation clear.

System requirements: IBM Compatible, 512K RAM, VGA Color, Hard Drive and DOS 3.2 or newer.

Here are the Modules

1. Atoms and Electrons
2. Volts / Current / Resistance
3. Numbers greater than one Scientific - metric notation
4. Numbers less than one Scientific - metric notation
5. Resistor Color Codes
6. Using Calculators
7. Ohms Law and Power
8. Series Circuits
9. Parallel Circuits
10. Series / Parallel Circuits
11. Voltage Dividers
12. Kirchhoff's Law
13. Advanced DC Circuit Analysis
14. Capacitors / RC Time Constants
15. Introduction to Magnetism
16. Inductors and L/R Time Constants
17. Volt/Ohm/Current Meters

Claggk Inc. P.O. Box 4099, Farmingdale, NY 11735

Send me my course, today! Charge me the special introductory price!

Name ____________________

$49.95 + $4.95 shipping

Address ____________________

Address ____________________

City ______________ State ________

Zip ________

Payment Enclosed $ ________

Check [ ] Money Order [ ] Credit Card [ ]

New York residents add local sales taxes. Canadians add $6 per order. Credit card orders by phone or fax. Automated telephone orders 516-293-3751. Fax 516-293-3115.

Allow 4 to 6 weeks for delivery.

Credit Card Info

[ ] MC [ ] Visa

Card # ____________

Exp Date ____________

Signature ____________

Q & A

READERS QUESTIONS, EDITORS ANSWERS

Safer Security System

Q *I presently have a simple security system utilizing loops with a load resistance between 1000 and 2000 ohms. Can you help me design a sensing circuit that will give logic-level outputs for "open," "shorted," and "correct resistance" conditions? — R. E. F., Lakewood, CA*

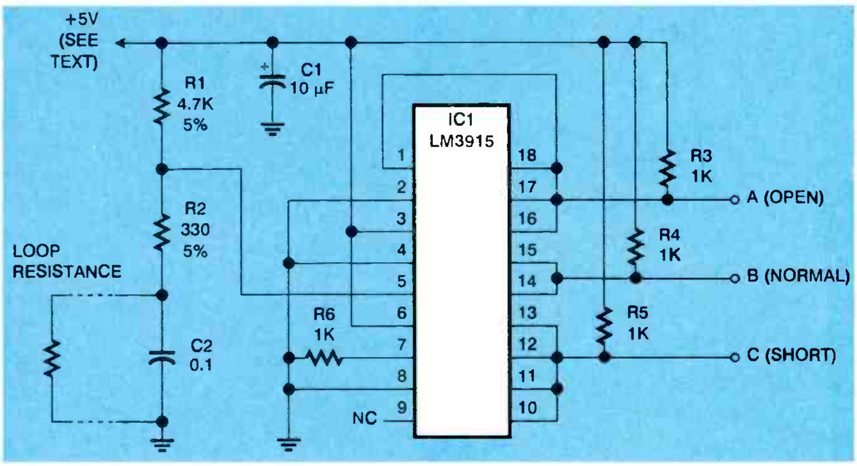


FIG. 1—ONE OF THREE OUTPUTS goes low depending on whether loop resistance is too high, too low, or just right.

A Many security systems use a closed loop of wires and switches arranged so that whenever a door or window is opened, the loop will be broken and the alarm will sound. An obvious problem is that someone can tamper with the system, short out the loop, and later on, come back and burglarize the premises without sounding the alarm.

Hiding a known resistance in the loop, as you propose, is a very good idea. That way, the alarm can distinguish a short circuit from a correctly functioning closed loop.

Figure 1 shows a circuit that does the job. It's a somewhat unusual application of a National Semiconductor LM3915 IC, normally used to drive LED bar-graph displays. That chip happens to contain the right combination of comparators and logic circuits to do what you need.

Step 1 is to translate the loop resistance into a voltage; that's done by putting it into a voltage divider with resistors R1 and R2. Capacitor C2 protects the circuit against electromagnetic noise—important because burglar alarms use long wires, often running near heavy electrical equipment.

Step 2 is to translate the voltage into a logic signal indicating whether it's in the correct range. That's where the LM3915 comes in. Normally, the LM3915 would drive ten LEDs, one for each of ten small ranges of voltage. To obtain logic-level outputs, we have it driving 1K resistors instead of LEDs. Since we only need to distinguish three situations, not ten, we tie some of the outputs together. The LM3915 has open-collector outputs that can be paralleled in that way.

LOOP RESISTANCE	OUTPUTS A	B	C
OPEN OR >2K	0V	+5V	+5V
1K–2K	+5V	0V	+5V
SHORT OR <1K	+5V	+5V	0V

FIG. 2—THIS TRUTH TABLE shows the states of outputs A, B, and C under different loop-resistance conditions.

The truth table in Fig. 2 shows how the outputs work. Note that they use negative logic (0V for "yes", +5V for "no"), the opposite of ordinary logic circuits. You can use inverters such as the 74HC04 to produce positive logic signals if that's what you need.

Finally, note that the circuit will actually work with any supply voltage from 3 to 25 volts. Of course, if the supply isn't 5 volts, the outputs will not be compatible with 5-volt logic circuits.

Joystick and World Wide Web

Q *I'd like to measure humidity by measuring wet and dry bulb temperatures. As suggested in your October 1995 issue, I connected a thermistor across pins 1 and 3 of my PC joystick port and used the BASIC statement R=STICK(0) to read it. R always came out zero, even when I tried several different resistors. What's wrong?*

Your article mentions PC Techniques, *April-May 1994, but when I called your BBS, I didn't find the program. Where can I get it? — G. P., U.S. Army, Incirlik, Turkey.*

A It sounds as though your joystick port (game port) isn't working, unless, possibly, you're using the wrong pins. Perhaps the game port has been turned off by a jumper on the I/O card or sound card; try running MSD.EXE (a diagnostic program that comes with Windows) to see if the game port is active. Do that with a resistor in place, of course.

You can find *PC Techniques* listings at that magazine's web site (http://www-.coriolis.com) and several BBSes (305-987-5688 for one). *PC Techniques* recently changed its name to *Visual Developer*, reflecting its emphasis on Windows programming. Since it's not one of our magazines, you won't find its listings on our BBS or web site. But if you've been waiting to see **Electronics Now** on the Web, take a look at http://www.gernsback.com. We're there!

Puzzled by Kirchhoff

Q *I understand Ohm's Law but can't understand Kirchhoff's First Law, which says the currents into and out of any point in the circuit add up to zero. Can you explain it and recommend some books on the topic? — D. G., Harrisburg, IL*

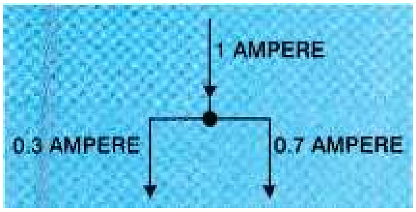


FIG. 3—AS STATED IN KIRCHHOFF'S first law, what flows into a node, must flow out.

A Certainly. Kirchhoff's Laws, in plain English without math, are:

(1) All the current that flows into a point must flow out again.

(2) All the voltage in a series circuit must be distributed among the components.

Making it even simpler: Current cannot disappear and voltage cannot disappear. As you note in your letter, those facts follow from the conservation of matter and energy.

Physics textbooks often explain those concepts by saying that the currents into a point add up to zero, and the voltages around a loop add up to zero. That's confusing until you realize that negative numbers are involved.

Suppose for example that some point in the circuit has 1 ampere flowing into it, 0.3 ampere flowing out through one path, and 0.7 ampere flowing out through another path (see Fig. 3). We count the incoming current as positive and the outgoing current as negative, so:

$$1.0 + -0.3 + -0.7 = 0.0$$

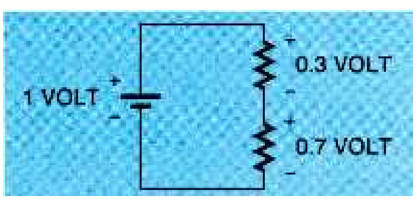


FIG. 4—KIRCHHOFF'S SECOND LAW states that the sum of all voltages in a loop must be zero. Watch the polarities to avoid confusion.

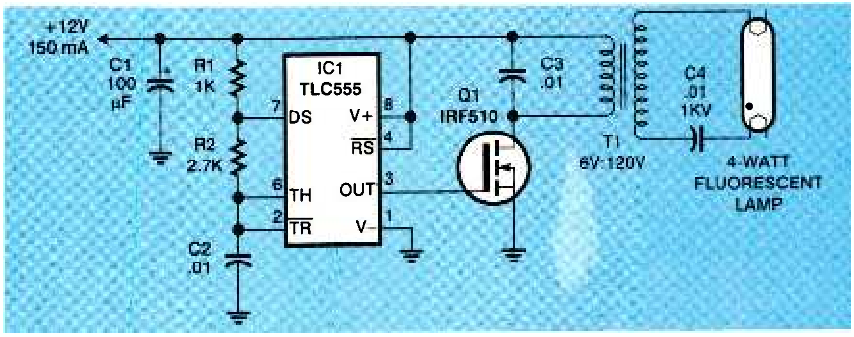


FIG. 5—THIS CIRCUIT lets you power a fluorescent light from a 12-volt DC source. You might need to experiment with the transformer.

and Kirchhoff's First Law is satisfied.

Now consider the circuit in Fig. 4. The battery supplies 1 volt and the resistors take up 0.3 volt and 0.7 volt, respectively. Notice that the polarity of the voltage on the resistors is opposite that of the battery. So the resistor voltages count as negative. Again,

$$1.0 + -0.3 + -0.7 = 0.0$$

(volts this time, not amps) and Kirchhoff's Second Law is satisfied.

We suggest you go to a good library and look for an electronics textbook that meets your needs. Bear in mind that every mathematical formula is actually a statement of how something works. For example, Ohm's Law tells us that voltage is the force that drives a current through a resistance. Bear in mind, also, that you won't need to solve complicated circuit networks in order to design most kinds of electronic equipment. Ohm's Law and the reactance formulas are almost all you need.

Custom Crystal

Q *I plan to build a couple of projects that will be operating on 18.990 MHz and am unable to find a crystal that matches my specifications. Should I use a PLL synthesizer? — R. P., St. Louis Park, MN*

A Easier than that—you can order a custom crystal for a few dollars from JAN Crystals, PO Box 60017, Fort Myers, FL 33906. Write to them for a price list.

Battery Fluorescent Lights

Q *I would like to know how to make a 12-volt battery-operated fluorescent light for use in my truck. Would you be able to help me, either by publishing a sample circuit or by explaining how it works? — S. A., San Jose, CA*

A Figure 5 shows a circuit you can experiment with. It's a close relative of the high-voltage power supply in our September, 1996, issue. The fluorescent tube is fed about 350 volts AC; at that voltage, the filaments don't have to be heated, so only one pin at each end is used. The ballast, or current-limiting element, is a capacitor rather than a coil.

The circuit consists of a 20-kHz oscillator, a switching transistor to amplify its output, and a step-up transformer. We used a 120-volt to 6-volt power transformer connected backward (Radio Shack 273-1352, using half of the 12-volt side for 6 volts). In the circuit, the transformer is working at considerably more than its rated voltage, but the high frequency keeps it from saturating. Although the lamp does not glow at full brightness, the circuit is energy-efficient, requiring only 150 mA.

The exact characteristics of your transformer will make a big difference here, so experiment. The transformer specified in our September issue will work better, but it's probably too expensive for the purpose. A 10-volt to 240-volt transformer would be ideal, if you can find one. Be careful around the high voltage, and remember that it's easy to burn out the IRF510 with excessive current.

BIOS Queries

Q *I have two related questions. Will the BIOS chip from a 386DX-25 work on a 386DX-40 motherboard? Also, I have a 386DX-25 motherboard with an AMI BIOS chip. When I power it up, it beeps 3 times over and over. Can you tell me what that code means? — B. F., Newport News, VA*

HOW TO GET INFORMATION ABOUT ELECTRONICS

On the Internet: See our Web site at http://www.gernsback.com for information and files relating to our magazines (Electronics Now and Popular Electronics) and links to other useful sites.

To discuss electronics with your fellow enthusiasts, visit the newsgroups sci.electronics.repair, sci.electronics.components, sci.electronics.design, and rec.radio.amateur.homebrew. "For sale" messages are permitted only in rec.radio.swap and misc.industry.electronics.marketplace.

Many electronic component manufacturers have web pages; see the directory at http://www.hitex.com/chipdir/, or try addresses such as http://www.ti.com and http://www.motorola.com (substituting any company's name or abbreviation as appropriate). Many IC data sheets can be viewed online.

Books: Several good introductory electronics books are available at Radio Shack, including one on building power supplies.

An excellent general electronics textbook is *The Art of Electronics*, by Paul Horowitz and Winfield Hill, available from the publisher (Cambridge University Press, 1-800-872-7423) or on special order through any bookstore. Its 1125 pages are full of information on how to build working circuits, with a minimum of mathematics.

Also indispensable is *The ARRL Handbook for Radio Amateurs*, comprising 1000 pages of theory, radio circuits, and ready-to-build projects, available from the American Radio Relay League, Newington, CT 06111, and from ham-radio equipment dealers.

Copies of past articles: Copies of past articles in **Electronics Now** and **Popular Electronics** (post 1991 only) are available from our Claggk, Inc., Reprint Department, P.O Box 4099, Farmingdale, NY 11735; Tel: 516-293-3751.

Electronics Now and many other magazines are indexed in the *Reader's Guide to Periodical Literature*, available at your public library. Copies of articles in other magazines can be obtained through your public library's interlibrary loan service; expect to pay about 30 cents a page.

Service manuals: Manuals for radios, TVs, VCRs, audio equipment, and some computers are available from Howard W. Sams & Co., Indianapolis, IN 46214 (1-800-428-7267). The free Sams catalog also lists addresses of manufacturers and parts dealers. Even if an item isn't listed in the catalog, it pays to call Sams; they may have a schematic on file which they can copy for you.

Manuals for older test equipment and ham radio gear are available from Hi Manuals, PO Box 802, Council Bluffs, IA 51502, and Manuals Plus, Box 637, Spanaway, WA 98387.

Replacement semiconductors: Replacement transistors, ICs, and other semiconductors, marketed by Philips ECG, NTE, and Thomson (SK), are available through most parts dealers (including Radio Shack on special order). The ECG, NTE, and SK lines contain a few hundred parts that substitute for many thousands of others; a directory (supplied as a large book and on diskette) tells you which one to use. NTE numbers usually match ECG; SK numbers are different.

Remember that the "2S" in a Japanese type number is usually omitted; a transistor marked D945 is actually a 2SD945.

Hamfests (swap meets) and local organizations: These can be located by writing to the American Radio Relay League (Newington, CT 06111; http://www.arrl.org). A hamfest is an excellent place to pick up used test equipment, older parts, and other items at bargain prices, as well as to meet your fellow electronics enthusiasts both amateur and professional.

A The answer to the first question depends entirely on whose BIOS and whose motherboard; you can try it and see. As for the three beeps, they indicate that there is a defective chip in the lowest 64K of memory, so that the rest of the BIOS self-test can't execute.

We got this information from *Troubleshooting, Repairing, and Maintaining Personal Computers*, by Steven J. Bigelow, published by Tab; it's the most comprehensive guide of this kind that we've seen.

Liquid Crystals

Q *I am trying to display the digits 1-6 on an LCD display, taken from a clock, using NTE4543 and NTE4055 drivers and a DC supply. The display acts erratic, showing the correct digits sometimes, but odd characters or segments at other times. Also, I do not understand the function of the* LD, PH, *and* PL *pins on the driver chips. Can you help? — K. J., Oneonta, NY*

A The NTE4543 is the same as the CD4543, and you can get a data sheet from National Semiconductor Corporation (2900 Semiconductor Drive, Santa Clara, CA 95051) or at http://www.nsc.com.

It sounds as though the LATCH DISABLE, PHASE, and BLANKING inputs are floating (disconnected) and are picking up random noise, as disconnected CMOS inputs often do. Connect LD (pin 1) to +5V, BLANKING and PHASE to ground, and things should work much better. If the wrong segments are activated, connect PHASE to +5V instead.

Many LCDs require an AC or pulsating drive. Yours apparently does not, or you wouldn't be seeing any display at all.

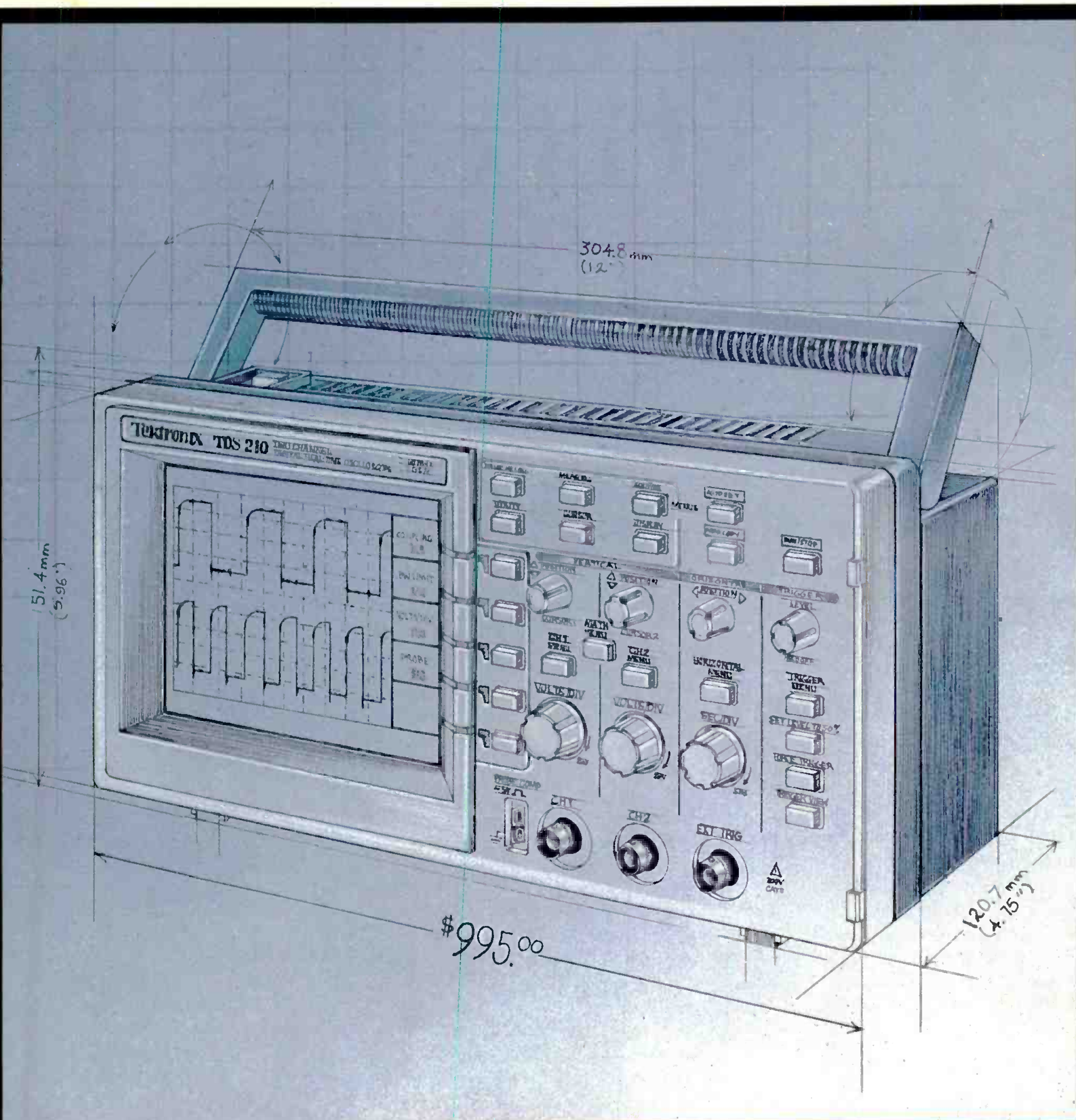
MIDI Mystery

Q *Help, help! A long while back, I saw a circuit for adding a MIDI interface to a pipe-organ keyboard. It used a MUX IC such as the HI-506 and a UART such as the 8650, and it just provided encoded key closures. Of course, I misplaced it since then. Does anybody have such a circuit in their files? Please keep it cheap and simple. — C. S., Glenhaven, CA*

A We don't recall it, but someone else might. Readers?

Writing to Q&A

We welcome your questions. The most interesting ones are answered in print, usually within 9 months. Please be sure to include plenty of background information (we'll shorten your letter for publication). If you are asking about a circuit, please include a complete diagram. We regret that we cannot give personal replies. EN


304.8 mm
(12")
151.4 mm
(5.96")
120.7 mm
(4.75")
$995.00
Tektronix TDS 210
CH1
CH2
EXT TRIG
VOLTS/DIV
SEC/DIV

LETTERS

SEND YOUR COMMENTS TO THE EDITORS OF ELECTRONICS NOW MAGAZINE

Low-Cost EEPROM Programmer For Macs

I am writing in regard to G. Y. Xu's article, "Low-Cost EEPROM Programmer" (**Electronics Now**, November 1995). In order to make that device available to Mac users, I have written driver software to interface a Mac running System 7.0X or later to the EEP-1. Like Mr. Xu's PC-based communications software, my application has the capability to generate a binary from an Intel hex file. It will also create a binary from a Motorola S19 record.

I have uploaded the application, called MacEEP, to the Mac ftp archive site at sumex-aim.stanford.edu. The path is /info-mac/app/ and the file name is mac-eep-101.hqx. This is a binhex encoded Stuffit archive that includes the application along with documentation and a shareware license. The sumex-aim site also has several mirrors. Those include the Washington University site (wuarchive.wustl.edu/systems/mac/info-mac), and Apple's mirror (mirror.apple.com/mirrors/info.mac).

BARRY NEWBERGER
Austin, TX

Mobile Electronics Test Dates

The Consumer Electronics Manufacturers Association (CEMA) has set new test dates for the Mobile Electronics Certification Program (MECP), the only nationally recognized program of its kind for 12-volt installers. Candidates can test in four categories: Installer, Specialist for Auto Sound, Security, and Cellular.

The MECP tests will be held in New Orleans, LA, on November 7; Minneapolis, MN, on November 14; Portland, OR, on November 28; Baltimore, MD, on December 5; Atlanta, GA, on December 12, Dallas, TX, on December 29; Las Vegas, NV, on January 12; Columbus, OH, on January 16; Denver, CO, on January 23; San Francisco, CA, on January 30; Seattle, WA, on February 6; White Plains, NY, on February 20 at 6:30 PM; and Los Angeles, CA, on February 27 at 6:30 PM. Unless otherwise noted, all tests start promptly at 5:30 PM.

To receive more information on test locations, study guides, and cost, call 703-907-7689.

MECP/CEMA
Arlington, VA

More Of The Same, Please!

I have a few comments in response to the editorial in the September issue of **Electronics Now**.

It is generally a great magazine. I have subscribed since forever, and continue to find it mandatory reading each month. The mix of technical, informative, and computer articles is about right. Please do not stray too far from the technical, build-it-yourself-type of feature. Over the years, I have built almost as many items from your magazine as I have Heathkits (and that number is 60-plus).

Please consider running long articles on consecutive pages, instead of all over the magazine. It is a real problem to try to follow a schematic or drawing that is 40 or 50 pages from the text. Sometimes I wind up with four fingers in various pages, trying to make sense out of a single article.

Thanks for the World Wide Web site (www.gernsback.com). I trust that there might be a possibility that e-mail addresses or mailboxes for the authors will be made available. That would be a faster way to provide corrections, too.

Keep up the good work, and thanks.

FRED ALBERTSON
via e-mail

As you might have noticed, we've already implemented some of your suggestions. While production necessities sometimes get in the way, we are running stories on consecutive pages where possible; sometimes continued pages are required, but we will try and keep them at a minimum. Also, as soon as the discussion groups are up and running on the Web page (perhaps by the time you read this), there will be a Corrections/Announcements forum where corrections and other types of information will be made available as soon as we have it.—Editor

Write To:
Letters,
Electronics Now Magazine,
500 Bi-County Blvd.,
Farmingdale, NY 11735

Due to the volume of mail we receive, not all letters can be answered personally. All letters are subject to editing for clarity and length.

Caption Correction

In the October, 1996 installment of Audio Update, the Samsung MAX555 mini-system that was profiled was misidentified as a Sanyo unit in a photo caption. We apologize to everyone concerned for that error.—Editor

Focus On The Hobbyist!

I've been an avid reader of **Radio-Electronics/Electronics Now** for the last 10 years. I like the magazine because of its focus on hobbyist hardware design. Although I prefer the magazine to be more on the technical side, I think there should be a variety of technical/non-technical articles. Computer-related articles are okay as long as they are related to using a computer for hobbyist applications. A few software projects are okay, but keep the focus on hardware.

I would prefer it if consumer-electronics reviews were kept out. I want a

If You're Getting Bad Reception, the Answer Is Clear.

imageLock
television ghost canceling reception system

Before imageLock | **After imageLock**

Your TV picture can sparkle without double images, shadows or ghosts.

There's nothing more frustrating. You're curled up on the couch with your favorite snack as you turn on a great show or movie...only to be met with a blurry, distorted picture. You can fiddle and fuss with the controls, wiggle the antenna... but the problem won't go away. Now, there's finally something you can do about it: **imageLock™**, the simple solution to the oldest of TV reception problems – ghosting.

imageLock is Emmy® Award-Winning Technology.

In 1995, **imageLock** technology won an Emmy® Award for its effectiveness in restoring picture clarity. Now you can put this award-winning technology to work in your own home to improve the quality of almost everything you watch on TV.

imageLock solves bad reception from antenna and cable.

Yes, even cable subscribers can experience poor reception, as some of you well know. But **imageLock** is designed to decode the Ghost Cancellation Reference (GCR) signal sent by broadcast and cable networks throughout the U.S. This eliminates signal contamination from cable and antenna by digitally restoring your picture to optimum clarity. So put this advanced Emmy® Award-winning technology to use in your own home. The result will be the sharper, clearer picture you've always wanted. And we back this promise up with our no questions asked 30 day return policy. Your satisfaction is always completely guaranteed.

Easy to install and use.

Easy to follow instructions will come with your shipment showing you how to hook **imageLock** to your TV through your VCR. Plus, you'll have a toll-free hotline to call with any questions or problems. Magnavox is committed to helping you every step of the way.

Once **imageLock** is installed, you will see an end to blurring, ghosting, color distortions and most other reception problems forever...or your money back.

AVAILABLE EXCLUSIVELY FACTORY DIRECT FROM MAGNAVOX

Your satisfaction guaranteed.

There may be reception problems in your area that imageLock cannot overcome. If that proves to be the case, simply return it within 30 days for a full refund, including shipping and handling. But chances are excellent that imageLock can give you the clear, clean picture you've longed for. You're invited to put imageLock to the test for 30 days without risk or obligation.

CALL NOW TO ORDER:

MAGNAVOX
Smart. Very smart.®

1-800-446-7860

Six Easy Payments of $32.95 Ext. 101

Plus $7.95 Shipping and Handling and any applicable tax. VISA and MasterCard accepted.

Performance may vary according to broadcasting and ghosting conditions. Requires transmission of the GCR signal by broadcast and cable networks. Television images are simulated.

magazine that focuses on hobbyist, "hardware-hacker" type projects. If I want reviews of consumer-electronics products, there are plenty of magazines that I can buy that review audio/video gear.

In short, I'm pretty happy with the magazine as it has been. I used to buy it solely for Don Lancaster's "Hardware Hacker" column, but lately that's gotten to be a little too self-promotional.

Thanks for asking for feedback!

STEVEN SPROUSE
via e-mail

Alternate Executive Decision Circuit

I enjoyed the "Executive Decision Support System" (**Electronics Now**, September 1996). It has an answer for every question. (I didn't say it has the right answer, but it does have an answer!)

Figure 1 shown here illustrates a circuit that does essentially the same thing, but does not require a microcontroller. The heart of the circuit is IC1, a 6-kHz oscillator. When it's running, the LEDs light up, one after another, too fast to see. When you release the button, one LED stays lit.

To use eight LEDs instead of ten, disconnect pin 15 (RS) from ground and connect it to pin 9 (QS).

MICHAEL A. COVINGTON
Athens, GA

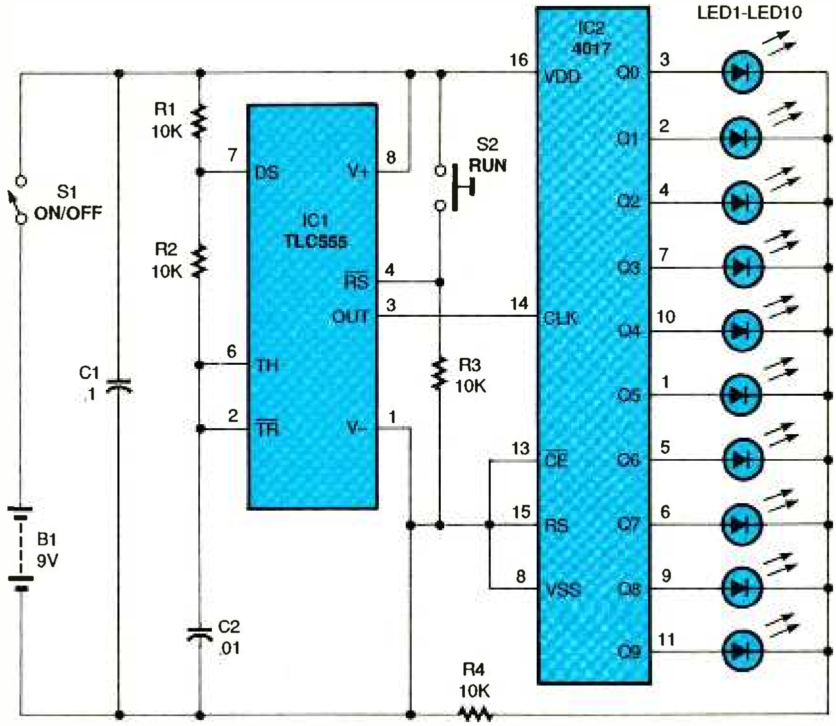


FIG. 1

Keep It Coming!

Please do not "improve" **Electronics Now**. There is a pretty good blend of consumer and technical articles and features in the magazine as it is. If I wanted more consumer and/or simpler projects, I would subscribe to one of the many consumer-oriented magazines that are out there already.

Electronics Now is one of the few magazines left that has not become entirely computer oriented. There is still a large area of electronics that is not digital, even though computer and digital circuitry is found as a part of most electronic items. With the demise of *Elektor Electronics USA*, **Electronics Now** is the only reasonably technical, readily available magazine left. Please remember that attempting to please everyone means that you could end up pleasing no one.

I especially enjoy the articles hy Jeff Holtzman and Don Lancaster. I do not always agree with them, but they do keep me thinking! And the stereo compressor was just what I have been looking for to reduce the range of CDs when transferring them to cassettes for use in my car. It will also be useful for converting classical music to a background listening range.

KIRBY McREE
Jackson, MS

Applauding Laser Experiments

I greatly appreciate Carl Bergquist's "Laser Experiments" column. In my job with the School Tour Division of Laser Fantasy International, I have the opportunity to perform educational laser shows in schools all around the country. After the shows, students and teachers usually ask me questions about different aspects of lasers.

Thanks to you, I can now direct them to Mr. Bergquist's concise and informative articles. I feel that anyone who wants to learn about the many uses of laser light should keep his columns handy for future reference.

I'm waiting for more! Keep up the good work.

In reference to Adam Rixey's letter (**Electronics Now**, September 1996), we here at LFI design and manufacture a variety of professional, multi-color laser-performance systems. For the hobbyist, I recommend obtaining copies of catalogs from MWK Industries, Meredith Instruments, and Midwest Laser Products. All are long-time advertisers in **Electronics Now.** I also recommend studying a copy of the "Laser Safety Guide," available from the Laser Institute of America (12424 Research Parkway, Suite 125, Orlando, FL 32826; Tel: 407-380-1553).

Happy lasering, folks!

STEVE McHATTON
Redmond, WA

No Hype, Please!

I have been reading **Electronics Now** for a long time— please keep it the way it is. If I wanted a review of a receiver or a CD player, I would read *Consumer Reports*, *Audio*, or any of the many, similar magazines.

The techs want magazines that are diversified. I guess Don Lancaster is kind of like the rest of us (he doesn't focus on just one small field of endeavor and likes to keep expanding his horizons).

Please keep the magazine as is, without the hype.

BOB MAKSON
via e-mail

EN

VIDEO NEWS

continued from page 8

VHS. It also can be used as a PC-compatible digital still-picture camera, storing up to 3000 still pictures on the disc, or recording four hours of digital audio without pictures. Because it uses a disc instead of tape, access to the still pictures or moving-picture segments is virtually instantaneous, and subjects are automatically indexed as they are recorded.

The secret of the new recording system is its use of MPEG- (Moving Picture Experts Group) compression technology, which has become standardized for computers, digital-TV transmission, and other uses. The camcorder records still pictures using standard JPEG (Joint Photographic Experts Group) technology.

Current digital camcorders using the industry-wide DV (Digital Video) format are already obsolete, at least in Hitachi's opinion. Hitachi credits its invention of an MPEG encoder integrating 3,000,000 components on a single chip that consumes only 600 milliwatts, and thus can work in a relatively low-cost, battery-powered camcorder. MPEG encoding hitherto had been thought far too complex to cram into a small consumer camcorder.

The DV format encodes each picture individually and requires a great deal of tape to make a recording. MPEG uses "asymmetrical" recording—massive processing power compresses video by a factor of about 100 by comparing groups of up to 15 frames at a time and encoding just the difference between them. MPEG requires only about 1.5 megabits-per-second and simple circuitry in the player or PC to decode the pictures—so playback can be done cheaply.

Hitachi hopes to have the tiny MPEG camcorders on the market in 1997, and at a cost of less than $2000. The first model will use the MPEG-1 standard. However, Hitachi is already working on chips needed to record in MPEG-2, which captures four times the picture detail but needs 10 times the processing power. The target for that HDTV model is 1999, and will result in what a top Hitachi engineer called "the final perfect digital recorder"—and a product that he said would start a new boom comparable to those triggered by color TV and the VCR.

That Extra Inch

TV manufacturers are engaged in a furious game of one-inch-upsmanship, and the main victim could be the 35-inch tube, currently the largest in mass production (although Mitsubishi does offer a 40-inch direct-view TV, it is hardly a mass item). The latest race was started by Thomson Consumer Electronics, maker of RCA, GE, and ProScan TVs, when it announced in December 1995 that its new ProScan line would have 36-inch tubes, rather than 35-inch. The same tube size later migrated to the RCA line, and the company is now offering the new tubes to other TV-set manufacturers. Toshiba then came along and started producing the 36-inch tube, while Zenith, Panasonic, and Philips all began changing their tooling for 36 inches.

In truth, however, that extra "inch" is more like a half inch. Picture tubes are measured by the diagonal of the viewable picture, and size advertising is governed by a Federal Trade Commission rule that permits manufacturers to round off the stated tube size to the nearest inch.

The move to 36 inches is reminiscent of the industry-wide changeover from 31- to 32-inch tubes in the last few years. The old 31-inch tube measured exactly 31-inches diagonally. In order to stretch that to a "32-inch" size, the tube makers were able to hold their changeover to the minimum by adding just over half an inch—so the "32-inch" tube actually measures just 31.501 inches. Likewise, the 35-inch tube, which measures a perfect 35-inches diagonally, will be transformed into a 36-incher whose picture actually measures 35.501 inches. The 32-inch tube is 3.24% larger in picture area than the 31-inch unit, while the 36-inch tube represents a 2.9% increase over the 35. EN

WHAT'S NEWS

continued from page 6

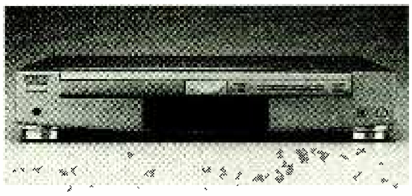
lines, and does not present a safety risk, it cannot be forbidden.

The FCC ruling seeks to balance the citizen's right to access over-the-air programming with local governments' and other organizations' concerns for safety and historic preservation. For instance, rules forbidding antennas to be installed on fire escapes remain in effect. Restrictions on satellite dishes may also be allowed at historic sites. And, for the sake of aesthetics, authorities can require that satellite dishes be installed in backyards instead of in front of a home.

The FCC ruling covers only property owners; it does not extend to renters who might want to mount a DSS dish outside an apartment window. However, according to a "Further Notice of Proposed Rulemaking," announced with the order, the FCC is considering whether to extend the rule to rental properties.

DVD Division

In the push toward a single DVD standard, Sony and Philips have jumped ship, announcing that they will begin licensing their own patents. The two companies were dismayed over the length of time it was taking to develop an industry-wide standard upon which all ten of the participating manufacturers could agree. Copy-protection issues were the major source of trouble, as manufacturers struggled to come up with a system acceptable to movie producers and content developers.



PHILIPS AND SONY, WHOSE PROTOTYPE DVD PLAYER IS SHOWN HERE, have split from the ranks of manufacturers seeking an industry-wide DVD standard.

The defection of Sony and Philips is not expected to further delay the DVD launch—now expected sometime next year. It will, however, make it harder for manufacturers to obtain the licenses they need to make DVD hardware and software. EN

EQUIPMENT REPORTS

FARGO ELECTRONICS FOTOFUN DIGITAL COLOR PHOTO PRINTER

Print real color photographs from your computer with photo lab color and clarity.

CIRCLE 15 ON FREE INFORMATION CARD

The technology of inputting photos and images into PCs has advanced significantly over the past two years. Digital cameras and scanners are decreasing in price, while the quality of the images they produce has increased. Add to that the millions of high-resolution images that are available on the World Wide Web and the need for a top quality yet affordable color-photo printer becomes very obvious.

Fargo Electronics has a digital color-photo printer that fills the bill perfectly. It produces prints of the same quality as photographs developed at a photo lab. The printer, called FotoFUN, is compatible with all Macintosh and PC\Windows graphics and image-editing software. Many different combinations of standard photo frame sizes can be printed, such as 2 × 3 or 3 × 3 inches. The maximum output size is 4 × 6 inches.

To produce a photograph, the printer passes a special paper against a three-color ribbon in a thermal dye-sublimation process. The ribbon consists of three consecutive color panels (yellow, magenta, and cyan) and a clear panel that serves to seal and protect the printed image from moisture, fingerprints, and ultraviolet light. The clear seal can be omitted if you want to produce color transfers. In fact, a kit for producing photo mugs is available (more on that later).

Hookup

Installing the FotoFUN printer is just about as simple as it can get. With the system power disconnected (a good idea on all hardware installations), the printer cable to your laser printer is disconnected and reconnected to the FotoFUN printer. A remote power supply provides 20-volts DC at 4.5 amperes to the unit.

Once the unit is hooked up, a print test should be made; there is no need to turn the PC on for that. The test is important for two reasons: One, it tests to make sure the unit is working properly. Second, it teaches the user the correct way to insert the paper, which can be a little tricky if you've never done it before.

The print paper is inserted, glossy side down, into the loading port. Once the printer's friction drive grips the paper, release your grip; the printer does the rest. Also, be sure you are inserting the paper straight, so that the paper's corners nearest you enter the printer without touching the sides of the entry port. Once the technique is mastered (usually in one or two tries), the test print comes out perfect, with amazing color quality and sharpness. The blacks are "solid" black—a must if you expect to get the best possible photographic reproduction.

Installing the Driver

The manual assumes you need 100% help and provides complete and unfailing directions for Macintosh, DOS, and Windows systems (there is no Windows 95 driver, but the standard Windows driver works fine under that operating system). Follow the instructions provided in the manual, and you'll have no problems in the few minutes that it takes to install the drivers.

Once the drivers are installed, you can use your favorite graphics or image software to produce full-color snapshots. For best print results, use only 24-bit color, 203 dots-per-inch (or higher) images, and print at an image size of 100%. Over-enlarging an image or printing lower-resolution images will cause your photos to appear jagged or pixelized when printed. The printing process takes about 2 minutes and 20 seconds. Regardless of the source (CD-ROM, World-Wide Web, or transparency scanner), the prints produced by the unit appear to be of the same quality as those from a photo lab.

The FotoFUN Digital Color Photo Printer lists for $599.95 (though street prices average $499.95 and lower) and comes with a Print Film Kit that consists of a 36-print ribbon and 36 sheets of photo paper (refills cost $34.95). Also available are a 36-print Postcard Film Kit ($39.95) and a 36-print FotoLABEL Kit ($39.95). The latter kit can make labels and bumper stickers. The FotoMUG! Starter Kit ($29.95) includes four photo mugs, a mug clamp, tape, and full instructions.

If you are into photography and want to copy photo snapshots, it's cheaper to go to your local discount photo lab or one-hour photo center. However, if you are into graphics and multimedia activities, and you like to retouch, modify, or generate new and unusual photo images, then the FotoFUN printer is definitely for you.

For more information, contact FARGO Electronics, Inc., Eden Prairie, MN 55344, Tel: 1-800-327-4694; outside the USA and Canada, call 1-612-941-9470; Fax: 1-612-941-7836. On the World Wide Web, they can be found at http://www.fargo.com. EN

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

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

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

We've lowered the cost of higher education.

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

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

step-by-step, and expert instructors are personally available to you with a toll-free call. What a way to earn an education!

A world of opportunity.

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

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

Without leaving home.

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

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

Choose your own pace.

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

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

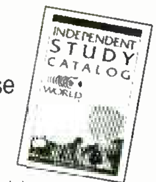
Take charge of your future in electronics

Four Powerful Reasons To Connect With World College Today:

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

Give Me The Power!

Send me a FREE World College course catalog today!



(Please Print Neatly)

Name ______________________

Address ______________________

City ______________________

State, Zip ______________________

Phone (   ) ______________________

Age ______________________

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

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

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

CIE
Affiliated with
Cleveland Institute of Electronics

WAE39

NEW PRODUCTS

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

Cellular Time Tracker

IF YOU'RE UNPLEASANTLY SURprised every time you open your cellular phone bill, you might want to get the situation under control with the Time Tracker from Ultradata Systems. The wristwatch-sized accessory monitors the costs every time you use your cellular phone. (It is not recommended for use with automotive roof or trunk-lid installations.)

CIRCLE 20 ON FREE INFORMATION CARD

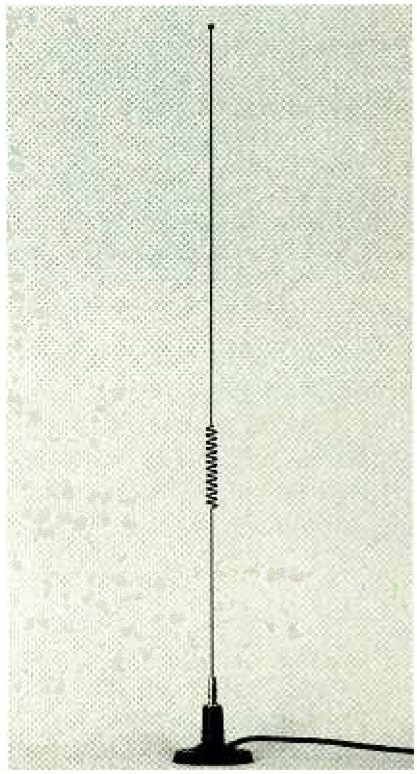
The Time Tracker device attaches to most cellular phones in less than a minute, using an included Velcro fastener, and is programmed to match the user's cellular package rate plan. From that point on, it automatically keeps track of "free time" usage and computes peak and off-peak charges. A variety of functions track, tally, and estimate phone usage costs and time increments, and displays them on its LCD readout.

During normal "hands-free" use, the Time Tracker displays one of two options: free minutes remaining/peak and off-peak charges, or actual total cost to date. By pressing a single button, the user then can access additional information including peak and off-peak time used, last month's peak or off-peak time used, last month's connect time used, last month's total cost, or connect time used and its cost.

The Time Tracker has a suggested retail price of $29.95.

ULTRADATA SYSTEMS, INC.
9375 Dielman Industrial Drive
St. Louis, MO 63132
Tel: 1-800-747-2605
E-mail: ultradata@cdmnet.com
Web site: http://www.ultradatasystems.com

Magnet-Mount Mobile Antenna



CIRCLE 21 ON FREE INFORMATION CARD

The MFJ-1729 Super*Gain is a powerful, dual-band, magnet-mount mobile antenna for ham radio. It provides a gain of 6.3 dB on 440 MHz and 2.6 dB on two meters. Low SWR on both bands allows you to operate your rig and deliver full power safely. The antenna handles 300 watts PEP.

Intended for use with dual-band mobiles and handhelds, the Super*Gain features MFJ Enterprises' exclusive 29¾-inch stainless-steel "SlimLineRadiator," which minimizes wind vibration for less SWR flutter. The antenna provides longer range and better readability thanks to MFJ's exclusive whip. Resembling a cellular antenna, the black stainless-steel whip screws onto a black base that has a protective outer pad to prevent scratching.

The MFJ-1729 Super*Gain magnet-mount antenna, complete with 12 feet of coaxial cable, a PL-259 coax connector, a BNC handheld adapter, and a one-year unconditional guarantee, costs $29.95.

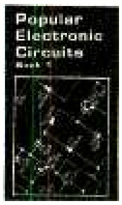
MFJ ENTERPRISES, INC.
P. O. Box 494
Mississippi State, MS 39762
Tel: 1-800-647-1800
Fax: 601-323-6551

Handheld Digital Multimeters

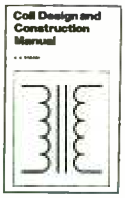
Amprobe Instrument's Ultimate Series Models AM-90 and AM-91 are

continued on page 71

Hobbyist's Paperback Budget Books



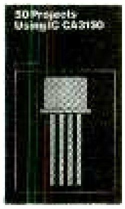
☐ **BP80/98—Popular Electronic Circuits-Books 1 and 2...$11.90.** Contains a wide range of circuits which are accompanied by text giving a brief introduction, circuit description and special notes on construction and setting-up that may be necessary.



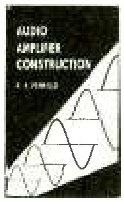
☐ **#160—Coil Design and Construction Manual...$5.95.** A complete book for the home builder on how to make RF, IF, audio and power chokes and transformers. Practically every possible type is discussed and calculations are explained in detail.

☐ **BP271—How to Expand, Modernize and Repair PC's and Compatibles...$7.75.** All the practical information you are likely to need to upgrade your PC and compatible. Also contains useful information and illustrations to help you with repairs.

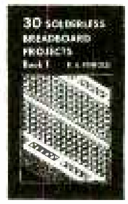
☐ **BP276—Shortwave Superhet Receiver Construction...$6.95.** Provides construction details, including coil winding, of a number of advanced-design receivers which should have performance levels at least equal to commercial sets of similar complexity.



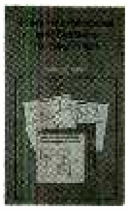
☐ **#223—50 Projects Using IC CA3130...$5.00.** One of the more practical and useful operational amplifiers (opamp), the CA3130 integrated circuit chip is the heart of several easy-to-assemble projects covered in the book. The projects are divided into five categories: audio projects, RF projects, test equipment, household projects and a catch-all miscellaneous group. Ideal for all skill levels.



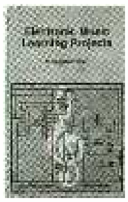
☐ **BP122—Audio Amplifier Construction...$5.75.** Practical designs are featured and include circuit diagram and description, Veroboard or printed-circuit board layout and construction notes. The text is divided into two parts. The first deals with many types of preamplifiers. The second covers power amplifiers from a simple low-power battery type to a 100-watt DC-coupled amplifier using four MOSFETs in the output stage.



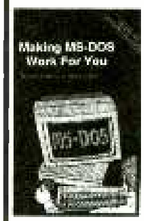
☐ **BP107—30 Solderless Breadboard Projects-Book 1...$5.95.** Each project is designed to be built on a "Verobloc" breadboard and is presented with a brief circuit description, circuit diagram, component layout diagram and components list. Notes on construction and applications are provided. Wherever possible, the components are common to several projects to keep project costs down.



☐ **BP266—Electronic Modules and Systems for Beginners...$7.25.** Shows the reader how to build a number of simple analog and digital circuit modules, all suitable for battery operation, and all based on only 1 or 2 transistors or ICs.

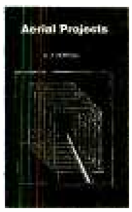


☐ **BP329—Electronic Music Learning Projects...$6.25.** A beginner's book that will assist you in assembling such projects as the Elexylophone, Gildaphone, Melody Ranger, Cordmaker, Appealing Handbells, Electronic Sol-Fa, Tune-up Box and more.



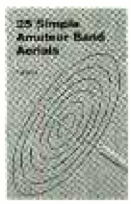
☐ **BP319—Making MS-DOS Work for You—$6.50.** What you need to know first, comes first, however the text is written in a circular style so that the reader can start anywhere in the text. This book is relevant to all versions of both MS-DOS and PC-DOS.

☐ **BP303—Understanding PC Software...$6.95.** Covers main types of PC software, giving details of typical uses, the basics of how they are used and their limitations. Each chapter covers popular software and programs of a similar type.

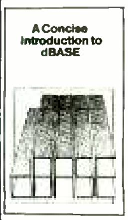


☐ **BP105 Aerial (Antenna) Projects...$5.50.** In this book the author has considered practical antenna designs, including active, loop and ferrite antennas which perform well and are relatively simple and inexpensive to build. The complex theory and mathematics of antenna design have been avoided. Also included are construction details of a number of antenna accessories including a pre-selector, attenuator and filters.

☐ **BP33—Electronic Calculator Users Handbook...$5.75.** The book eliminates the mysteries of the calculator and offers unique ideas for the simplest to most complex calculators. Covers the basic functions plus trigonometric, hyperbolic, logarithms, square roots and powers. Included are formulas and data for VAT, discounts, and mark up, currency conversion, interest, binary and octal numbers, and much more!

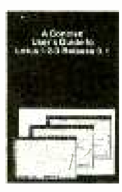


☐ **BP125—25 Simple Amateur Band Antennas...$5.50.** Plans to build antennas that are simple and inexpensive to construct and perform well. From the simple dipole to beam, triangle and even mini-rhombic types made from four TV masts and about 400 feet of wire. After the antenna discussion you will find a complete set of dimension tables that will help you "tune" an antenna on a particular frequency.

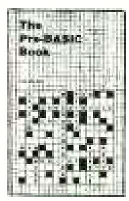


☐ **BP263—A Concise Introduction to dBASE...$6.95.** The most popular data-base program, dBASE, is difficult to master without help. This book helps you spend your time using dBase, not setting it up. A user's guide that covers all the basics up to dBase IV.

☐ **PCP104—Electronics—Build and Learn...$9.95.** Construction details are given to build a circuit demonstrator that is used throughout the book to introduce common electronic components and how these components are built up to useful circuits.



☐ **BP302—A Concise Users Guide to Lotus 1-2-3 Release 3.1...$6.25.** Written to help existing spreadsheet users upgrade to 1-2-3 Release 3.1, which has the ability to work 3-dimensionally with both multiple worksheets and files.



☐ **BP146—The Pre-BASIC Book...$6.95.** Another book on BASIC but with a difference. It concentrates on introducing technique by looking in depth at the most frequently used and more easily understood computer instructions.

Just What the Project Builder Is Looking For!

- ☐ **#160—Coil Design and Construction Manual**..........$5.95
- ☐ **#219—Solid State Novelty Projects**..........$4.95
- ☐ **#222—Solids State Shortwave Receivers for Beginners**..........$5.50
- ☐ **#223—50 Projects Using IC CA3130**..........$5.00
- ☐ **#225—Practical Introduction to Digital ICs**..........$5.25
- ☐ **PCP111—Electronic Test Equipment Handbook**..........$13.95
- ☐ **1596T—24 Silicon-Controlled Rectifier Projects**..........$9.95
- ☐ **BP58—50 Circuits Using 7400 Series ICs**..........$5.50
- ☐ **BP69—Electronic Games**..........$5.50
- ☐ **BP71—Electronic House Projects**..........$5.00
- ☐ **BP84—Digital IC Projects**..........$5.50
- ☐ **BP93—Electronic Timer Projects**..........$5.50

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

Name ______________________

Address ______________________

City ____________ State ________ Zip ________

PE5 Allow 6-8 weeks for delivery

SHIPPING CHARGES IN USA AND CANADA

$0.01 to $5.00	$2.00
$5.01 to $10.00	$3.00
$10.01 to 20.00	$4.00
$20.01 to 30.00	$5.00
$30.01 to 40.00	$6.00
$40.01 to 50.00	$7.00
$50.01 and above	$8.50

SORRY No orders accepted outside of USA & Canada

Number of books ordered ☐

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

All payments must be in U.S. funds!

NEW LITERATURE

USE THE FREE INFORMATION CARD FOR FAST RESPONSE

LAN Times Encyclopedia of Networking

by Tom Sheldon
Osborne/McGraw-Hill
2600 Tenth Street
Berkeley, CA 94710
Tel: 1-800-822-8158
Fax: 614-759-3644
$39.95

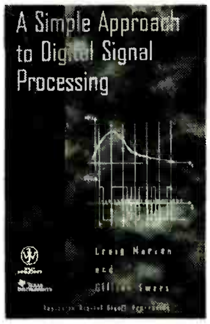
CIRCLE 337 ON FREE INFORMATION CARD

Designed to serve as a comprehensive desk reference for anyone involved in networking, this book explains the complex world of networking. In more than 1000 pages, it covers every aspect of the subject, from Peer-to-Peer to LANs and WANs. The book's alphabetically organized sections make it easy to locate information quickly. Each entry includes an informative description, plus examples and pictures where appropriate and extensive cross-references to related subjects.

The book covers the latest trends in object-oriented environments, distributed computing environments, enterprise networking, database connectivity, and network architectures. It discusses general networking concepts used in the most popular networking systems, including the Distributed Computing Environment (DCE), Novell NetWare, Banyan VINES, Microsoft LAN Manager, AppleTalk, and UNIX. Up-to-date information on network management and security issues is provided. The book fully describes protocols and standards including WAN protocol, client-server protocols, messaging APIs, and e-mail. It also covers different network methods and technologies; cabling, internetworking, wiring requirements, interoperability, and gateways; and telecommunications topics such as Frame Relay, ATM, ISDN, and SONET carrier services.

A Simple Approach to Digital Signal Processing

by Craig Marven & Gillian Ewers
John Wiley & Sons, Inc.
605 Third Avenue
New York, NY 10158-0012
Tel: 1-800-225-5945
Web site: http://www/wiley.com
$39.95



CIRCLE 338 ON FREE INFORMATION CARD

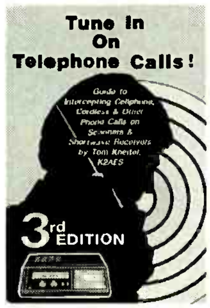
Most books on digital signal processing (DSP) involve complicated mathematics and assume a prior knowledge of the field. This practical guide is a readable, understandable alternative. It assumes no prior DSP experience and provides clear explanations and examples while keeping mathematics to a minimum.

To help readers develop a fundamental understanding of DSP, the book proceeds step-by-step through the most basic signal-processing concepts to more complex functions and devices, including sampling, filtering, transforming signals into the frequency domain, encoding waveforms, data compression, and DSP-hardware design issues. An extensive glossary of DSP acronyms and a bibliography of DPS books give readers the tools they need to tackle more advanced topics.

The book was written by two specialists in DSP who work for Texas Instruments, which has been designing and manufacturing single-chip DSP devices since 1982, and now produces eight distinct generations as part of the industry-standard TMS320 family. Much of the book is based on the experience TI gained in developing DSPs and training first-time users. A real-world example of a typical DSP system development cycle allows even beginners to understand the process and achieve a final working system.

Tune in on Telephone Calls Third Edition

by Tom Kneitel, K2AES
CRB Research Books, Inc.
P. O. Box 56
Commack, NY 11725
Tel: 1-800-656-0056
$16.95 plus $5 shipping
(NY residents add $1.81 tax)



CIRCLE 339 ON FREE INFORMATION CARD

Despite repeated reminders, most people don't understand that cordless- and cellular-telephone calls can be easily monitored. Thinking that no one else is listening, they gossip, conduct financial transactions, discuss their innermost feelings, conduct love affairs, and even engage in criminal activities. Recreational eavesdroppers are well aware that such conversations can be much more entertaining than TV.

This "official handbook of recreational eavesdroppers" provides pointers on listening in on cellular, cordless, and other phone calls made from cars, portable phones, homes, offices, and even plains, trains, and ships. It offers vital information, proven techniques, opinions, frequencies, stations, and laws related to eavesdropping.

The third edition explains why it's easier than ever to intercept calls. It has been updated with plenty of new information, including 900-MHz cordless-phone channels and the 30 new frequencies available for 46/49-MHz cordless phones. It describes an accessory unit that clarifies scrambled phone conversations and discusses inexpensive DTMF tone decoders that display the phone, credit card, PIN code, bank account, voice mail, answering machine, and other numbers that people send with pushbutton phones. The book explains how to decode and read digital non-voice business and (often spicy) personal beeper messages. More frequencies for voice and digital radio are provided, along with new information on air/ground phones.

The Web Page Workbook

by Dawn Groves
Franklin, Beedle & Associates
8536 SW St. Helens Drive
Suite D
Wilsonville, OR 97070
Tel: 1-800-322-2665
$19.95, including software

CIRCLE 340 ON FREE INFORMATION CARD

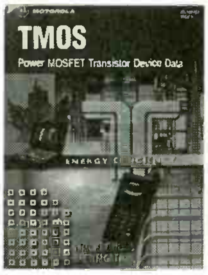
Aimed at Web enthusiasts who want to create useful, appealing Web pages quickly and easily, this book teaches the basics of Web design, development, and promotion. It offers straightforward instructions for the programming and design of Web pages. Examples and practice exercises allow readers to practice before developing their own pages. A Web-site development form guides readers through the page-planning process.

The book is designed to give readers the fastest, most direct introduction to HTML available. All planning, writing, and troubleshooting can be performed offline. Later, once the Web page is complete, it can be published on a server without further modification.

The book includes a complete Web development kit. The Internet software package, called Earth's TotalAccess, features Netscape 2.0 and Eudora e-mail software. Also included is an evaluation copy of *HotDog Standard*, a shareware HTML editor.

TMOS Power MOSFET Transistor Device Data Book (DL135/D, Revision 6)

Motorola Inc.
Literature Center
P. O. Box 20924
Phoenix, AZ 85063
Tel: 1-800-441-2447
Fax: 602-994-6430
Web site: http://Design-Net.com
Free



CIRCLE 341 ON FREE INFORMATION CARD

Updated to reflect new and current products, this data book includes sections for insulated-gate bipolar transistors (IGBTs), MOS gate drivers, miniature surface-mount *Micro8* high-density devices, and Zener gate-protection devices. The new version provides an alphanumeric index of part numbers and a cross-reference page for obsolete parts. Revision 6 also features data sheets, a selector guide, tape and reel specifications, surface-mount package information, case dimensions, and complete information on how to receive Motorola Semiconductor technical information via Fax, e-mail, phone, or the Internet. EN

BY JEFF HOLTZMAN

The Five Monkeys and Personality Characteristics of the Nerd

RECENTLY I COMPLETED AN IN-DEPTH PSYCHOLOGICAL AND SOCIOLOGICAL ANALYSIS OF THE TYPES OF PEOPLE WHO GET INVOLVED WITH COMPUTERS-AND THE RESULTS ARE PRETTY FRIGHTENING. THE STUDY WAS COMMISSIONED BY A group convened from the Federal Government, a major state university, and the CIO's (Chief Information Officers) of ten Fortune 50 corporations, along with senior officials of the National Security Agency, the FBI, the CIA, and several French agencies: *Jenesais Quoi* (Zhen-say kwah), *Jenesais Qui* (Zhen-say key), *Jenesais Quand* (Zhen-say con), *Jenesais Ou* (Zhen-say ooo), and *Jenesais Pourquoi* (Zhen-say po-kwah), collectively known in international circles as The Five Monkeys.

Members of the committee included extremely senior theorists and practitioners in psychology, psychiatry, sociology, business management, and computer science from the University of Chicago and Columbia University. It would take more than one hand to count the number of Nobel prizes on that committee.

My Role

I was selected to be secretary of the committee because of my 20+ years of experience in all facets of the industry: hardware, software, manufacturing, management, and communications. Initially, a high-profile newspaper journalist was chosen. However, the committee subsequently rescinded its offer when asked whether it was to be a Mac or PC project. Numerous employees of well-known computer magazines were considered, but all were ultimately rejected for their inability to count to two in either binary, hexadecimal, or decimal.

Thus I got my shot at glory. My only condition was that I be allowed to share the early results of the study first with the loyal "Computer Connection" readers of **Electronics Now**. You guys and gals are special. I hope you appreciate that, because this hasn't been easy.

Survey Overview

After issuing thousands of questionnaires and analyzing millions of data points, what we came up with was not a set of personality types, but a set of qualities that tend to mix and match in different individuals (and perhaps the same individual at different times), leading to a multi-dimensional spectrum of possibilities. Then, by constructing an elaborate set of computer models, we have been able to successfully predict the behavior of various historic individuals. Ongoing field tests are underway at the above-mentioned Fortune 50 corporations as to whether our model can be used in real-world settings.

Under terms of our agreement, I cannot discuss details of the model. However, I am at liberty to discuss the set of qualitative attributes used in constructing the model. That way, those of you with

THE STRESS AND STRAIN of high technology gets to all of us at one time or another. For proof of that, read this column!

some coding skills should be able to build your own models, although I should warn you that to achieve anything like real-time response, the committee's model requires a coordinated array of 65,536 RS/6000 processors running a special-purpose parallel-processing operating system and analysis tools.

Nonetheless, we are currently negotiating with Sega, Nintendo, Sony, and Intel concerning development of hand-held models that can be used during engineering design review meetings. Texas Instruments and Casio may produce units with built-in plotting and printing functions. Needless to say, Hewlett-Packard plans to do an RPN version. It is likely that the hand-helds will also have built-in versions of *Tetris*, *Duke Nukem*, and *Doom*.

Microsoft has also shown interest in incorporating a scaled-down version as a Design Wizard in the next versions of Visual C++ and Visual Basic. We've also been in contact with most other software-tool vendors. Netscape has announced a Navigator plug-in that will allow ordinary citizens to log in to a Defense Department computer system and get a free personality profile based on the model. We've also been approached by vendors of late-night television gadgets, "one-minute" management gurus, IDG publications (which wants to publish a "... for Dummies" version), the Norwegian rowing team, and the caretaker at Pitcairn Island. But I digress.

The Findings

A few notes before we get started.

1. An old joke has it that there are two kinds of people in the world: those who divide the world into n kinds of people, and those who don't. The committee unabashedly aligns itself with the former.

2. Given the orientation of this magazine, I'm not going to bore you with the dry sociological and psychological terms developed by the committee. Instead, I'll use the nicknames we used among ourselves during the project.

3. In addition to the data strictly required by the questionnaires, we also collected data on the subjects' favorite colors, astrological signs, sports teams, microbrewery beers, underwear preferences (boxers or briefs), and attitudes toward checkered shorts, Hawaiian shirts, toy Poodles, Jim Carrey movies, and other subtle indicators of culture, education, and attitude. Extensive cross-checks were run as part of the analysis, and some extremely interesting correlations turned up. Unfortunately, my nondisclosure agreement prevents me from revealing the details. But I won't be saying too much if I hint that Jim-Carrey admirers had a tendency to show positive attitudes toward most items in the list, and a negative correlation with leaders of technology, business, and politics in most traits except raw intelligence, where they led.

4. To be honest, the real purpose of the study was to find ways for CIOs to be able to control renegade technologists who are supposed to be implementing policies prescribed by CIOs, but who often pursue their own agendas or those of their constituencies, at the expense of the CIO, coworkers, the corporation as a whole, and ultimately, the shareholders.

Ultimately what resulted were 22 primary characteristics distributed across seven categories:

- Primary motivator
- Sociability
- Interaction style
- World view
- Provider instinct
- Management style
- Technique

We'll examine each in turn.

Primary Groups

Primary motivator concerns the real-world goal that primarily motivates a given individual most of the time. The options include power, money, and knowledge. Among committee members, representatives of each category were informally known as Pols, MBAs, and Neurons, respectively.

Regarding Sociability, the committee graciously acknowledges the pioneering insights of Steven Covey in developing the following distinctions: Dependent, independent, and interdependent. Dependent individuals ("Diapers") are those who are incapable of doing anything by themselves. Independent individuals ("Hillbillies") are those who are incapable of doing anything with others. And Interdependent individuals ("Coveys") are those who enjoy working with others, compromising, and in general, sacrificing the good of the one for the good of the many.

Interaction style breaks down into three subgroups: Betsys, Rodmans, and Drones. Betsys tend to avoid public exposure at all costs; conversely, Rodmans crave it like food, water, or air. Drones tend not to care one way or the other. Their lack of self-consciousness helps avoid personal embarrassment, but their lack of showmanship tends to make them boring. A successful Pol needs to be either a Betsy or a Rodman; Drones need not apply. On the other hand, the committee remarked that scientists and engineers tend to be drawn from the ranks of the Drones and the Betsys.

World view also breaks down into three subgroups: Black-and-white, gray, and color (B&Ws, Gs, and Cs, respectively). B&Ws tend to see every choice as being among polar opposites: true or false, good or evil, for us or against us. Gs see a broader range of choices, without discontinuities. Cs see an even broader range of choices, brought about by the ability to paradigm-shift; that is, to cast problems in new lights to arrive at innovative solutions. Scientists and engineers tend to come from the ranks of the Cs and Gs. Pols are an interesting case. Regardless of their actual World View, they almost always profess to be from the B&W class.

Provider Instinct subdivides into two interrelated groups of two: Hunters, Gatherers, Collectors, and Hemingways. Hunters and Hemingways both hunt; Gatherers and Collectors both gather. Hunters and Gatherers never take more than they need; Hemingways and Collectors never have enough. Pols and MBAs tend to be Hemingways, scientists tend to be Collectors, and engineers tend toward Gatherers.

Another important category is Management style. Here we find three possibilities: Chief, brave, and hermit. A chief leads, a brave follows, and a hermit stays as far away from the process as possible. Pols and MBAs universally profess the Chief attribute, whereas in reality, most would be better suited as Hermits. Technical people tend toward the extremes: either chief or hermit.

The final category is Technique, comprised of Gepettos, Gomers, and Klutzes. Gepettos are craftsmen who excel in performing all facets of a task. Gomers and Klutzes are both more or less incompetent. They are distinguished in that Gomers sometimes succeed in spite of themselves, whereas Klutzes always fail.

What About You?

The point of this presentation is to outline some of the chief characteristics

continued on page 32

BY FRANKLIN J. MILLER

Microphone Splitting Made Easy

JUST WHAT IS MICROPHONE-SPLITTING, AND WHY WOULD ANYONE WANT TO WRITE ABOUT THAT SUBJECT? WELL, FOR ONE THING, I HAVE SPENT OVER TWENTY YEARS OF MY LIFE DOING IT. WHY? SIMPLY BECAUSE I HAD TO. I HOPE THAT BY THE TIME YOU finish reading this article, you'll understand why it is important and necessary to do it correctly. Lets get started with a little background information.

Why Split?

In its most basic form, microphone splitting is the art of taking a single microphone and splitting its output to feed multiple sources. It is almost always necessary in live performances.

Most performers, whether in auditoriums or outdoor venues, need a little help to amplify the performance. At one time, sound systems were mainly used to enhance the acoustical sound; multiple microphones, large power amplifiers, and large speaker systems were not yet the norm. In those days, a single 100-watt power amplifier was all that was necessary to power the single speaker system.

In the 1960s, a new era in live sound was developed as the result of changes in the recorded-music industry. Rock-and-roll bands were attracting larger audiences in bigger arenas. Amplified sound was overtaking acoustic sound, and the average listener was expecting and getting used to highly amplified performances. Speakers became speaker systems that included stacks and stacks of bass cabinets and many high-frequency horns.

As those speaker systems expanded, the need for more and larger power amplifiers become evident. The use of multiple microphones in live performances became the standard. The sound level became so high that the performers were unable to hear each other, or themselves, as they played.

To overcome that, monitor speakers are placed in front of each performer. To feed both the monitor speakers and the main house PA system, the outputs from each microphone must be split. The most basic scheme used is shown in Fig. 1. However, that microphone-splitting scheme creates new problems. One is feedback. Also, since the house PA system and the monitor speaker are fed from a single mixer, equalization settings can not be arranged to satisfy each individual performer's preference.

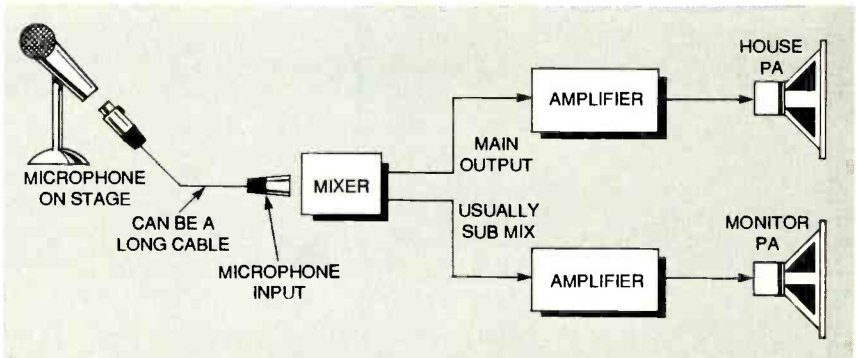


FIG. 1—IN THE BEGINNING all the mixing was done ahead of the amplifiers.

A New Solution

One solution to that problem is to have a separate feed from each microphone to a mixer that is devoted to the house PA, and another that is devoted to the monitor system. Figure 2 shows that arrangement.

To implement that microphone-splitting solution, several important fac-

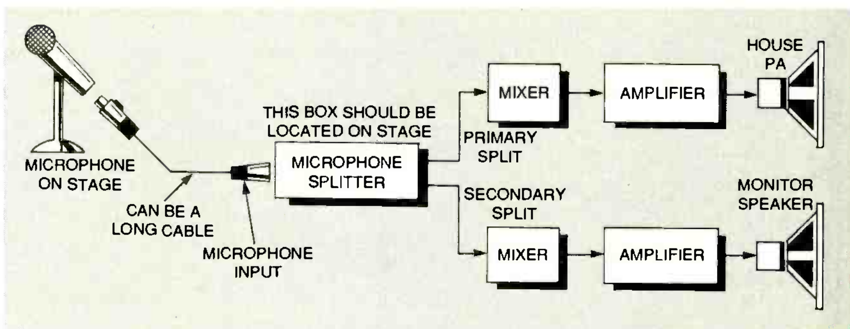


FIG. 2—AS SYSTEMS BECAME MORE ADVANCED, separate mixers were used for the PA system and the monitor speakers.

tors have to be considered. Those include maintaining audio quality and minimizing signal loss. Also, the new system must be passive so that there would be a minimal amount of noise, distortion, etc.

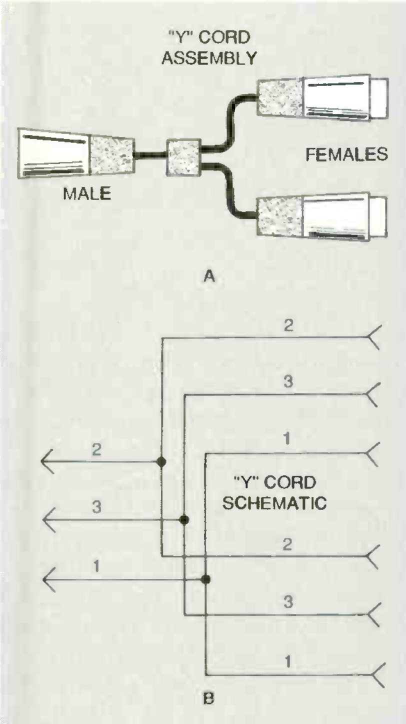


FIG. 3—TWO VIEWS OF THE Y-CONNECTOR. At the top (A) is a pictorial view. The lower portion (B) shows a simple schematic.

The problem with that solution is that it is difficult and expensive to implement. As a result, another solution that is frequently used is the "Y" connector assembly shown in Fig. 3. That set up is easy to use and inexpensive.

The problem is that the "solution" is entirely wrong! It results in the signal being cut by 6 dB, which means that the signal level is reduced 50% at the primary part of the setup. What makes the setup particularly bad is that this is the point where the signal is the weakest and most affects the system's overall signal-to-noise ratio.

In summary, under normal circumstances the Y connector scheme should be avoided. However, if time and money make its use necessary, by all means use it. After all, the show must go on! EN

FOR MORE INFORMATION

For a copy of a complete 32-page booklet on *Mic-Splitting Demystified* send $5 to Franklin J. Miller, 2100 Ward Drive, Henderson, NV 89015-4249. Price includes shipping. NV residents must add sales tax.

BY DICK LAJEUNESSE*

Making Your Job Easier with a DSO

NOT THAT LONG AGO, ANALOG-OSCILLOSCOPE TECHNOLOGY WAS THE ONLY PRACTICAL SCOPE TECHNOLOGY AVAILABLE. IN THOSE DAYS, ANALOG SCOPES PERFORMED VERY WELL; THEY DISPLAYED REPETITIVE SIGNALS IN REAL TIME and were affordable, familiar tools that users had come to depend upon.

Over time, as the use of electronic devices accelerated, so did signal complexity. New measurement power was needed to capture and analyze the new, complex, and, in many cases, single-shot signals. The answer proved to be digital technology, and a new generation of scopes was born—the digital storage oscilloscope, or DSO.

Initially, digital technology was too expensive for all but high-end R&D applications. Also, technical limitations such as limited sampling rates, slow screen updates, and unfamiliar user interfaces slowed widespread acceptance of DSO technology by analog users.

Today, much has changed. Digital-storage technology has become highly affordable, and an exciting DSO technology called Digital Real Time (DRT) has overcome the sampling limitations in lower cost DSOs. Screen-update rates and the user interface also have improved dramatically.

What benefits can you expect from the new digital storage oscilloscopes, and how will they make your job easier? Digital storage capabilities fall naturally into four categories, and, as we shall see, there are benefits to be found in each: The first is acquisition (of waveforms); second is viewing (the information); third is interpretation (of the data); and fourth and last is storage (of waveforms and data). Within those categories, you'll have the ability to capture and analyze the most complex single-shot signals; manipulate them on-screen; analyze them with automatic measurements and reference waveforms; store them indefinitely; and obtain hard copy from a variety of printing resources. Those are all capabilities that are not provided by analog oscilloscopes.

Acquiring Waveforms

In addition to the acquisition capabilities you've come to expect from your analog scope—automatic setups, cursor-based readouts, save/recall settings, peak detect and triggers—you'll be pleasantly surprised by the significant new acquisition capabilities a digital scope supplies.

Whether you are troubleshooting an electronic device such as a CD player or dealing with the kinds of signal noise that electronic devices generate over power lines, you will find today's DSO an invaluable tool. It will enable you to capture easily not only the single-shot signals that occur frequently in the digital world, but also a variety of glitches, high-frequency noise, and harmonic signals. Those are the kinds of events that you were unable to view with your analog scope, but that you may be encountering much more regularly in your work.

When your DSO incorporates DRT technology, your job becomes dramatically easier. That is because DRT oscilloscopes run at incredibly high sample rates (up to 5 GS/sec) and actually acquire their signals in real time. At such high sampling speeds, they can gather from each signal cycle all the samples necessary to faithfully construct the waveform, even from elusive single-shot events.

In fact, DSOs with DRT can achieve real-time acquisition up to their full analog bandwidth, both for repetitive and single-shot events. And they provide that capability on all acquisition channels

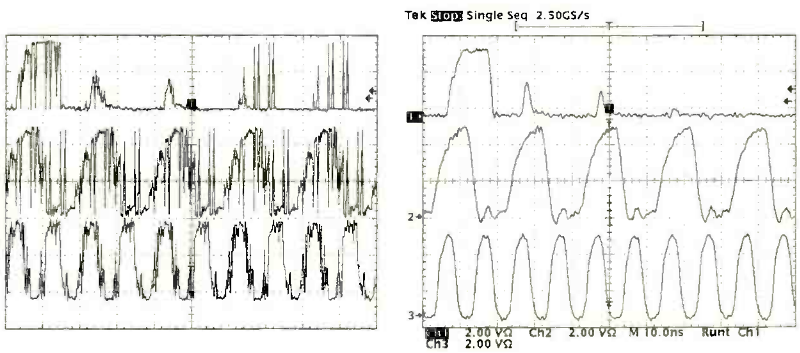


FIG. 1—A DRT (LEFT) ELIMINATES the confusing distortion and aliasing sometimes found in conventional DSOs (right), while achieving full bandwidth for repetitive and single-shot events.

*Tektronix, Inc.

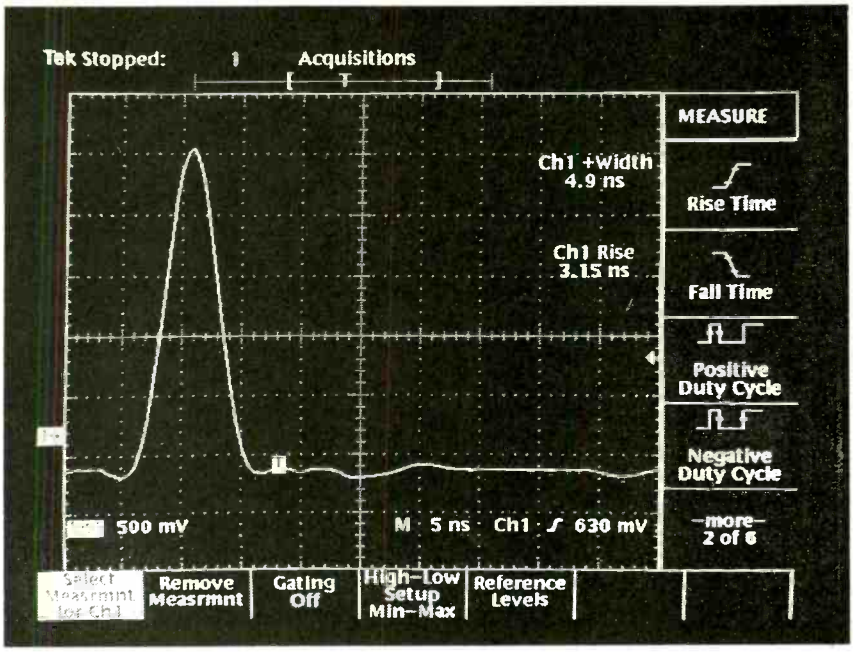


FIG. 2—AUTOMATIC MEASUREMENTS, like pulse width and rise time, help take the guesswork out of interpreting the information and give you the confidence of right answers every time.

simultaneously. The benefit for you is a clear, easily understood display (see Fig. 1) without the confusing distortion and aliasing found in conventional DSOs.

What's more, you can now choose from a variety of acquisition modes to find the optimum method you need to capture the waveform information. For example, you can select from sample mode to uncover spurious events, or peak-detect mode to see the extremes of the signal. You also might choose envelope mode to show the signal's highest and lowest points, or average mode to minimize the effects of noise. In addition, pre-trigger, a function not available in analog scopes, lets you capture information that occurs prior to a trigger event.

With a modern DSO, you also will be able to easily save not only the waveforms you need for future reference, but any setups as well. Saving sample waveforms can facilitate your job significantly when it comes to viewing and analyzing the information.

Viewing the Data

Because the data is stored permanently in a DSO, you gain a lot of flexibility when viewing the information. Unlike analog displays, you can manipulate the DSO display in any number of ways to view the information after the acquisition. For example, you can zoom in or out on segments of the waveform. Although you might have set up the scope in one way to view the entire waveform, with DSO waveform-manipulation features, you are free to isolate any segment of it, including the trigger point, and examine it in greater detail. You can limit your measurements, including any pre-trigger conditions, within a specific region of data or view the waveform in its entirety.

Interpreting the Information

Once you've captured and viewed the information, a whole new world opens to you when analyzing the data. Automatic measurements, which take much of the drudgery out of your work, give you the confidence of right answers every time. Automatic measurements essentially give you a computer inside your scope in the form of digital signals processors (DSPs). The DSPs perform a variety of mathematical calculations very rapidly and supply answers that make it significantly easier to interpret the waveform (see Fig. 2).

Beyond the common arithmetic functions of add, subtract, divide, and multiply, users benefit from averaging functions that remove noise and improve resolution. FFT (Fast Fourier Transform) functions perform spectral analysis of any trace, and histograms show distributions of measured values. Pass/fail testing functions and trending data, as well as a variety of other useful calculations, round out the selection of automatic measurements found on most modern DSOs.

Reference waveforms—waveforms you saved earlier—now can be used to compare with current waveforms. By simply overlaying the reference waveform on the newly acquired one, you can readily see the differences between the two and more easily interpret the conditions that caused the change.

Alphanumeric readouts, while not new to DSOs, are considerably improved.

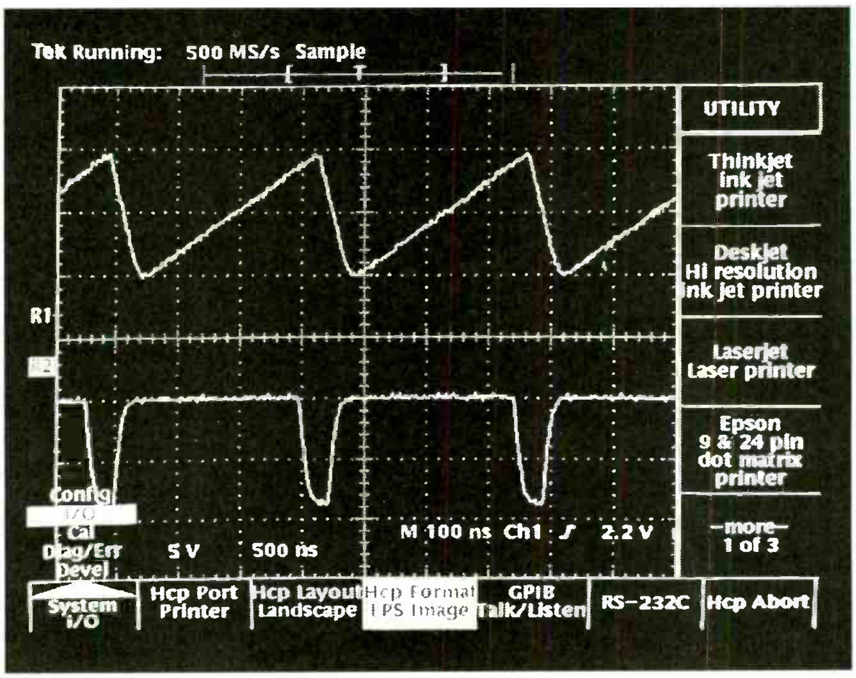
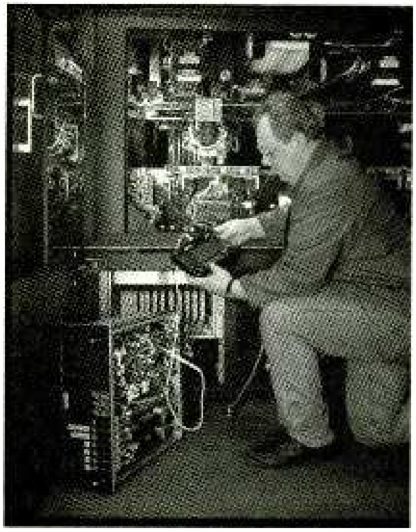


FIG. 3—ALPHANUMERIC READOUTS of control settings provide confirmation when setting up your DSO, as well as helping you interpret the waveform data once it's acquired.



TODAY'S DSOs can make even the toughest troubleshooting job much easier.

Instead of only cursor-based readouts, you see computed values displayed in alphanumeric form as they occur. That means you can look at characteristics while you are acquiring the data and decide which data to keep. You'll benefit both from how easy it is, as well as from the increased accuracy of a value continuously displayed in alphanumeric form.

In addition to providing readouts of automatic measurements, alphanumeric readouts of the various control settings are simultaneously displayed (see Fig. 3). They provide confirmation to guide you in setting up the instrument and interpreting the waveform data once it's acquired.

Storing the Data

If you are like the majority of new DSO users, data storage is becoming increasingly important. You might need to use waveform data in a variety of reports, including service reports and statistical-trend analysis. Waveform storage in a DSO can range from saving a few reference waveforms to mass storage of entire runs, typically on floppy disks. The built-in floppy disk drive has become standard for transferring waveforms to a personal computer for further analysis or reporting functions.

DSOs also allow direct connection to a PC. Connection to a PC is useful, for example, in a manufacturing test environment where it's necessary to record the waveform quality from many measurements over time. That will not only enable easy documentation of test results, it will provide a simple way to collect data for statistical analysis or to detect trends.

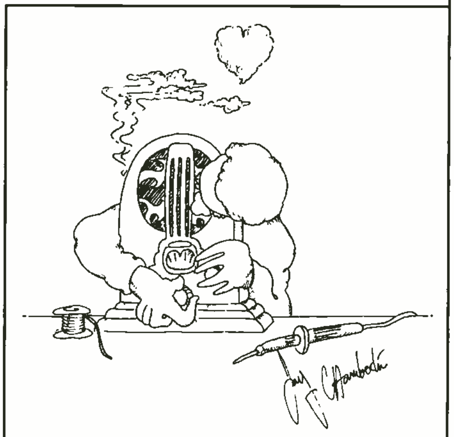
Waveform storage also allows you to share data. For instance, you can easily distribute copies of important reference waveforms on diskettes to your supervisor, co-workers, or workers in the field. Besides facilitating communication, sharing data improves the teamwork and productivity of all workers.

Finally, because waveform storage is in digital format, it's easy to output the data directly to a number of hard-copy sources, with a wide variety of printers and plotters providing the most common formats. And, remember, any front-panel setups you've saved also can be printed, along with the waveforms.

In Conclusion

Twenty years ago, when analog was the only scope technology available, it served its users well. Today, you have a whole new world of oscilloscope technology available to you in the form of Digital Storage Oscilloscopes that will help you meet the challenges of an increasingly complex world. DSOs will make your work significantly easier with features such as reference waveforms, store and recall of multiple waveforms, and hard-copy output. Only DSOs can provide effort-saving automatic measurements such as averaging (to remove unwanted noise) and built-in pre-trigger (so you can view what happens before the main event).

Finally, with the advent of DSOs' newest technology—Digital Real Time—you have the long-awaited acquisition power to capture those single-shot and other infrequent events that are becoming such an important requirement in your workplace. Welcome to the world of digital storage oscilloscopes . . . and to new opportunities for high measurement confidence, increased productivity, and a job made easier. EN



COMPUTER CONNECTIONS

continued from page 27

of several key personality types in our world. Knowledge of these characteristics can teach you both about yourself, and about your friends, family members, and coworkers.

At the behest of several of the clinicians on the committee, I'll present a few hints about appropriate roles for personality types in which a particular characteristic dominates. For more detailed information, please contact the relevant academic department at the University of Chicago or Columbia University.

If your primary motivator is knowledge, don't even think about politics. If it's money you're after, don't even think about science. In contrast, if you're a Gomer or a Klutz, you're probably not going to want to be seen in public, so politics is out. On the other hand, a Gomer may be suitable for a bureaucratic position, particularly if you can enlist the aid of a Hemingway to keep you supplied with paper clips, notepads, and malicious gossip.

What About Me?

If you've gotten this far, and I hope you have, you're probably either rolling on the floor laughing, or wondering if I've left my senses. Well, I haven't (at least I think I haven't). In this high-stress, high-tech world, a little parody and humor from time-to-time can keep all of us a little saner—at least I hope so! That's all for now. Until next time, you can contact me at my psychiatrist's office, or via e-mail at jkh@acm.org. EN

RETAILERS THAT SELL OUR MAGAZINE MONTHLY

Alaska

Frigid North Co.
1207 W. 36th Avenue
Anchorage, AK 99503

Arizona

Dalis Electronics
2829 E. McDowell Road
Phoenix, AZ 85008

California

California Electronics
221 N. Johnson Ave.
El Cajon, CA 90202

Ford Electronics
8431 Commonwealth Avenue
Buena Park, CA 90621

All Electronics
14928 Oxnard Street
Van Nuys, CA 91411

Gateway Electronics of CA
9222 Chesapeake Drive
San Diego, CA 92123

Mac's Electronics
191 South "E" Street
San Bernardino, CA 92401

Electronics Warehouse
2691 Main Street
Riverside, CA 92501

Orvac Electronics
1645 E Orangethorpe Ave.
Fullerton, CA 92631

Sav-On Electronics
13225 Harbor Blvd.
Garden Grove, CA 92643

Marvac Dow Electronics
980 S. A Street
Oxnard, CA 93030

Kandarian Electronics
1101 19th Street
Bakersfield, CA 93301

Whitcomm Electronics
105 W. Dakota #106
Clovia, CA 93612

Marvac Dow Electronics
265-B Reservation Road
Marina, CA 93933

Minuteman Electronics
37111 Post St., Suite 1
Fremont, CA 94536

HCS Electronics
6819 S. Redwood Drive
Cotati, CA 94931

Halted Specialties Co.
3500 Ryder Street
Santa Clara, CA 95051

Metro Electronics
1831 J Street
Sacramento, CA 95814

The Radio Place, Inc.
5675-A Power Inn Road
Sacramento, CA 95824

HSC Electronics
4837 Amber Lane
Sacramento, CA 95841

Colorado

Gateway Electronics of CO
2525 Federal Blvd.
Denver, CO 80211

Centennial Electronics
2324 E. Bijou
Colorado Sps., CO 80909

Connecticut

Signal Electronics Supply
589 New Park Avenue
W. Hartford, CT 06110

Cables & Connectors
2198 Berlin Turnpike
Newington, CT 06111

Electronic Service Prod.
437 Washington Avenue
North Haven, CT 06473

Florida

Sanyca Electronics
596 NW 99th Ct.
Miami, FL 33172

Georgia

Norman's Electronics, Inc.
3653 Clairmont Road
Chamblee, GA 30341

Illinois

Tri State Elex
200 W. Northwest Hwy.
Mt. Prospect, IL 60056

Maryland

Mark Elec. Supply Inc.
5015 Herzel Place
Beltsville, MD 20705

Amateur Radio Center
1117 West 36th Street
Baltimore, MD 21211

Massachusetts

U-Do-It Electronics
40 Franklin Street
Needham, MA 02194

Michigan

Purchase Radio Supply
327 East Hoover Avenue
Ann Arbor, MI 48104

Norwest Electronics
33760 Plymouth Road
Livonia, MI 48150

The Elec. Connection
37387 Ford Road
Westland, MI 48185

Elec. Parts Specialists
711 Kelso Street
Flint, MI 48506

Minnesota

Acme Electronics
224 Washington Avenue N.
Minneapolis, MN 55401

Missouri

Gateway Electronics Of MO
8123-25 Page Blvd.
St. Louis, MO 63130

William Elec & Ind Supply
803 Davis Blvd.
Sikeston, MO 63801

New Jersey

Lashen Electronics Inc.
21 Broadway
Denville, NJ 07834

New York

Sylvan Wellington Co.
269 Canal Street
New York, NY 10013

R&E Electronics
4991 Rt. 209
Accord, NY 12404

Unicorn Electronics
Valley Plaza
Johnson City, NY 13790

Ohio

Philcap Electronic Suppliers
275 E. Market Street
Akron, OH 44308

Oregon

Norvac Electronics
7940 SW Nimbus Avenue
Beaverton, OR 97005

Pennsylvania

Business & Computer Bookstore
213 N. Easton Road
Willow Grove, PA 19090

Texas

Mouser Electronics
2401 Hwy. 287 N
Mansfield, TX 76063

Tanner Electronics
1301 W Beltine
Carrollton, TX 75006

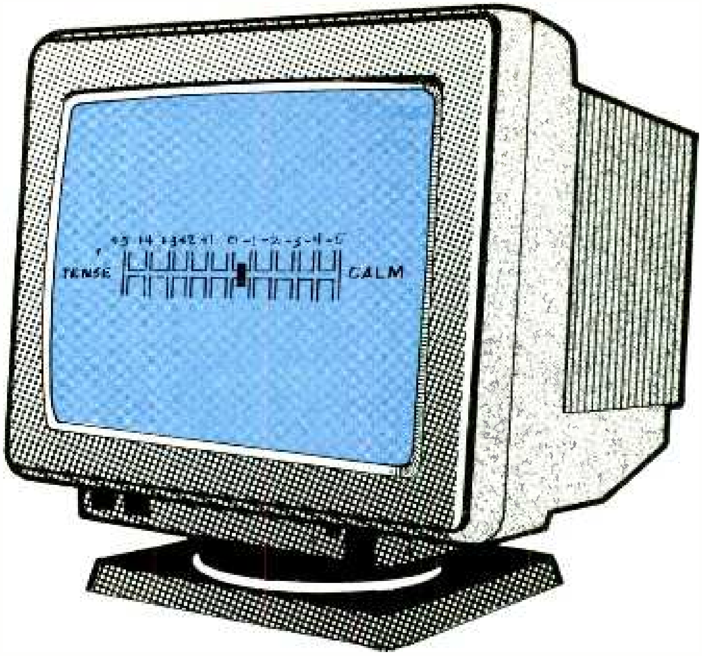
Electronic Parts Outlet
17318 Highway 3
Webster, TX 77598

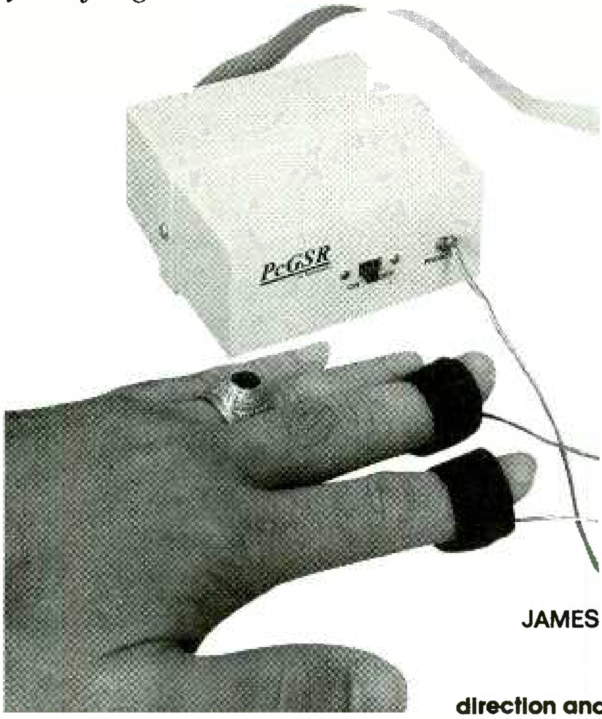
Washington

Amateur Radio Supply Co.
5963 Corson Ave., Ste 140
Seattle, WA 98108

If you'd like to sell our magazine in your store, please circle 210 on Free Information Card.

Stressed out from your job? Life's got you in a tizzy? Is your stomach in knots trying to find parts for that last **Electronics Now** *project? With this simple device and an IBM or compatible PC, you can use biofeedback techniques to smooth over some of life's rougher edges and calm your jangled nerves.*





BUILD A Biofeedback MONITOR

JAMES J. BARBARELLO

Stress reduction through biological feedback is a time-tested and relatively simple process. It consists of measuring a person's level of stress while thinking of various things. The current stress level is fed back to the person in real time, usually by some form of audio tone, lights, or other display. You can then discover the mental exercises that aid in reducing stress, and eventually use those exercises in everyday situations without biofeedback assistance. In a sense, biofeedback devices can be thought of as a set of mental training wheels. Once you get the hang of controlling your stress levels, you no longer need to rely on artificial support.

Note: If you have either a serious or medically-related stress problem, you should only attempt biofeedback or other types of treatment **under the direction and guidance of a doctor or other medical professional**. But for those of us who just want to reduce everyday tension, or simply relax, a self-administered biofeedback program is both safe and beneficial.

To make our monitor work, we obviously need a way to measure a person's stress level. Galvanic skin response (GSR), which is the measurement of the electrical resistance of the skin, changes with various levels of stress. Therefore, a GSR sensor whose output can be examined and fed back in real time would make an effective basis for a biofeedback system.

Over the years, there have been many such devices with a sensor based on a resistance-to-frequency conversion technique. The stress-level monitor was in the form of discrete circuitry, a microprocessor, or a computer of some type. In today's high-speed, Windows-based PC world, the computer-based resistance-to-frequency approach has a few drawbacks. First, that system depends on the microprocessor clock speed, and must be adjusted from computer to computer. Second, the sensor's frequency varies directly with the galvanic skin resistance. That causes an annoying disparity between the feedback rate at calm levels (very slow) and tense levels (very fast). Lastly, the sampling is interrupted periodically by the PC as it does "overhead" stuff (like keeping the clock updated). That is even more pronounced if you use it in an MS-DOS environment under Windows. The result is random variations in the sensor output that can cause shifts in the displayed stress level.

The *Stress-A-Bater* biofeedback monitor discussed here is a low-cost, PC-based home biofeedback system that eliminates the drawbacks of resistance-to-frequency GSR sensors. It uses an analog-to-digital (A/D) converter that measures GSR by referencing it to a fixed, known resistance. Common parts are used throughout, and no special construction techniques are required. The Stress-A-

LISTING 1

```
REM** GSR41.BAS -- V960220
REM** Galvanic Skin Response
        Biofeedback using ADC0831-
        Based Hardware
REM** (c) 1996, JJ Barbarello,
        Manalapan, NJ  07726 -- (908)
        536-5499
REM**
'
'******** Do Housekeeping (Variables,
        etc.) *************
'add is the parallel port address.  r() are
        all possible values of
'the four resistors switched in combination
        by the CD4066.
'xsupply1 produces 00000000.
        xsupply1+xsupply2 produces
        11111111
'
DEF SEG = 64: DEFINT A-T: add = 888:
        DIM a(7), r(15)
FOR i = 0 TO 7: a(i) = 2 ^ i: NEXT
disp$ = CHR$(204): d$ = STRING$(4,
        205) + CHR$(206)
FOR i = 1 TO 9: disp$ = disp$ + d$:
        NEXT i
disp$ = disp$ + STRING$(4, 205) +
        CHR$(185)
r(1) = 100: r(2) = 220: r(3) = 69: r(4) = 470
r(5) = 83: r(6) = 150: r(7) = 60: r(8) = 1000
r(9) = 91: r(10) = 180: r(11) = 64: r(12) =
        319
r(13) = 76: r(14) = 130: r(15) = 57
xsupply1 = 1.54: xsupply2 = 2.61
'
'******** Housekeeping Done, Program
        Starts Here *********
'
programloop:
COLOR 7, 1: CLS : LOCATE 1, 21:
        PRINT "PcGSR Biofeedback
        Monitor (Version 4.1)"
LOCATE 2, 1: PRINT STRING$(80, 223);
COLOR 7,0: FOR i= 8 TO 12: LOCATE i,
        6: PRINT SPACE$(69): NEXT i
LOCATE 8, 6: PRINT CHR$(218);
        STRING$(67, 196); CHR$(191)
FOR i = 9 TO 11: LOCATE i, 6: PRINT
        CHR$(179); TAB(74);
        CHR$(179): NEXT i
LOCATE 12, 6: PRINT CHR$(192);
        STRING$(67, 196); CHR$(217)
COLOR 2, 1: LOCATE 16, 26: PRINT
        "Press <Esc> To End
        Monitoring";
COLOR 7, 1
'
'******** Initialization Begins
        ************************
'Take a reference reading with the 100K
        resistor.  From that, calculate
'the probe resistance, rx.  From that, see
        which of the 15 ref resistor
'combinations come closest to start at mid
        range.  Set the mask as the
'resistor number * 16 (ex: r(4) mask is
        4*16 or 64) to be sent to port
'pins 6-9.  Use that resistor to take a
        baseline average of 5 readings.
'
baseline = 0: jsum = 0: delta = 9999:
        mask = 16: rref = 15
LOCATE 10, 28: PRINT "Initializing .";
OUT add, 1 + mask
start! = TIMER
WHILE (TIMER - start!) < .1: WEND
OUT add, 0 + mask: OUT add, 2 + mask:
        OUT add, 0 + mask: OUT add,
        2 + mask
j = 7
  WHILE j > -1
    OUT add, 0 + mask: OUT add, 2 +
        mask
    jsum = jsum + (INP(add + 1) AND 64)
        * a(j)
    j = j - 1
  WEND
vx = ((jsum / 64) * xsupply2) / 255 +
        xsupply1: rx = vx * 100 / (5 - vx)
FOR i = 1 TO 15
 IF ABS(rx - r(i)) < delta THEN delta =
        ABS(rx - r(i)): rref = i
NEXT i
mask = rref * 16: jsum = 0
FOR i = 1 TO 5
  OUT add, 1 + mask: PRINT " .";
  start! = TIMER
   WHILE (TIMER - start!) < .04: WEND
  OUT add, 0 + mask: OUT add, 2 +
        mask: OUT add, 0 + mask:
        OUT add, 2 + mask
  j = 7
    WHILE j > -1
     OUT add, 0 + mask: OUT add, 2 +
        mask
     jsum = jsum + (INP(add + 1) AND 64)
        * a(j)
     j = j - 1
    WEND
  baseline = baseline + jsum / 64: jsum =
        0
NEXT i
baseline = baseline / 5: IF baseline = 0
        THEN baseline = 1
'
'******** Main Monitoring Starts Now
        ********************
'f is map for appropriate resistor(s).  1 +
        mask brings CS* high.
'2 + mask pulses Clk hi, with resistor
        selected and CS* low
        (enabled).
'0 + mask pulses Clk lo, with resistor
        selected and CS* low.
'jsum is 64 or 0.  At end, divide results by
        64 to get 1 or 0.
'
start:
jsum = 0: jsumtotal = 0
FOR i = 1 TO 5
 OUT add, 1 + mask
 start! = TIMER: WHILE (TIMER - start!) <
        .08: WEND
 OUT add, 0 + mask: OUT add, 2 + mask:
        OUT add, 0 + mask: OUT add,
        2 + mask
  j = 7
   WHILE j > -1
    OUT add, 0 + mask: OUT add, 2 +
        mask
    jsum = jsum + (INP(add + 1) AND 64)
        * a(j)
    j = j - 1
   WEND
 jsumtotal = jsumtotal + jsum / 64: jsum =
        0
NEXT i
jsum = jsumtotal / 5
'
'******** Print Results Of The Scan
        *********************
'
COLOR 8, 0
LOCATE 9, 15: PRINT "+5   +4   +3   +2
        +1   0  -1  -2  -3  -4  -5"
COLOR 7, 0: LOCATE 10, 9: PRINT
        "TENSE"; TAB(16); disp$;
        TAB(68); "CALM"
COLOR 9, 0: delta = ((jsum - baseline) /
        baseline) * 100 + 25
SELECT CASE delta
  CASE IS <= 0
   delta = 0: COLOR 4, 0
  CASE 0 TO 24
   COLOR 4, 0
  CASE IS > 49
   LOCATE 10, 66: PRINT CHR$(219); "
        CALM": GOTO donemonitoring
END SELECT
x$ = "t240l12n" + STR$(64 - delta): PLAY
        x$
LOCATE 10, 16 + delta: PRINT
        CHR$(219);
a$ = INKEY$: IF a$ = "" THEN GOTO
        start
IF ASC(RIGHT$(a$, 1)) <> 27 THEN
        GOTO start
'
'******** Done Monitoring.  Decide What
        To Do Next *******
'
donemonitoring:
COLOR 10, 1: LOCATE 16, 26
 PRINT SPACE$(3); "Monitoring Session
        Ended"; SPACE$(3)
COLOR 15, 1: LOCATE 18, 20
 PRINT "<Enter> for Another Session,
        <Esc> to End...";
optionselect:
a$ = INPUT$(1): a = ASC(a$)
SELECT CASE a
   CASE IS = 13
     GOTO programloop
   CASE IS = 27
     VIEW PRINT: CLS : LOCATE 18, 1:
        END
   CASE ELSE
     BEEP: GOTO optionselect
END SELECT
```

Bater is powered by a single 9-volt battery and connects to an IBM or compatible PC through any available parallel port.

How It Works. The schematic in Fig. 1 shows how simple the Stress-A-Bater's hardware is. There are only three integrated circuits: an ADC0831 A/D converter (IC1), a CD4066 quad analog switch (IC2), and a 78L05 5-volt regulator (IC3).

Let's begin with a quick description of the A/D converter. (For more information on A/D converters in general, see "Build an 8-Channel A/D Converter" in the June, 1995 issue of **Popular Electronics**.) Integrated circuit IC1 converts an analog voltage into an 8-bit binary number between 0 and 11111111 (255 decimal). The reading is zero when the input voltage on pin 2 ($V_{IN}+$) is equal to the voltage on pin 3 ($V_{IN}-$). A value of 255 is reached when the input voltage is equal to the sum of the voltages on pin 3 and pin 5 (V_{REF}). That arrangement allows IC1 to measure input voltages that span a range less than 5 volts. In order to convert an input voltage to a digital number, pin 1 ($\overline{\text{CHIP SELECT}}$) is brought low and a clocking signal is supplied to pin 7. The most significant bit (D7) appears on pin 6 (DATA OUT) on the falling edge of the second clock pulse. Each following bit (D6, D5, etc.) appears on pin 6 with the falling edge of each additional clock pulse. When all eight bits have been read, pin 1 should again be brought high to prepare for the next conversion.

The input to IC1 is a two-resistance voltage divider. Resistors R5–R8 form the upper part of the divider. Those resistors are selected by IC2, a quad bilateral-analog switch. That device contains four identical switches, each with an input, an output, and a control. When a switch's control signal is low, a low-resistance connection (about 50 ohms) is made between the input and output. Thus, any single or parallel combination of the four resistors (R5–R8) can be selected with the appropriate control signals to IC2 pin 5, 6, 12, or 13. By selecting one of the 16 possible on/off combinations for the switches, the resistance in the top portion of the voltage divider can be adjusted between about 56,000 ohms and 1 megohm.

The lower part of the voltage divid-

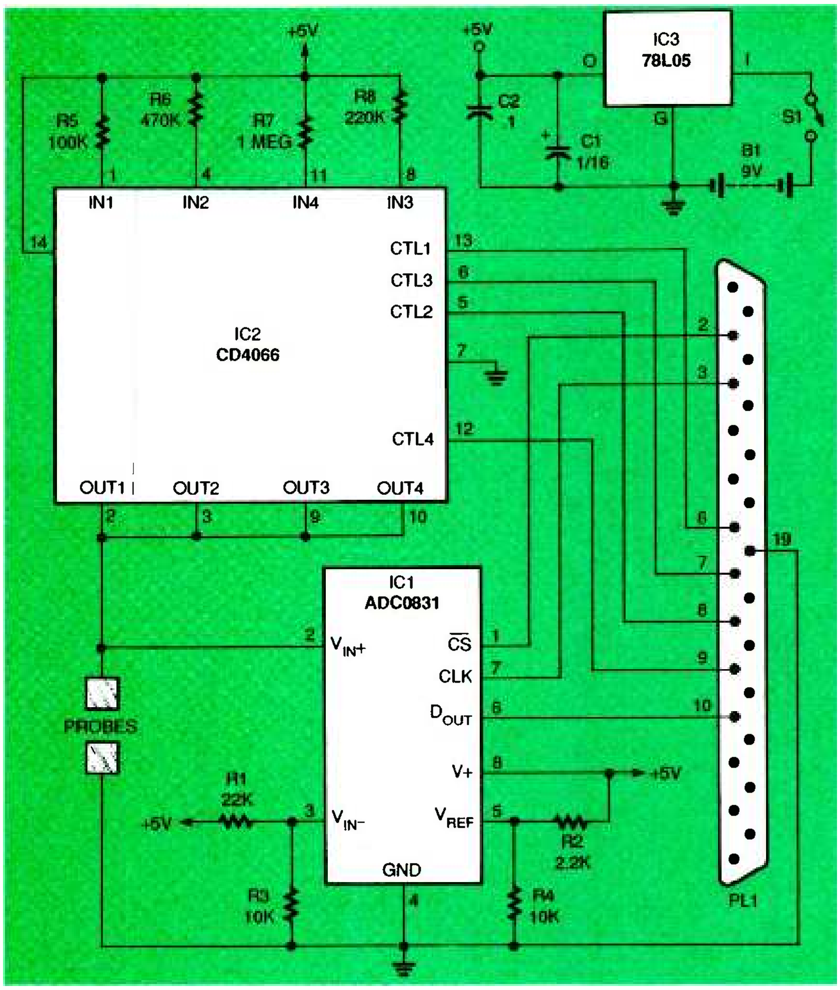


Fig. 1. The circuit for the Stress-A-Bater's hardware is very simple. The 3-wire output of the ADC0831 makes it very easy to interface the A/D converter to many different types of computers.

er is the resistance of a person's skin. One of the GSR probes connects to the input of the A/D converter, and the other probe is connected to ground. When the probes are attached to a person's fingers, a resistance (GSR) is seen between pin 2 of IC1 and ground. Since the selected resistors and the GSR probe together form the voltage divider, the input voltage at IC1 generated by the voltage-divider circuit is directly proportional to the galvanic skin resistance across the probes.

The V_{IN-} and V_{REF} voltages are generated by voltage-divider resistor pairs R1/R3 and R2/R4. Using the values shown in Fig. 1 for R1-R4, the reference voltage are approximately 1.6 volts for V_{IN-}, and 2.6 volts for V_{REF}. With those voltage levels, IC1 provides a 0 output at 1.6 volts, and a 255 output at 4.2 volts (1.6 + 2.6). The resolution of IC1 is the input voltage range divided by the number of possible binary output steps. That is , or about 10-mv/step. As an example, with only R5 selected and a GSR of 100,000 ohms, the input to IC1 will be:

$$V_{IN+}=5\times(R_{select}/(R_{select}+R_{probe}))$$
$$=5\times(100{,}000/(100{,}000+100{,}000))$$
$$=2.5v$$

The V_{IN+} equation can be rearranged to:

$$R_{probe}=5\times(R_{select}/V_{IN+})-R_{select}$$

Using the 10-mv (0.1-volt) resolution we previously calculated, we can see that the next change in output will be when the input voltage changes to either 2.49 volts or 2.51 volts. Using 2.51 volts in the R_{probe} formula above gives us a GSR of:

$$R_{probe}=5\times(^{100{,}000}/_{2.51})-100{,}000$$
$$=99{,}200 \text{ ohms}$$

The resistor values chosen for R5–R8 let us see changes in GSR of about 1%. The Stress-A-Bater can operate at that

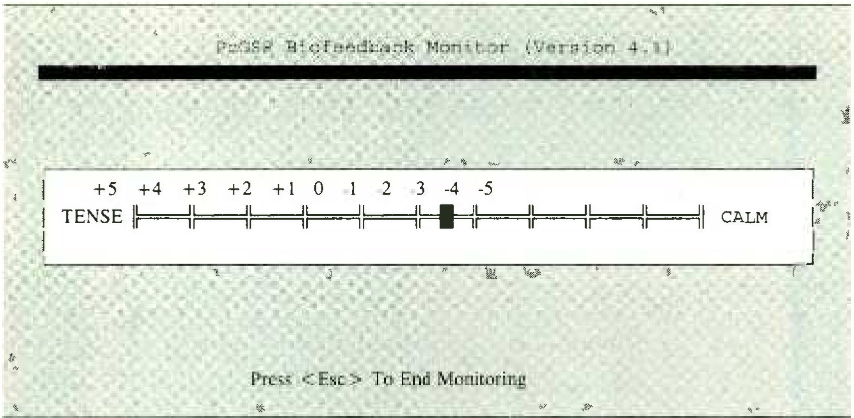


Fig. 2. The QBasic program for the Stress-A-Bater displays this moving dot across a horizontal scale showing how much stress a person is under. A beeping also sounds from the computer's speaker; the more tense you are, the higher the pitch of the beeping.

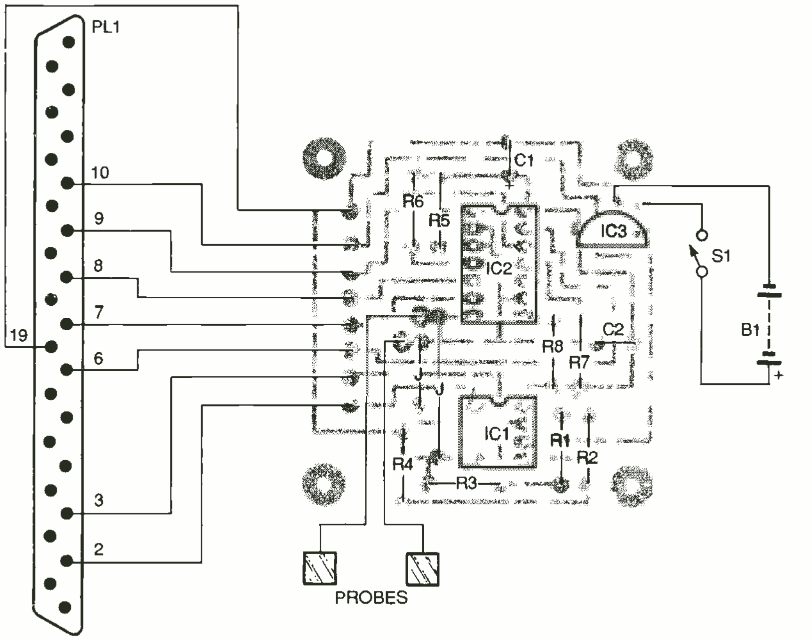


Fig. 3. Here's where the components are located on the PC board. Single-sided board design makes assembly easy—there is no worry about placed-through holes or solder connections on the top side of the board.

good a level of resolution because of IC1's ability to operate over an input range smaller than 5 volts, and the ability of IC2 to selectively set the fixed resistance in the input-voltage divider.

The control lines from IC2 for selecting the voltage-divider resistors, along with the control and data lines from the A/D converter, are connected with a length of ribbon or round cable to a male DB-25 connector. That allows the Stress-A-Bater to be hooked up to the printer port of an IBM or compatible PC for computer control and monitoring of biofeedback sessions.

Power from a 9-volt battery is regulated by IC3 to 5 volts. That 5-volt source powers IC1 and IC2, and also connects to all the voltage dividers (R1, R2, and R5–R8). It is very important to include C2 in the circuit. If C2 is left out, electrical noise will interfere with the A/D converter, causing erratic and unstable readings.

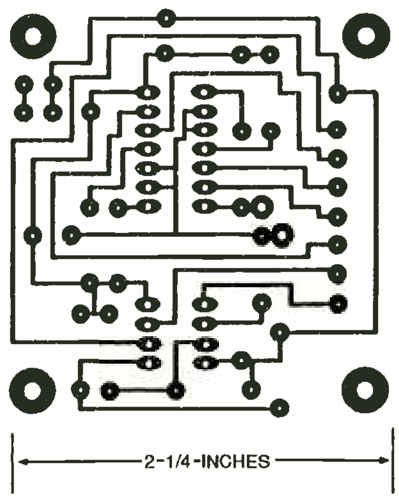
The Computer Program. Listing 1 is the source code for a simple biofeedback program that can be run under Microsoft QBasic. An enhanced version of the program, with better resolution, data logging, and results graphing is available from the source given in the Parts List. Each of the lines beginning with an apostrophe (') is a remark line. They have no program function—merely documenting certain aspects of the program. If you are typing in the program, you do not need to enter the remark lines.

The "Do Housekeeping" and "Housekeeping Done . . ." sections set up program variables and do initial formatting of the screen. Of special interest are the following statements:

```
add = 888
xsupply1 = 1.54
xsupply2 = 2.61
```

The variable *add* specifies the address of the parallel port you intend to use. The program listing sets that variable to 888, which is the decimal address number for LPT1. If you are going to use a different parallel port, you must change the value for the *add* variable to the proper address of the port to be used. The variables *xsupply1* and *xsupply2* are the voltages present at pins 3 and 5, respectively, of IC1. Based on the actual values of the resistors you use in the device, the voltage values will most likely be slightly different than what is mentioned here. You will need to measure those values, change the values assigned to *xsupply1* and *xsupply2*, and re-save the program before using it.

The "Initialization Begins" section uses the starting GSR of the person attached to the Stress-A-Bater to establish an initialization "baseline". As mentioned in the remarks lines for that section, an initial reading is taken after the 100,000-ohm resistor is



Here's the foil pattern for the Stress-A-Bater. Only 2 jumper wires are needed on this single-sided board.

switched into the circuit. That reading is used to calculate the person's current GSR across the probes. The program then figures out which of the available resistor combinations come closest to the person's current GSR. Finding the person's current GSR resistance reading will set the input voltage to IC1 at about mid range. Once that has been done, five readings are taken within a quarter second to obtain an average. That average is then used as the starting baseline. That approach minimizes any instantaneous GSR variations such as hand movement or changes in position of the probe's contact surfaces against the skin.

The "Main Monitoring" section uses a similar approach to obtaining monitoring samples. The variable *mask*, set during the "Initialization Begins" section, is the value that selects the appropriate resistor combination. To repeat what the remarks in the program listing say, that value is added to whatever data is to be sent out each time to the Stress-A-Bater to make sure that those resistors stay connected in the proper configuration. Just like in the initialization section, five samples are taken and averaged to minimize excess variations.

The averaged GSR value is displayed in the "Print Results Of The Scan" section. A typical screen display in Fig. 2 shows the stress measurement cursor positioned midway between 0 and -1 (moving towards the calm portion of the scale). In addition to the visual display, there is a continuous audio tone whose pitch is directly proportional to the displayed stress level. Lower stress levels lower the pitch of the tone, and higher stress levels raise the pitch. After the tone pitch is played, the following two lines check to see if you want to end the monitoring session:

```
a$ = INKEY$: IF a$ = "" THEN GOTO start
IF ASC(RIGHT$(a$, 1)) <> 27 THEN GOTO start
```

If no key, or a key other than the escape key (whose ASCII value is 27) is pressed, the program loops back to the label *start:* (in the main monitoring section) for the next sample. If the escape key was pressed (or the CALM level has been reached), the program goes to the "Done Monitoring" section. Here, you can press the enter key to start another monitoring session, or press the escape key to end the program.

Construction. Building the Stress-A-Bater is simple when using a single-sided PC board. After fabricating the board or obtaining one from the source mentioned in the Parts List, follow the placement diagram in Fig. 3 for location of the components. The orientation of polarized components C1 and IC1–IC3 should be followed carefully. Attach the black lead of a 9-volt battery clip to the hole marked "–", and the red lead to one lug of S1. The other lug of S1 is connected to the hole marked "+". The two jumper wires may be formed from two excess capacitor or resistor leads. Solder all the parts into place.

Before connecting PL1 and the probes, decide what type of case you will be using to house the Stress-A-Bater. One inexpensive alternative is a case for holding 3½-inch floppy disks. Such cases can be found almost anywhere for around a dollar and are just the right size to house the PC board

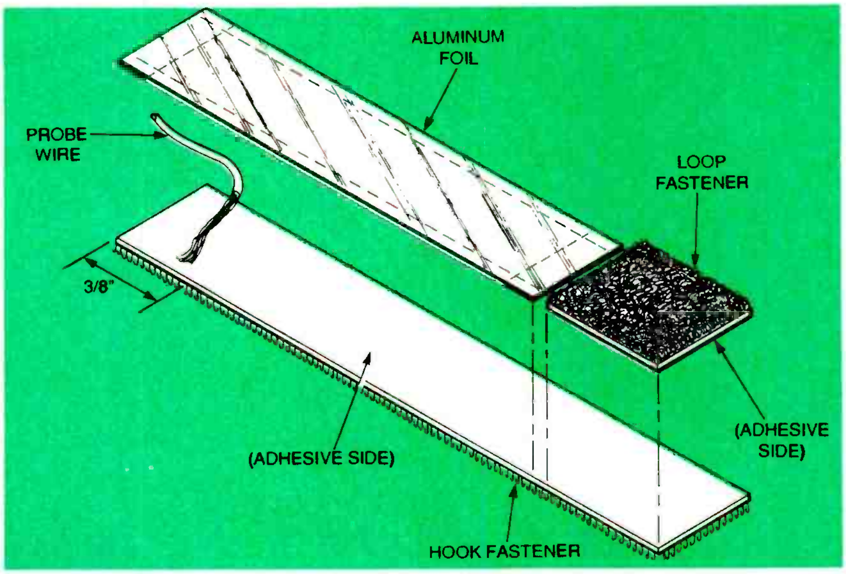


Fig. 4. Self-adesive Velcro-style hook-and-loop fasteners make assembly of the skin probes very simple. You could substitute a single layer of heavy-duty aluminum foil for the 2 layers of regular aluminum foil for the contact itself. With either type of foil, be sure to fold over the edges for added resistance to wear and tear on the probes.

PARTS LIST FOR THE STRESS-A-BATER BIOFEEDBACK MONITOR

RESISTORS
(All resistors are ¼-watt, 5% units.)
R1—22,000-ohm
R2—2,200-ohm
R3, R4—10,000-ohm
R5—100,000-ohm
R6—470,000-ohm
R7—1-megohm
R8—220,000-ohm

CAPACITORS
C1—1µF, 16-WVDC, electrolytic
C2—0.1-µF, ceramic-disc

SEMICONDUCTORS
IC1–ADC0831 analog/digital converter, integrated circuit
IC2—CD4066 CMOS quad bilateral switch, integrated circuit
IC3—78L05 5-volt regulator, integrated circuit

ADDITIONAL PARTS AND MATERIALS
B1—9V battery
PL1—DB25 male connector and hood
S1—SPST switch
9-volt battery snap, printed-circuit board, hook-and-loop fasteners, household aluminum foil, 24-gauge two-conductor cable, 9-conductor multi-conductor or ribbon cable (see text)
NOTE: The following items are available from: James J. Barbarello, 817 Tennent Road, Manalapan, NJ 07726: Printed circuit board (GSR-PC), $10; Enhanced software with source code and executable file on 3.5-inch disk (GSR-S), $12; Complete kit includes printed-circuit board, all parts, case, wire, and enhanced software (GSR-K), $35. NJ residents must add appropiate sales tax.

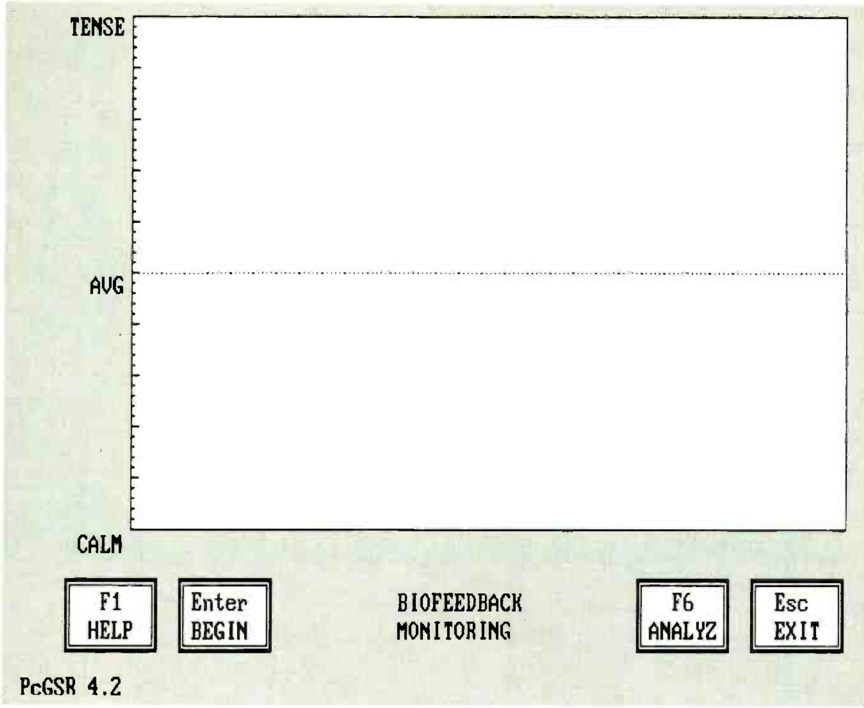


Fig. 5. The enhanced software from the source listed in the Parts List gives you greater detail in analyzing your indidiual stress-reduction sessions. Several different people can use the same program to store their individual sessions on disk for future reference.

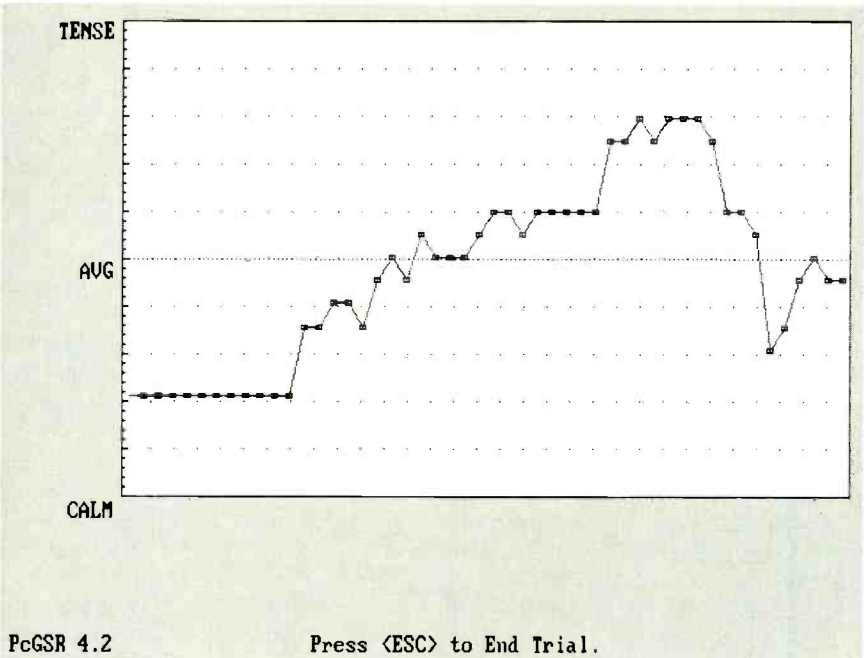


Fig. 6. After a session is done, the enhanced software graphs shows how you did. Time runs right to left, with the first reading of the session to the right, and the last reading of the session to the left. You can see in the example that the person started calming right away, but then tensed up and took a while to relax again. That may have been caused by readusting the sitting position.

and battery. One example is a Radio Shack 26-273 disk case. The PC board is mounted in the case with #4-40 × ½-inch machine screws and nuts. To hold the battery in place, a "Z" shaped bracket is bent from light aluminum and secured to the case with another #4-40 × ½-inch machine screw and nut. Two more #4-40 × ¼-inch machine screws are force-threaded into a pair of 3/32-inch diameter holes drilled in either side of the case to hold the two case-halves together. Choose where the computer and probe cables will exit the case and cut the appropriate openings. Pick a spot on the case where the on-off switch will be mounted and drill the needed holes.

You'll need a male DB-25 connector, along with a suitable length (4 to 6 feet) of seven conductor cable with ground wire, or a 9-conductor cable for PL1. You could also use a ribbon cable with a DB-25 male insulation-displacement connector (IDC) on one end as an alternative. The inclividual conductors on the free end of the ribbon cable can be separated for connection to the PC board. Thread the cable through the opening you made for it in the case, and wire the corresponding pads on the PC board to the cable wires using Figs. 1 and 3 as a guide.

Thread 4 to 6 feet of two-conductor cable for the probe cable through the appropriate opening in the case; 22-gauge or 24-gauge stranded audio-speaker "zip-cord" wire works well. If you're using that size zip-cord wire, a ⅛-inch diameter hole in the case will fit the wire just fine. Make sure there is sufficient wire in the case to allow it to be opened and closed easily when it comes time to change the battery. Tie two knots in the wire, one on either side of the case wall. Slip the knots snugly towards the case wall to form a strain relief. Solder the wire's conductors to the probe pads on the PC board. Either conductor may be soldered to either pad. Mount the PC board, the battery, and the switch to the case. Make sure the switch is in the off position.

The final construction step is to build the two skin probes and attach them to the unconnected end of the two-conductor wire. Get a piece of adhesive-backed hook-and-loop fastener. The hook portion contains evenly spaced rows of hooks, while the loop portion appears fuzzy. Cut one hook piece to 3 by ¾ inches, and one loop piece to ⅝ by ¾ inches. If you have large fingers, you might want to make the hook piece a bit longer than 3 inches. Remove the paper backing on both pieces, and following the layout in Fig. 4, stick the adhesive-backed sides of the loop piece onto one end of the adhesive-backed side of the hook piece. Separate the two conductors of the probe cable about 6 inches and tie a knot at the junction to ensure that the cable does not unzip any further. Strip 1 inch of insulation from the free end of one of the probe conductors. Curl the stranded wires into a circle and push them into the adhesive of the hook piece. Cut two pieces of common household aluminum foil to ⅝ by 1 inches. Place the two pieces together and fold over all four edges ⅛ inch so the final dimensions are 2⅜ by ¾ inches. Place the aluminum foil strip onto the exposed adhesive of the hook piece, covering the stranded wires. Build the second probe the same way.

Operation. Using the Stress-A-Bater is straight forward. Have your computer fired up and sitting at a DOS prompt. Connect the unit to whichever parallel port you will be using, and turn the unit on. Wrap one probe around the tip of the index finger of your left hand (if you are right handed), and secure it by overlapping the loop end of the probe. The wire should be under your fingerprint and stick out away from your hand. Apply the other probe to your middle finger in the same way.

Rest the hand with the probes on a solid surface so that there is no muscle tension in your hand or forearm. Keeping your hand still, start the program in Listing 1 with QBasic on your PC. After a few seconds, the initialization process will end, and the Stress-A-Bater will be reading your stress level. Watch the indicator and listen to the beeps. Concentrate on trying to lower the pitch of the beeps and move the indicator to the right (more calm). At first, you may find that the harder you concentrate on moving the indicator right, the more it will move to the left (more tense). That is perfectly normal at first. You just haven't created an effective biofeedback loop between the indicator and your thought processes.

To create that loop, start by becoming aware of your breathing pattern. Try taking long, deep breaths. Do that for a few minutes, and the indicator should begin moving to the right as you start to relax. That is the beginnings of a biofeedback loop. Continue doing that until you can no longer move the indicator any further to the right. Pressing the escape key or moving the indicator all the way to the right will end the session.

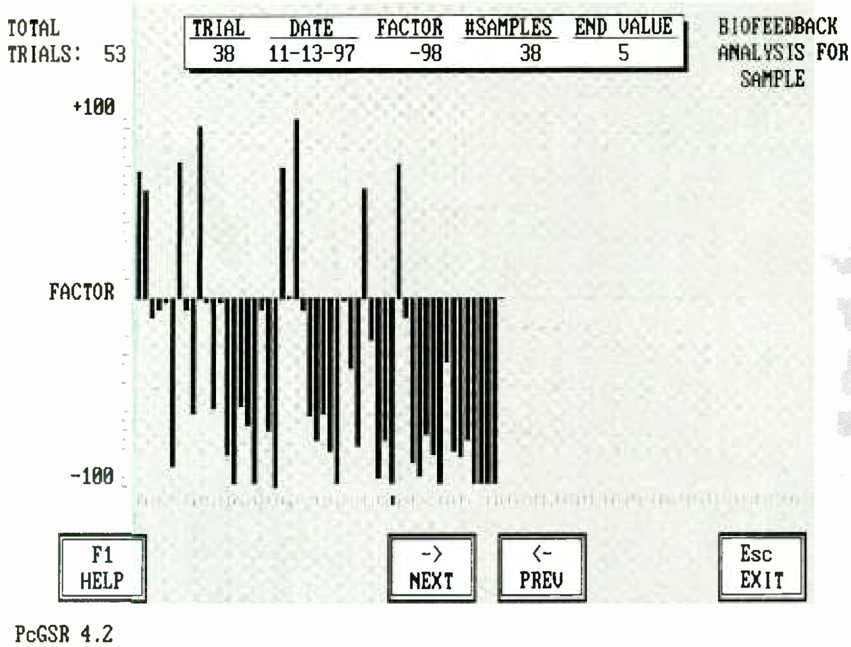


Fig. 7. Not only can the enhanced software graph your performance for each session but it can also store the results of each session and display all of them.

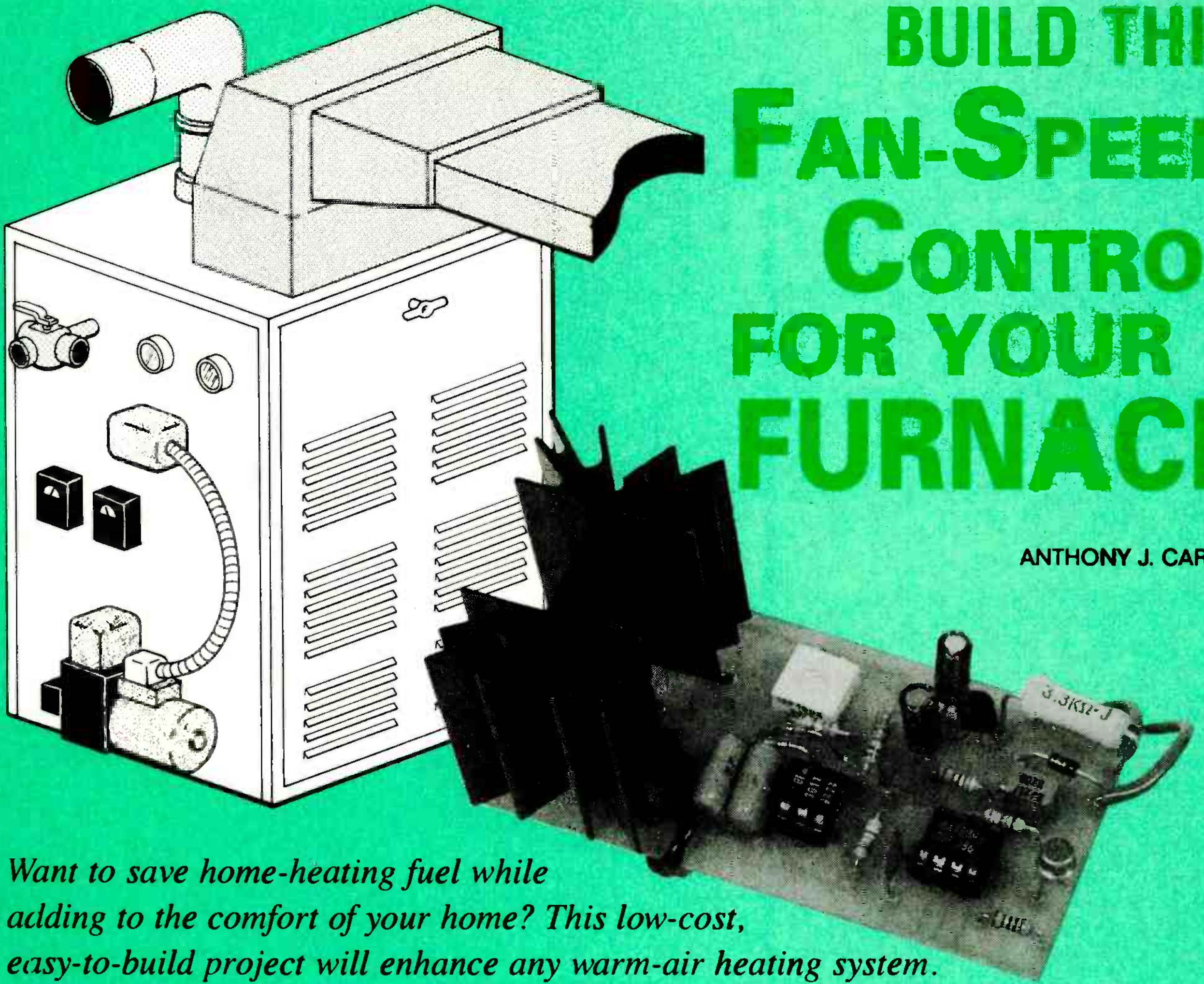
Once you become proficient at using controlled breathing to reduce tension, try moving on to visualization. In that process, you mentally picture scenes or bring forward thoughts that cause calming. As you discover one or more pictures or thoughts, use the Stress-A-Bater to help reinforce your ability to call them up and have them produce a calming effect on you.

The Stress-A-Bater will be most effective if you use it consistently over a long period of time. For instance, you might like to set aside 10 to 15 minutes each day for biofeedback sessions. If you choose to do that, you will probably want to keep a record of your various sessions, and have a better view of trends during each session. The enhanced software application available from the source gven in the Parts List has those capabilities. Figure 5 shows the main working screen. Here you have the option to get additional help on using the program, begin a biofeedback session, analyze your stored data from previous sessions, or exit the program. If you had just completed a monitoring session, an additional option to save the result of the session would also appear.

Figure 6 shows the results of a monioring session. The latest indication appears on the left of the graph as the previous results move to the right. To end the session, you press the escape key. You can then save the results to a named file.

At any time you can analyze the contents of your file. The display in Fig. 7 shows a file containing the results of 53 sessions. Up to 1000 sessions can be recorded in each individual's file. The cursor on the bottom horizontal indicator row is pointing to the results of session 38, which are detailed in the box at the top of the screen. Besides indicating the session number, the box also shows the system date of that trial, the session factor, the number of samples during the session, and the value that existed when the session was ended. The session factor is based on a formula that takes into account the ending value and the number of samples. The lower the ending value (more calm), the lower the factor. However, a shorter session with an end value of 5 will show a lower factor than a longer session with the same end value. This gives a relative measure of how long it took to come to a specific calm state. The best result is a session factor of -100.

The example in Fig. 7 shows that there were periodic excursions into the plus zone, indicating that whoever was using the Stress-A-Bater had trouble reaching a calm state during those sessions. The analysis function can help pinpoint stress causing events on different days that would not otherwise be obvious. Ω



BUILD THIS FAN-SPEED CONTROL FOR YOUR FURNACE

ANTHONY J. CARISTI

Want to save home-heating fuel while adding to the comfort of your home? This low-cost, easy-to-build project will enhance any warm-air heating system.

Unless the warm-air furnace which heats your home is one of the very latest, most highly sophisticated units available today, it suffers from one drawback: its constant blower speed. Most 80% AFUE (annual fuel utilization efficiency) warm-air furnaces manufactured today use a fixed-speed blower, which is set to work best during the coldest, most severe weather conditions. Most of the time such conditions do not exist, so the blower speed is too great for maximum comfort. It cools the furnace's main warm-air distribution duct (the plenum) too fast, shuts down, and deprives you of a very important feature of a properly designed warm air heating system—Continuous Air Circulation, or CAC.

An ideal situation is where blower motor speed is set by the temperature of the furnace plenum. At relatively low temperatures, the blower runs slowly; it increases in speed as the plenum gets warmer. Not only does that provide increased comfort, but the noise level of the blower system is greatly reduced most of the time, and less electrical power is used to drive the motor.

Chances are your warm-air heating system does not have a two-speed blower control. However, you can easily modify your system by installing our low-cost Blower Speed Control. It will enhance your comfort during the heating season, and might allow you to set your thermostat a couple of degrees lower, letting you save precious and expensive fuel.

Design Overview. The Automatic Blower Speed Control sets the blower motor RPM to either of two speeds, low or high, as required by the heating load on the heating system. Low speed will operate most of the time when the furnace plenum is at a relatively cool 110° Fahrenheit or less. That will keep air circulating throughout the home and help eliminate that cold feeling that sometimes occurs when the blower shuts down.

When heating demand increases from either colder outside temperatures or by setting the thermostat higher, the increase in plenum temperature is sensed by the Speed Control, which automatically switches the blower motor to high speed. Air flow is boosted to the maximum possible volume, transferring as much heat as it can from the furnace heat exchanger to the living area of the home.

Once the thermostat is satisfied and the plenum cools down below about 110°F, the blower automatically returns to low speed. You'll benefit from continuous air circulation and enhanced comfort, all while saving fuel.

About the Circuit. The heart of the blower speed control is the phase-controlled Triac circuit illustrated in Fig. 1. During each AC half-cycle, capacitor C_A is charged through adjustable resistor R_A. The voltage on C_A is applied to a diac, which acts like a bidirectional Zener diode. The diac will trigger and conduct current when its switching voltage is reached. That

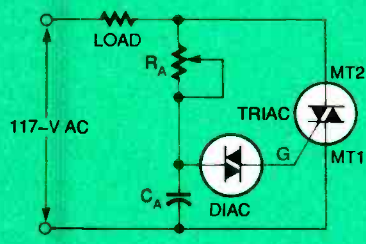


Fig. 1. A typical phase-control Triac circuit. Adjusting the resistance of R_A changes the time it takes to charge up C_A, and fire the diac.

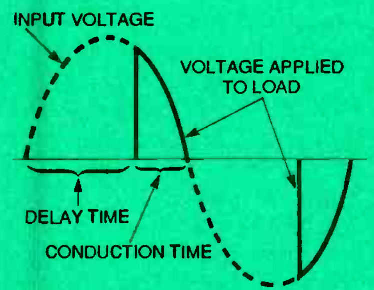


Fig. 2. If the Triac's trigger pulse is delayed, this waveform is the result. Delaying the trigger applies less energy to the load.

current is in turn applied to the gate terminal of the Triac, which will switch on and let current flow through the load. The Triac will continue to conduct until the end of the AC half-cycle, when it switches off and waits for the next trigger input.

The amount of resistance R_A is set to controls how fast C_A charges up to the trigger voltage of the diac. The greater the resistance, the longer it will take. That delay controls how much current the load sees. A longer delay in triggering the Triac allows less time in the half-cycle for the Triac to conduct, so less electrical energy is applied to the load. Figure 2 is an example of that type of waveform. When the load being driven is a permanent split-capacitor (PSC) induction motor, the reduced amount of available electrical energy slows the motor down. By adjusting the value of R_A, we can control the motor's speed.

Let's look at Fig. 3, the schematic diagram of the blower-control circuit. The basic variable-motor-speed circuit described above is composed of Triac TR1 along with phase-control network D4, R8, R9, and C5. Those components form the low-speed circuit, with R8 adjusted for the desired low-speed operation of the blower motor. That network is always in place, so the motor cannot rotate at a speed that is less than the desired minimum.

A second RC network composed of R7, C4, and diac D3, forms a duplicate phase-control network that is connected, through optoisolator IC3, in parallel with the first network. In effect, either phase-control network can be used to control motor speed. In the second phase-control network, the value of R7 is low enough to provide a minimal delay, essentially delivering full line power to the motor. That results in high-speed blower operation. Note that when the high speed phase-control network controls the Triac, the low-speed circuit has no effect on motor performance since the Triac will have been triggered earlier in the half-cycle.

Optoisolator IC3 is used to switch in the high-speed phase-control network. That permits the low-voltage part of the circuit to be electrically isolated from the motor wiring.

When plenum temperature is below 110°F, IC3 is off, allowing the low-speed phase-control network to run the motor. Above 110°F, IC3 is activated. That turns the second phase-control network on, which runs the motor at high speed.

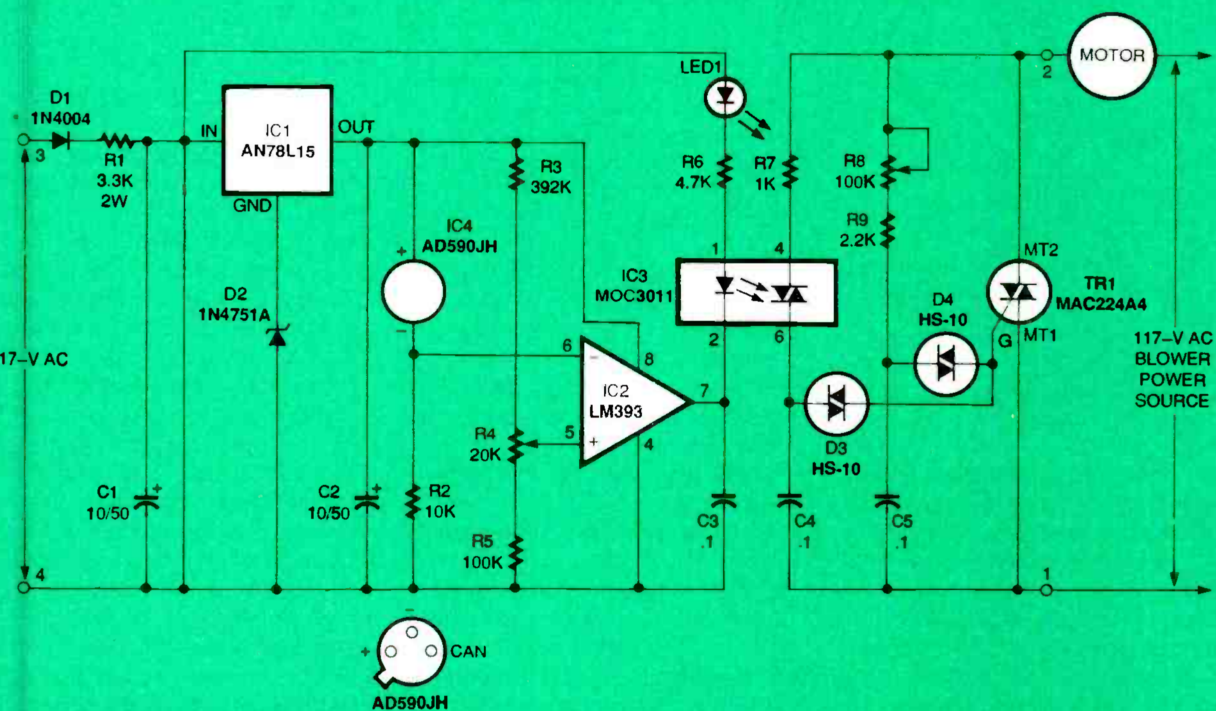


Fig. 3. Here is the schematic of the Automatic Blower Speed Control. An optoisolator protects IC2 from the destructive voltages of the blower motor. It's a good idea to use two different-colored wires for the temperature sensor's "+" and "−" terminals. The sensor terminal marked "CAN" is not used.

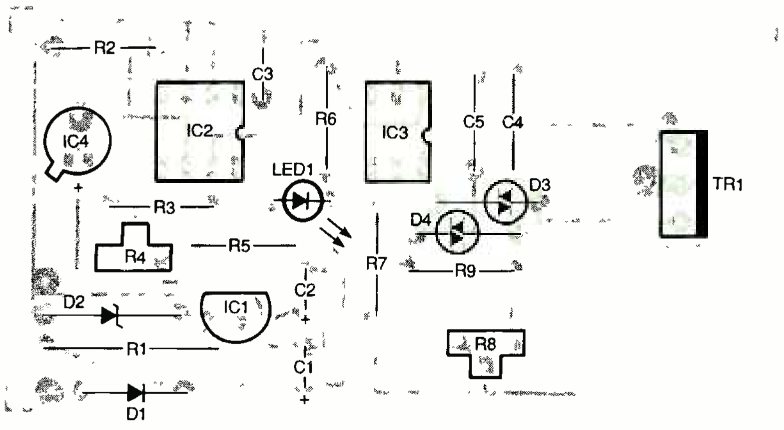
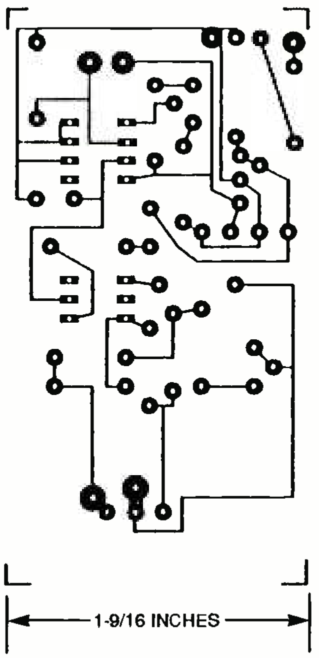


Fig. 4. Component layout of the Blower Speed Control is simple and straightforward. Take care that all polarized parts, such as ICs, capacitors, and diodes are inserted with the proper orientation or they could be damaged.



Here's the foil pattern for the Automatic Blower Speed Control. The design of the Controller is simple enough to use a single-sided printed circuit board. If you don't want to drill and etch your own board, the Controller can be hand wired on a piece of perfboard.

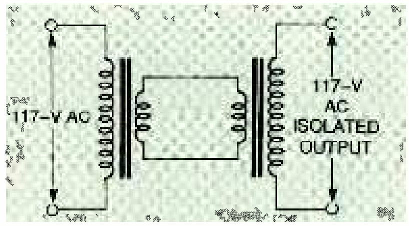


Fig. 5. If you have to troubleshoot the high-voltage section of the Blower Speed Control, it's a good idea to use an isolation transformer for additional safety. You can wire two transformers back-to-back for reasonable isolation.

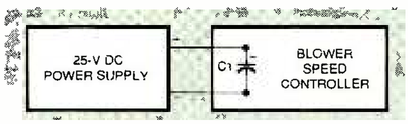


Fig. 6. When you're ready to do preliminary testing of the low-voltage side of the Blower Speed Control, temporarily hook up a 25-volt DC power supply in this way to power the circuit.

A half-wave Zener-regulated DC power supply formed by R1, D1, D2, and C1 feeds 30-volts DC to the input of IC1, a fixed 15-volt linear regulator. The regulator supplies temperature sensor IC4 and a voltage divider network composed of R3, R4, and R5.

The output of IC4 is designed to provide a current of 1 microampere-per-degree Kelvin in response to the ambient temperature surrounding it. Its output current is passed through R2 to produce a known temperature/voltage relationship. At a temperature of 25°C (77°F), the equivalent Kelvin temperature is 25 + 273.2, or 298.2° K. A sensor current of 298.2 microamperes produces a voltage of about 2.98-volts across R2. In order to measure the temperature of the warm air, IC4 is placed inside, or in close contact with, the plenum.

Only one section of voltage comparator IC2 is used. A voltage comparator, as its name implies, compares the level of two input voltages. It acts like an op-amp that has no external feedback, resulting in very high gain. The output voltage of the comparator is either 15-volts or 0, depending on which of the two voltages present at the input terminals is higher than the other.

The negative input terminal of the comparator is the voltage across R2, accurately representing the plenum temperature. The positive input of the comparator is connected to a voltage level set by potentiometer R4. That level is set to about 3.16 volts during calibration of the circuit. That is the voltage that appears across R2 when the furnace plenum is at about 110°F.

When the plenum temperature is below 110°F, the comparator's output terminal is high. That leaves the LED in IC3 dark. As a result, the high-speed phase-control network is disconnected, and the motor runs at low speed when the plenum switch calls for blower operation.

When plenum temperature exceeds 110°F, the output of IC2 goes low, and its open-collector NPN output transistor sinks current through the internal LED of IC3. That activates the high-speed phase-control network, causing the blower motor to run at maximum speed.

An LED indicator is connected in series with the input circuit of IC3 to provide visual indication of high speed motor operation. That feature is useful when testing the Blower Speed Control.

Construction. The blower speed-control circuit is contained on a single-sided printed-circuit board. A drilled and etched board is available from the source given in the Parts List if you do not wish to etch your own. Alternatively, the circuit may be hand wired on a perfboard using good construction techniques.

Figure 4 illustrates the parts placement of the board. Note that the Triac will require a heatsink since it will dissipate several watts, depending upon the size of the blower motor. The Parts List suggests one possible selection, but you may use any heatsink that provides sufficient cooling. Bear in mind that the metal tab of the Triac is electrically hot, so both it and the heatsink must not be shorted to any part of the circuit or furnace.

Before starting assembly, clean the copper side of the PC board with steel wool to remove any dirt or oxidation. Wash it with detergent and water, and dry thoroughly. Refer to Fig. 4 for proper location of all the parts. All polarized components, such as semiconductor devices and electrolytic ca-

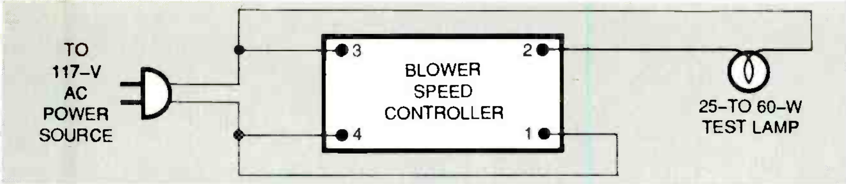


Fig. 7. Wire the Blower Speed Control in this way to test the high-voltage side. Use a 25- to 60-watt light bulb to simulate the blower motor. The Triac and its heatsink will be electrically live—don't touch them unless the Controller is unplugged from the wall socket.

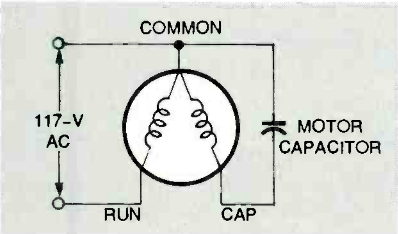


Fig. 8. This is how a typical permanent split capacitor (PSC) motor is wired. Sometimes both capacitor terminals are isolated.

pacitors, must be properly oriented. Just one part placed backwards in the board will prevent the circuit from working, and will probably cause damage to one or more components.

The integrated circuits should be soldered directly onto the printed circuit board for reliability, since the circuit might be exposed to vibrations from the furnace while the blower is operating. Before soldering, be absolutely sure that each IC is properly oriented as illustrated in Fig. 4. Be careful; it is difficult to remove an IC from the board once it has been soldered in place. The two diacs are bi-directional; they are placed into the circuit board without regard to polarity.

It is important to use metal-film resistors where specified in the Parts List to ensure proper calibration and stability of the temperature-switching point. Ordinary carbon resistors are not temperature stable, and should not be used where metal-film types have been specified.

Be very careful when handling the Triac. If the leads need to be bent slightly, be sure that the bends take place away from the plastic body of the Triac. That will avoid any possible damage to the Triac from mechanical stress. It is best if two long-nose pliers are used to perform the bending operation. Be absolutely certain that the orientation of the Triac is correct when inserting it into the printed circuit board. The Triac should be mounted to the heat sink using suitable hardware and heat-sink compound. If necessary, use 16-gauge wire to connect the power leads of the Triac to the PC board. Refer to Fig. 4 to properly locate those connections. The heatsink should be securely mounted to prevent breaking the Triac's leads.

The temperature sensor will be mounted either in close contact, or inside the plenum of the furnace to sense plenum temperature. Refer to the schematic diagram (Fig. 3) before wiring the temperature sensor to the circuit board. Only two of its three terminals are used: positive and negative. The third terminal is connected to the sensor's metal case and is not used. It is mandatory to insulate the wiring and body of the sensor to prevent any possible short circuit to the sheet metal of the furnace. A short circuit here might destroy the sensor and other components.

Connections between the PC board and the sensor is made with 20-gauge stranded wire with insulation rated at 105°C (221°F). Any length will be satisfactory. Use different color wires if possible. That will make identifying the sensor leads easier. Measure and cut the required length of wire, noting the final location of the PC board and sensor.

When the printed-circuit board is completed and the Triac is securely mounted to its heatsink, examine the assembly very carefully for opens, short circuits, and bad solder connections, which might appear as dull blobs of solder. Any solder joint that is suspect should be redone by removing the old solder with desoldering braid, cleaning the joint, and carefully applying new solder. It is far easier to correct problems now rather than later if you find that the circuit does not work.

If the circuit board is to be mounted outside the furnace cabinet, it must be placed in a small covered plastic enclosure to protect it from dirt and inadvertent short circuits; if mounted inside, the enclosure could be omitted. If an enclosure is used, remember that the heatsink will need some air flow to maintain Triac cooling. Drill holes in the sides of the enclosure for

PARTS LIST FOR THE AUTOMATIC FAN-SPEED CONTROL

RESISTORS

(All resistors are ¼-watt, 5% units, unless otherwise noted.)
- R1—3,300-ohm, 2 watt, metal-oxide
- R2—10,000-ohm, ¼ watt, 1%, metal-film
- R3—392,000-ohm, ¼ watt, 1%, metal-film
- R4—20,000-ohm, cermet potentiometer (Digi-Key 36C24 or similar)
- R5—100,000-ohm, ¼ watt, 1%, metal-film
- R6—4,700-ohm
- R7—1,000-ohm
- R8—100,000-ohm, ½ watt, cermet potentiometer (Digi-Key 3386P105 or similar)
- R9—2,200-ohm

CAPACITORS
- C1, C2—10-µF, 50-WVDC, electrolytic
- C3—0.1-µF, ceramic disc
- C4, C5—0.1-µF, 250-WVDC, Mylar

SEMICONDUCTORS
- IC1—78L15 regulator, integrated circuit
- IC2—LM393 dual comparator, integrated circuit
- IC3—MOC3011 optoisolator, integrated circuit
- IC4—AD590JH temperature sensor (Analog Devices)
- TR1—MAC224A4 Triac (Motorola)
- D1—1N4004 silicon diode
- D2—1N4751A Zener diode
- D3, D4—HS-10 diac (Teccor)
- LED1—Light-emitting diode, red

ADDITIONAL PARTS AND MATERIALS
- Heatsink (Mouser 532-529802B25 or similar), printed-circuit board, hardware, enclosure (optional, see text), hookup wire

Note: The following items are available from: A. Caristi, 69 White Pond Road, Waldwick, NJ 07463: Etched and drilled printed circuit board, $12.95; TR1, $4.75; IC1, $2.75; IC2, $3.25; IC3, $3.25; D3, $2.00; D4, $2.00; IC4, $9.75. Please add $5.00 postage/handling. NJ residents must add appropriate sales tax.

air flow and the power input and output leads. It is best to use 16-gauge, 105°C insulated stranded wire for those connections. Use several different colors to help avoid miswiring.

Do not install the circuit board into its case or the sensor into the furnace at this time. The assembly must first be checked out to be sure it is operating properly.

Preliminary Testing. The preliminary test is divided into two parts. First, the primary side of the circuit is checked using a low-voltage DC power supply as the source of power. The second part consists of checking the AC power side of the circuit using an ordinary lamp bulb to simulate the blower motor of the furnace.

CAUTION: Since the circuit will be powered directly by the AC line during the AC power portion of the test procedure, it is mandatory that no contact be made to any part of the Triac circuit. If you have to troubleshoot that part of the circuit, an isolation transformer must be used to prevent electrical shock. Figure 5 shows how two identical step-down transformers might be connected back-to-back for line isolation.

Refer to Fig. 6 when setting up a DC power supply for the first half of the preliminary test. The supply voltage should be no more than about 25 volts. If the voltage breakdown rating of D2 (about 27 to 33 volts) is exceeded, D2 will burn out.

Connect the negative lead of the DC power supply to the negative side of C1, and connect the positive lead to the positive side of C1. Measure the voltage at the positive side of C2. A normal reading is between 14.75 and 15.25 volts. If you do not obtain that voltage, disconnect power and troubleshoot the circuit before proceeding. Check the orientation of D2, IC1, C1, and C2. Measure the resistance across C2 to be sure there is no short circuit on the 15-volt line. A normal reading is about 13,000 ohms. If that is not seen, examine the board thoroughly for shorts, opens, and bad solder joints. When the fault has been located and repaired, continue with the checkout procedure.

Connect a DVM or VOM across R2 to monitor the sensor current. Apply 25-volts DC power to the circuit and note the voltage reading of the meter, which should be about 3-volts DC, depending upon ambient temperature. If the reading is not correct, check the sensor's polarity.

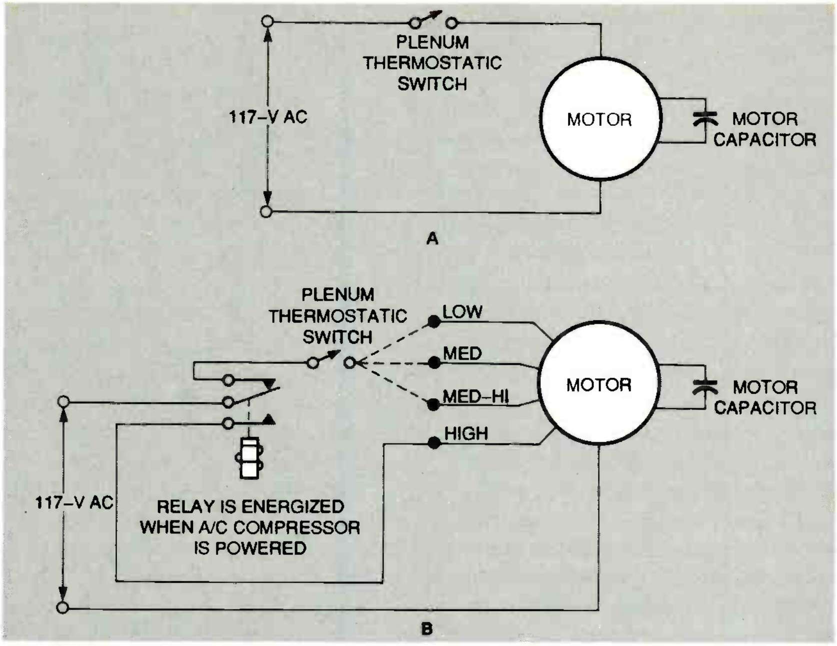


Fig. 9. Here are some typical blower motor wiring diagrams, showing a single-speed (A) and a four-speed (B) arrangement. The lower speeds in arrangement (B) are usually hard-wired to one choice, depending on the size of the house and the capacity of the furnace. The high speed is automatically selected by the air conditioner.

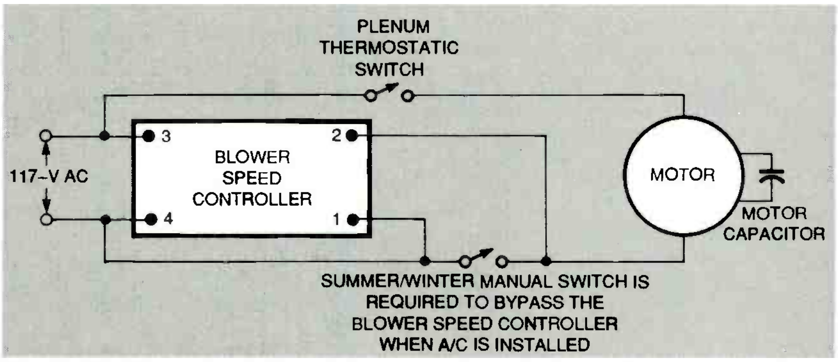


Fig. 10. The Blower Speed Control is connected to a single-speed motor system like this. If you also have air conditioning, you'll have to add the summer/winter bypass switch shown.

With 25-volts DC applied, measure the voltage at pin 5 of IC2. Adjust R4 for a reading of 3.16 volts.

Assuming that the temperature sensor is at normal room temperature (much less than 110°F), LED1 should be off. Take a hand-held hair dryer and gently heat the sensor while monitoring the voltage across R2. Do not touch the sensor with the dryer. As the sensor heats up, the reading on the meter should begin to rise. When the voltage exceeds 3.16 volts, LED1 should come on. Remove the heat. When the voltage across R2 falls below 3.16 volts as the sensor cools back down to room temperature, LED1 should turn off.

If LED1 does not light up, check its orientation. Check IC2 and IC3 to be sure they are inserted into the board as shown in Fig. 4. Try a new LED.

Disconnect the power supply. Refer to Fig. 7 and very carefully wire the circuit board, lamp, and AC power cord as shown. Double check the wiring before applying power, and be very careful not to touch any of the wiring or circuit board components.

Insert the line cord into an AC receptacle. Adjust R8, using an insulated screwdriver, over its range and note that it is possible to obtain anywhere from full to partial brightness of the lamp bulb. Set R8 so that the bulb is noticeably dim.

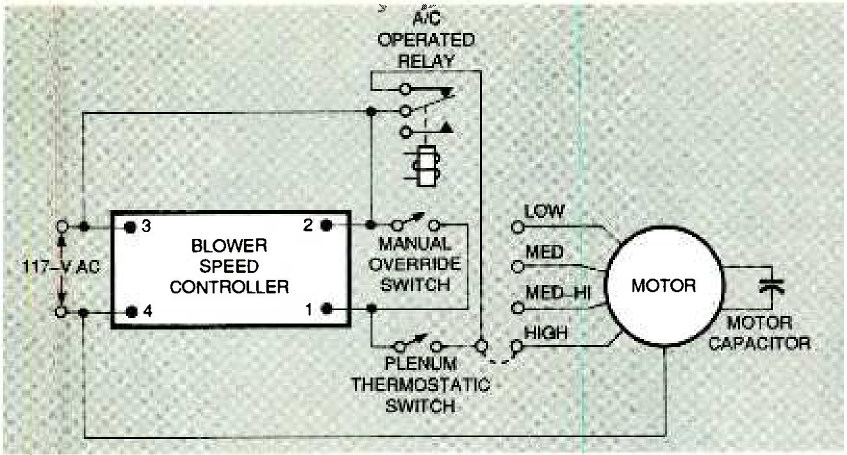


Fig. 11. The Blower Speed Control is connected to a multi-speed motor system like this. The air conditioning relay automatically bypasses the Controller during the summer. The lower speeds are no longer needed as the Controller will automatically set the blower motor's speed.

Gently heat up the temperature sensor as before, being very careful that the hair dryer does not touch the sensor. When LED1 comes on, the lamp should change to full brightness. If the lamp does not respond as described, check the orientation of the Triac. Check the circuit board for opens and shorts. If possible, try replacing IC2, IC3, D3, D4, or TR1 with new parts.

When the board is operational as described, it is ready to be installed into the furnace.

Installation. There may be literally hundreds of models of warm-air furnace in use today, so it is not possible to address each and every one. However, most furnaces will have either a single-speed or multi-speed permanent split-capacitor (PSC) blower motor (Fig. 8). Units designed to handle both air conditioning and heating will usually have a two-, three-, or four-speed motor that is automatically set to high speed for cooling and low speed for heating with a switching relay. Two such wiring diagrams are illustrated in Figs. 9-a and 9-b.

When installing the Blower Speed Control, the motor wiring should be such that it operates at maximum speed when its two input leads are powered by 117-volts AC. The phase-controlled Triac in the circuit will take over setting optimum motor speed.

Figures 10 and 11 illustrate typical wiring diagrams for single speed and multi-speed blower motors. Note that for systems that include central air conditioning, a manual summer/winter switch or an A/C-operated relay must be included as shown to provide maximum motor speed during A/C compressor operation.

Before starting any wiring, disconnect power from the furnace by throwing the circuit breaker and emergency switch off. Then locate the 117-volt input wires to the motor and disconnect them from the furnace wiring. Rewire the circuit as shown in Fig. 10 or 11, depending on which type of system you have. Connect a pair of wires from the 117-volt AC power source at the furnace emergency switch to the 117-volt AC input terminals of the Controller.

As described earlier, the temperature sensor must be placed inside, or in close contact with, the plenum of the furnace where it can respond to temperature rise. Remember, the sensor cannot short out to any metal part of the furnace. Insulate and secure the sensor at the desired location.

Final Test. If you can, obtain a narrow stem thermometer that can be placed inside the plenum to measure the plenum air temperature. Otherwise, your hand placed on the sheet metal provides a fair measure of temperature.

Set the room thermostat down as far as it will go. Turn the furnace power on. Initially, the blower should be off. Locate the blower's plenum thermostatic switch, which turns the blower on and off. Set that switch to its minimum temperature setting. The blower motor should turn on. If the plenum is too cold, operate the burner for a minute or two to warm it so that the blower will operate at the minimum temperature setting.

Using an insulated screwdriver, adjust R8 for the desired minimum blower speed. Do not set the speed too slow; check to be sure the motor is self-starting when power is applied. Once low speed has been set, you'll find the noise level in the living area is virtually non-existent.

Now turn the thermostat up so the burner operates. Monitor the temperature of the plenum. When the plenum becomes slightly warm (about 110°F) and LED1 glows, the blower should switch to high speed.

Turn the thermostat down to shut the burner off, and wait for the plenum to cool. The blower should switch back to low speed.

The final adjustment is the switching temperature of the plenum thermostat. For optimum heating efficiency, the blower motor should run when the plenum reaches about 95- to 100°F. The motor will operate at low speed, wringing every possible BTU out of the furnace plenum.

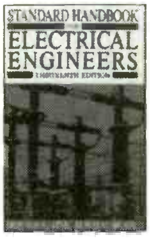
When the system has been set up as described, you will find that the furnace fan operates almost all of the time (continuous air circulation), is quiet, and provides a significant increase in your comfort level.

After operating the system through several variations in weather conditions, you may wish to fine tune the blower switching temperature (R4) and low speed adjustment (R8) to suit your individual preference. Ω

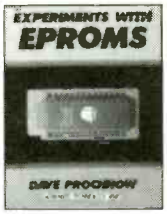
Get 3 books for only $9.95
when you join the *Electronics Engineers' Book Club®*

Plus 1 book FREE upon prepayment

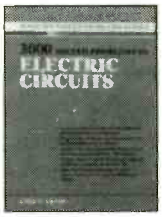
Values to $230.00



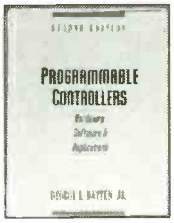
0209847-XXX **$115.00**
Since 1907, this massive handbook has been the standard by which all other electrical engineering handbooks have been measured. The collective expertise of more than 100 contributors has been assembled to make this book the most current and comprehensive electrical reference available today.
2,208 pp., 1,421 illus.
Counts as 3



156490X **$18.95**
This complete EPROM instruction manual provides a detailed explanation of underlying theory, plus 15 different projects–including programmers, erasers, and EPROM-based circuits. 240 pp., Softcover.

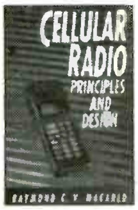


0459363 **$22.95**
Fine-tune your electric circuit skills. You'll cover units and basic concepts, resistance and Ohm's Law, series and parallel resistive circuits, Kirchhoff's Laws, network theorems, waveforms and circuit relationships, magnetically coupled circuits, resonance, frequency response and filters, and much more. 765 pp., Softcover.



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

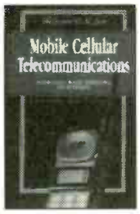
0289778-XX **$56.00**
Unleash the power of controllers with this guide. You'll see how a controller can be used in antilock brakes, cash registers, and robotic systems. You get details on controllers such as the Motorola 8-bit MC68HCII, and the 32-bit Intel 8051 and 80960CA to help you use devices in your projects. 350 pp., 125 illus.
Counts as 2



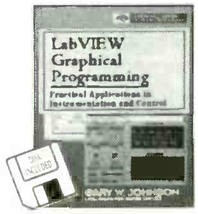
0443017 **$50.00**
This book provides complete coverage of the principles and design techniques for cellular systems. Gain a firm understanding of some of the most advanced person-to-person communications systems being installed today with this comprehensive look at modern cellular technology. 224 pp., 142 illus.

0239193 **$27.95**
This practical guide focuses on the specific digital circuits used in electronic power applications. It presents state-of-the-art approaches to analysis, troubleshooting, and implementation of new solid-state devices.
272 pp., 197 illus.

0240620 **$45.00**
Examine all aspects of radar, from its history and development, through components and theory, to installation, maintenance, and repair techniques. Topics covered include transmitters, modulation techniques, Rf generators, waveguides, antennas, receivers, MTI Theory of Operations, indicators, ancillary and auxiliary equipment for radar installations, and more.
304 pp., 232 illus.

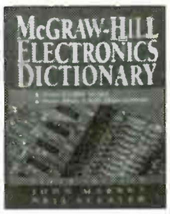


0380899-XX **$60.00**
Find a complete technical description of the design, analysis, and maintenance of cellular systems in the second edition of this classic reference. It features new chapters on the CDMA standard, microcell systems, digital cellular systems, and more.
550 pp., 170 illus., *Counts as 2*



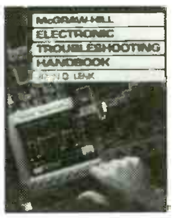
0326924 **$45.00**
Put LabVIEW to work solving your specific instrumentation problems on all platforms available to LabVIEW: PC/Windows, Macintosh, and Sun SPARCstation. Outlines a logical analysis methodology, detailing how to define each problem and then showing how to establish a solution.
546 pp., Illustrated.

0359687 **$65.00**
Keep up on the standards, services, architectures, applications, markets, and key players with this reference. It emphasizes the asynchronous transfer mode (ATM) technology, its protocol, and its switching/ working environment. Details technologies that will be the future of broadband communications in transmission and switching domains.
544 pp., 300 illus.



0404348 **$49.50**
More than 14,000 entries and 1,500 illustrations make up this reference. It is perfect for anyone who's seeking complete, up-to-date definitions for hundreds of electronics terms. Plus, it's the only dictionary that focuses on the words and phrases specific to the field of electronics, engineering and computer science.
608 pp., 1,500 illus.

0717753 **$19.95**
Become self-employed as a security systems contractor–this book shows you how. Woodson helps you decide whether you are cut out to run your own business and covers every aspect, from start-up capital to collecting past-due accounts.
304 pp., 150 illus., Softcover.



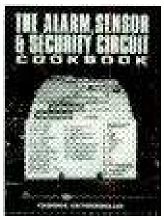
0376581 **$39.50**
Pinpoint component faults and correct design flaws for virtually every type of electronic circuit with this handbook. Both circuit theory and step-by-step troubleshooting techniques are given for each circuit or component. All kinds of electronic circuits and basic components are covered as well as complete coverage of electronic equipment.
350 pp., 200 illus.

005147X-XX **$65.00**
This simple-to-use book walks you through every aspect of analog and digital voice/data communications technologies, from the invention of the telephone and the use of Telset through the evolution of today's high-tech digital services, using easy-to-understand terminology so you can fully comprehend each topic. 656 pp., 350 illus.
Counts as 2

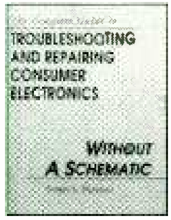
0628432 **$60.00**
Covers the latest high-potential systems, such as Pentium, PowerPC, DEC Alpha, and SuperSPARC, and others. Beginning with the basic architecture principles related to advanced microprocessors, the second edition moves into detailed descriptions of CISC and RISC machines.
580 pp., 155 illus.

0100926 **$24.95**
Understand the basics of receiver operation, the proper use and repair components in RF circuits, and principles of radio signal propagation from low frequencies–all with this guide. 416 pp., 411 illus., Softcover.

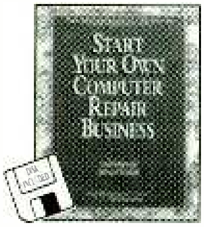
911525X **$50.00**
Packed with sample circuit simulations that illustrate a variety of common problems and their solutions. Shows you how to deal with the stumbling blocks of nonconvergence, numeric integration instabilities, and timestep control errors.
208 pp., 200 illus.



0497060 **$29.95**
Construct sophisticated security, convenience, and entertainment devices with this guide. You'll find schematics, photos, and instructions for building temperature and pressure sensors, smoke and toxic gas detectors, a remote video control system, door and window alarms, motion and impact detectors, and more!
304 pp., 232 illus.

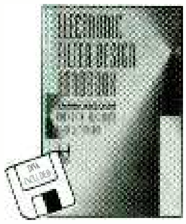


0156492 **$34.95**
Tackle troublesome circuits without the benefit of a schematic with these tricks of the trade by a veteran electronics technician. You'll see how to locate, test, and repair defective components in virtually every type of consumer electronics device imaginable. 304 pp., 250 illus.



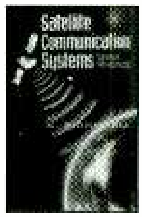
9119018 **$32.95**
Turn your repair skills into profit with this guide. It offers information on everything from computer parts and tools to pricing and advertising. It covers areas of specialization, profiles auxiliary services, and even predicts future opportunities. The shareware disk packaged with the book includes a collection of diagnostic tools. 352 pp., 63 illus., Softcover.

0209820-XXX **$110.00**
From classic theory to contemporary practice, this is the standard desktop reference to the entire range of electronics engineering. You get over 2,400 pages of design and cost-cutting solutions from more than 170 authors. 2,528 pp., illus.
Counts as 3



0704414-XX **$79.50**
Still the number one resource for designers in the field, the third edition of this classic handbook has been extensively revised and updated to reflect the enormous recent advances in electronic filter design ... while maintaining the overall emphasis on practicality that made prior editions so appealing. 704 pp., 220 illus.
Counts as 2

0180318 **$55.00**
Turn to this reference for practical, problem-solving techniques. This heavily illustrated guide covers all aspects of power supply use, causes of poor power quality, monitoring and analyzing abnormal voltage and currents, utility and end-user strategies, and more. 448 pp., 220 illus.



0523746-XX **$55.00**
This book provides an in-depth look at the basics of designing the elements and components that comprise a satellite communication system, including the geosynchronous satellites prevalent in mobile communications. 400 pp., 120 illus.
Counts as 2

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

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

All books are hardcover unless otherwise noted. Publishers' prices shown. If you select a book that counts as 2 choices, write the book number in one box and XX in the next. If you select a book that counts as 3 choices, write the book number in one box and XXX in the next 2 boxes. A shipping/handling charge & sales tax will be added to all orders. ©1996 EEBC

If card is missing, write to: Electronics Engineers' Book Club
A Division of The McGraw-Hill Companies
P.O. Box 549, Blacklick, OH 43004-9918

Phone: 1-614-759-3666
(8:30 A.M. to 5:00 P.M. EST Monday-Friday)
FAX: 1-614-759-3749
(24 hours a day, 7 days a week)

ELECTRONICS ENGINEERS'®
BOOK CLUB

A Division of The McGraw-Hill Companies, P.O. Box 549, Blacklick, OH 43004-9918

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

☐ Bill me (FREE book not available with this payment option.)

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

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

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

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

Code # of my FREE BOOK: SINGLE SELECTION ONLY

☐ Check or money order enclosed made payable to: The McGraw-Hill Companies
Please charge my: ☐ VISA ☐ MasterCard ☐ American Express ☐ Discover

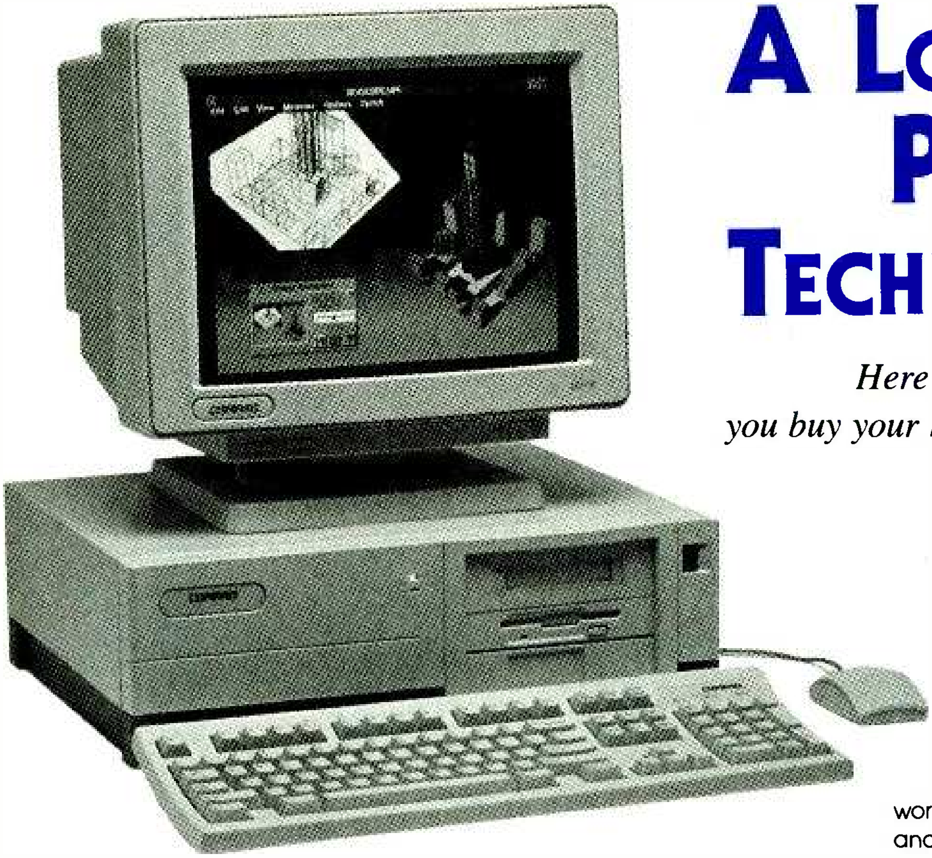
Acct. No. ____________________ Exp. Date ________

Name ____________________ Signature ____________________
(required on all orders)

Address / Apt.# ____________________

City/State/Zip ____________________ Phone ____________________

Offer valid for new members only, subject to acceptance by EEBC. U.S. orders are shipped 4th Class Book Post. Canada must remit in U.S. funds drawn on U.S. banks. *Canadian orders are shipped International Book Post–add $12.50 shipping/handling. Applicants outside the U.S. and Canada will receive special ordering instructions. A shipping/handling charge & sales tax will be added to all orders.
DRE1296



A Look At PC Technology

Here's what to look for when you buy your next personal computer.

MARC SPIWAK*

With the holiday-shopping season fast approaching, one item high on many lists might be a new personal computer. Unfortunately, even for the technically savvy, the process of purchasing a PC could be a daunting experience.

First and foremost, the rate of evolution in PCs is unlike anything you will encounter in any other area. Regardless of what you buy, or when you buy it, in six months, at the latest, something flashier, faster, or cheaper is sure to be on the shelves. It doesn't make what you purchased obsolete, but it is sure to lead to many cases of "buyer's remorse."

So how do you keep up, let alone stay ahead when it comes to computer technology? The first rule is "don't blink." The second is to be aware of the state-of-the-art for the moment, and what is scheduled to come down the pike in the near future.

In this article we will attempt to bring you up to date on the current (at least at the time this was written) and future state of PC technology. However, remember that this is only an overview; space prevents us from going into great detail. If you need or want further information, you should make a point of perusing the usual computer magazines, or visit some of the many resources available on the Internet.

Once you've read this article and done any further research you feel is needed, keep one thing in mind: Don't let your awareness of what's to come paralyze you if you *need* (as opposed to want) a new computer now. Announced new technologies are almost never released on time, and some never materialize at all. And even when they are released, it usually takes some time for standards and implementations to finally settle down, and for any bugs to be found and dealt with. Early adopters often learn what the term "bleeding edge" means from personal experience.

The CPU. Today's processors of choice are the Pentium and the Pentium Pro. Despite its attractive price, the day of the 486 (if you can find one) is over. Some newer software won't even run on it (or will run poorly at best). As far as CPU speed, look toward a 133-MHz unit as a minimum; the cost savings for slower systems will not be worth the trade-off in performance, and software usability could become a problem down the road.

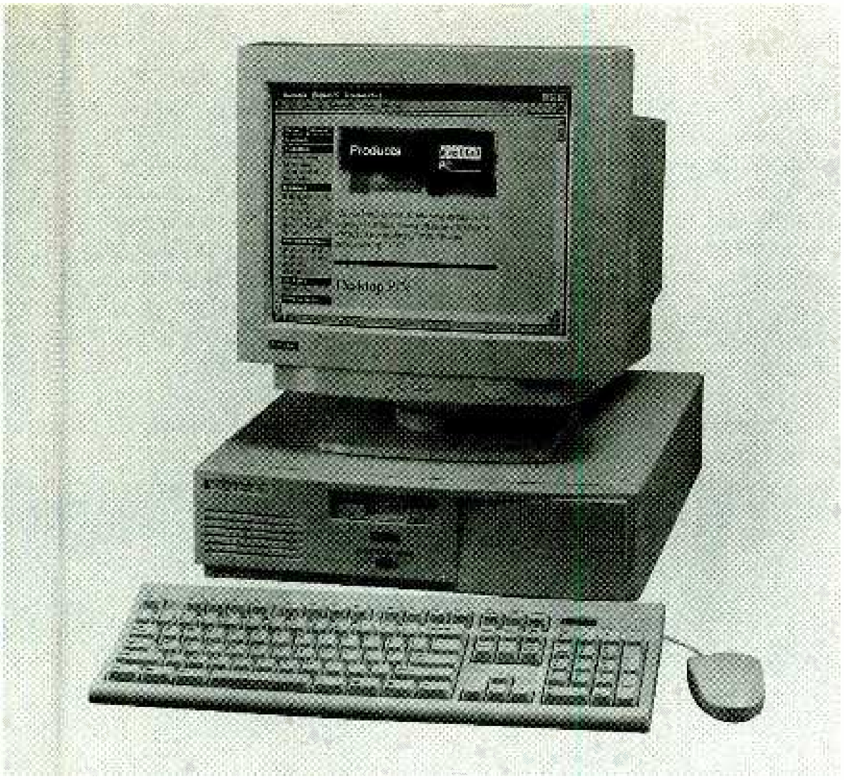
Another cost/performance issue to keep in mind is that, unless you are doing a lot of calculations, stay with PCs that use a 66-MHz system (external) bus (100-, 133-, 166-, or 200-MHz). The other popular Pentium models (120- and 150-MHz) are based on a 60-MHz system bus. In short, despite the fact that its CPU runs faster, a 150-MHz PC does not perform appreciably better than 133-MHz model when running most commercial software applications due to its slower system-bus speed.

If you are more into power with an eye toward the future, you'll want to consider a Pentium Pro. The Pentium Pro is a superpipelined design with the same built-in Level-1 cache as the Pentium and a built-in Level-2 cache.

If you are considering going with the Pentium Pro, you'll want to consider running Windows NT. It's a true 32-bit operating system that wrings out the best of the Pentium Pro. In fact, there is a performance penalty if you run Windows 95 (a pseudo 32-bit operating system) on a Pentium Pro (although it will still perform well). Remember, however, that NT will not run all Windows 95, Windows 3.x, or DOS software.

What about future developments?

*Technical Editor, Windows Magazine



This DEC Venturis FX personal computer features a Pentium processor, EDO memory, and a pipeline-burst cache. It also features a "tool-less" case that is easier to open than traditional cases.

There has been a lot of excitement over an Intel technology called MMX. MMX, or Matrix Math eXtensions, is to be incorporated into all CPUs from Intel sometime next year. It is the first major change to the x86 instruction set in a while and should, among other things, improve the performance of multimedia applications, mainly audio and video (that's why MMX is erroneously called multimedia extensions by many).

Will the introduction create a glut of non-MMX systems on store shelves? Perhaps. Should you wait for MMX? Well, lets just say that MMX was originally slated to be introduced at the end of this year but has been delayed—remember what we said earlier about the reliability of introduction schedules!

Motherboards. While few people ever mention the motherboard that's inside their system, that major piece of hardware that glues everything together can make the difference between a good system, a great system, or a mediocre (or worse) one. As long as you stick with reputable manufacturers, flaky motherboards are very rare these days. However, a good motherboard design can make the inside of a PC neater and let it accommodate peripherals more easily as well.

The long-time standard Baby-AT motherboard design is being replaced by Intel's new ATX motherboard specification. The Baby AT design often made memory modules difficult to reach and CPU placement blocked long expansion cards from some of the slots. ATX motherboards are rearranged so that the slots aren't blocked and memory is easily accessed.

The motherboard also houses the chip set that basically orchestrates the operation of everything attached to the motherboard. Intel's popular Triton chip set is being phased out by the newer 430HX and 430VX chip sets. The HX is intended for high-end systems and supports more memory and dual processors; the VX is intended more for home systems. Interestingly, however, Intel boards that use the VX chip set are the first to support super-fast synchronous DRAM (SDRAM) memory (more on that later); Intel's HX boards do not.

Buses. The Enhanced Integrated Drive Electronics, or EIDE bus has taken over IDE's position as the bus of choice for storage devices including hard drives, CD-ROM drives, and tape backups. Today's systems can support up to four EIDE controllers, and each controller can support two devices, up to a maximum of 8 devices per system. Most motherboards come with two integrated controllers. The newest mode-4 EIDE drives have a maximum throughput of around 13 MB-per-second; older mode-3 drives have a maximum throughput of 8 megabytes.

If you are interested in the greatest possible flexibility, SCSI (Small Computer Systems Interface) is the storage-device controller of choice. That single controller can control up to 7 devices. Fast SCSI has an 8-bit bus and a throughput of 10 MB-per-second, while Fast/Wide SCSI has a 16-bit bus and transfers up to 20 MB-per-second. In real-world applications, SCSI offers very little in the way of added performance over EIDE—you won't notice a difference between the two in actual use with mainstream software. However, SCSI is necessary for specialized equipment such as extremely fast hard drives or disk-drive arrays, and for CD-R (CD-Recorder) drives that, for the moment, only come in SCSI form. And once installed, SCSI can simplify the task of adding additional peripherals such as scanners and tape-backup units. One possibly useful feature of SCSI is that a good adapter will allow you to choose your boot device (handy if your main drive dies during a critical job).

The PCI (Peripheral Component Interconnect) bus is the chosen bus for today's fast graphics accelerators and network cards. You won't find a hot graphics accelerator that's not a PCI model. The VESA Local Bus (VLB) has disappeared, having been phased out by PCI. The ISA bus is still used by a lot of common peripherals, and so ISA expansion slots are still standard on motherboards, at least for the time being.

Although there's not a lot you can do with it yet, the Universal Serial Bus (USB) has started to show up on some motherboards. That bus can transfer up to 12 megabits-per-second, and is intended for low-speed devices such as keyboards, cameras, and input devices.

On the horizon is the IEEE 1394 interface, or FireWire. That high-speed connection of up to 400 MB-per-second—to start with!—is intended for applications such as digital video.

Memory. A PC uses different types of memory in different places. Dynamic Random Access Memory, or DRAM, is basically the place between the hard drive and the CPU where programs and other data load into. The more DRAM you have, the better off you are—to a point. DRAM is supplied in the form of memory modules that mount on the computer's motherboard along with the CPU.

Fast Page Mode DRAM (FPM DRAM), the last hot development in memory, has largely been phased out by the newer Extended Data Out RAM (EDO RAM). Basically EDO RAM eliminates wait states by keeping its output buffer active until the next access, rather than turning it off. That helps to speed up its operation. Look for EDO RAM in your next PC, or even faster Burst EDO RAM (BEDO RAM).

The next hot development (available now on Intel motherboards that make use of the VX chip set) is Synchronous DRAM (SDRAM). The biggest advantage that type of memory offers is that it runs off the same clock as the CPU (hence the name synchronous). Interestingly, SDRAM memory is not housed in standard SIMMs (Single In-line Memory Modules), but rather 168-pin DIMMs (Dual In-line Memory Modules).

Turning our attention elsewhere, secondary cache memory, or Level-2 cache, consists of very fast Static RAM (SRAM) that holds data that the CPU uses frequently. That way the CPU doesn't have to deal with the slower DRAM as often. A secondary cache is usually some type of module that mounts on the motherboard, as opposed to a primary cache that's built right into a Pentium CPU. That secondary cache is vital in the design of a fast system. Inexpensive systems sometimes come cacheless, but that is not the right way to save money. The memory type of choice today for a Level-2 cache is pipeline burst. Look for at least a 256K pipeline-burst cache on your next system, or even better a 512K cache, which has become the standard size in high-end systems.

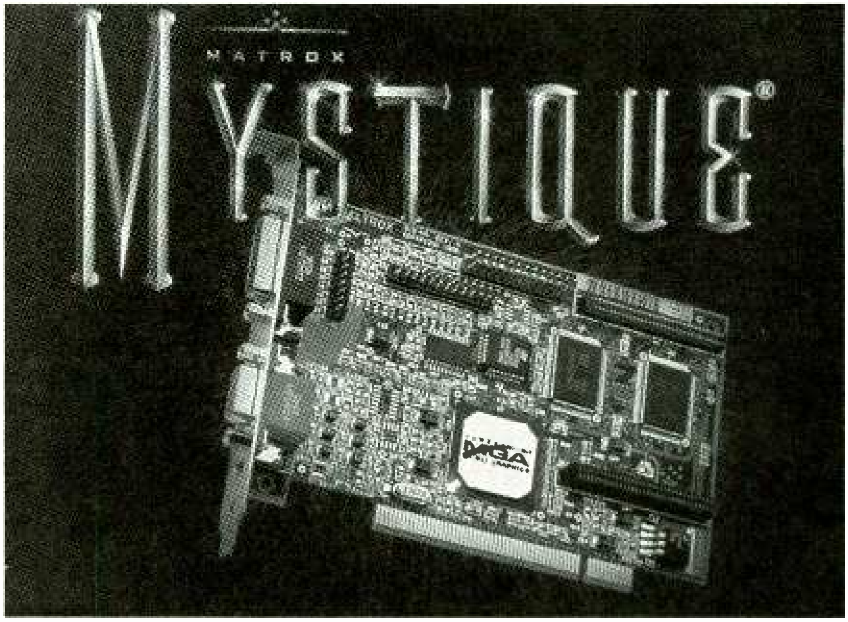
Hard Disk. Aside from the recent move to EIDE technology, the most startling development in hard drives is how far their prices have fallen in recent years. Considering the "bloatware" world of Windows 95, that's fortunate. For today's software, anything less than 1 gigabyte must be considered small. Look for a minimum of 1.6 gigabytes, and if your budget allows (the price difference is relatively small), 2 gigabytes or larger. You might think you'll never fill that up, but once you've experienced Windows 95, you'll realize that you eventually will!

What about SCSI drives? As mentioned earlier, most users will not notice an appreciable performance difference over EIDE. However, if the system bundle you are purchasing includes a SCSI controller, it might pay to spend the extra money for a SCSI hard drive.

If you are planning on doing video editing on your new PC, look into a system that's specially tailored for it. That means the system should include an AV hard drive that spins very fast and has special features added, along with other specialized hardware.

Graphics Accelerator. Any good computer deserves a fast graphics accelerator. Without one, the computer's CPU (regardless of type) will quickly become overtaxed, greatly slowing down the entire system.

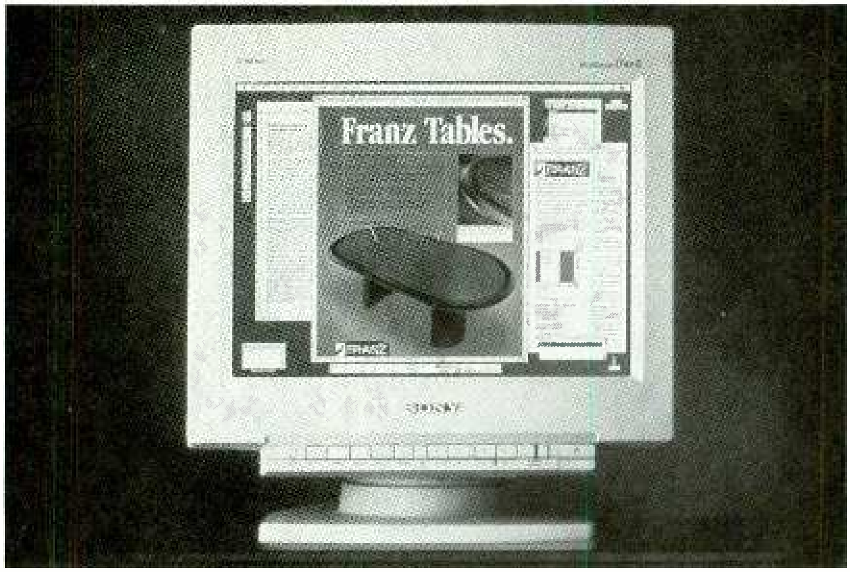
The bandwidth of a graphics card dictates how fast data can be passed through it. When a video card is said to be "64-bit" or "128-bit," that refers to the data bus between the accelerator chip and the video memory on the card itself. The wider the bus, the faster information can get into memory. However, a well designed 64-bit card can beat a lesser 128-bit card, so systems containing 64-bit cards should not necessarily be overlooked.



The Matrox Mystique is one of the newest generation of video cards. That 64-bit PCI card offers 3D acceleration, which is great for games and other applications.

Video memory holds picture information. The more pixels on your screen, or the higher the resolution (640 × 480, 800 × 600, 1024 × 768, etc.), the more memory is needed. More colors also require more memory. A card with 2 MB of video memory can display only up to 65 thousand colors in a 1024 × 768 resolution, whereas a 4 MB card can display the full 16.8 million colors (true color) in the same resolution and even higher. A card with only 1 MB of video memory—unacceptable by today's standards—is too limited in what it can display.

Make sure the system you buy comes with a graphics accelerator that has at least 2 MB of memory, with 4 MB becoming standard for high-



To really see windows in Windows 95, go with a 17-inch unit such as this Sony Multiscan 17seII.

end systems. The least expensive type of memory used on graphics accelerators, DRAM, is also the most common. VRAM, or Video RAM, is more expensive and faster than DRAM. Better accelerators will come equipped with VRAM, and some now come with EDO RAM.

Finally, make sure that the card you select supports refresh rates above 75 Hz. Otherwise, flicker, and the eye strain that results from it, could be a problem.

What about video? Today, any good graphics accelerator will speed up and smooth out desktop video, and allow the image to be scaled to any size without hurting performance. Of course, better video accelerators do a better job of handling video. As for MPEG video, most cards can handle it adequately using software MPEG players. For more demanding applications, some high-end systems come with hardware MPEG decoders that allow high-quality playback of MPEG video.

The new hot thing in video are the 3D graphics accelerators. Those cards do a better job of handling textures and manipulating 3D images, and are dynamite for game applications. One problem with them is that the technology is not yet mature and there are some still unresolved standards issues.

Monitors. While 15-inch and smaller models are certainly available, and attractively priced, if economics allow, you should limit your monitor selection to 17-inch and larger screen sizes. The increase in screen size, even from 15 inches, is more beneficial than you might imagine. You can actually use windows within Windows! Also look for a monitor that supports refresh rates above 75 Hz and has a dot pitch of 0.28mm or less. The new plug-and-play monitors can communicate with a plug-and-play graphics card, allowing the card to set parameters such as refresh rate and resolution for maximum performance.

Finally, the best high-end monitors give the user plenty of control over picture parameters. Among the controls you might find on such a monitor is an adjustment for pincushioning, which lets you straighten the sides of a display if they are bowed in or out, or one for color temperature. That last setting lets you match the colors you see on the screen to the output of your color printer, or to an industry color standard for desktop-publishing applications.

CD-ROM Drives. Gone are the days when CD-ROM drives were cranky, expensive luxuries with SCSI or proprietary interfaces. Today's 8 × EIDE drives often sell for under $200, and even less when included in a system bundle. And one is no longer a luxury—many software packages ship on CD-ROM, and once you've installed an application from a CD-ROM, you'll never want to do it from floppies again.

By the time you read this, some high-end systems should be shipping with SCSI CD-R drives. Note that the fastest CD-R drives currently available is 4 ×; as time goes on, faster models are sure to be available.

The next big thing in CD technology will be the Digital Versatile Disc (DVD). Once slated for delivery by the end of 1996, its introduction has been delayed until this spring, at the earliest. The double-sided, double-layer DVD discs look like regular CDs, and the players will be backward compatible, but each disc will store up to 17 gigabytes. The medium is also recordable, which is great for computer applications, but has caused concern among music and video providers and contributed to the introduction delay.

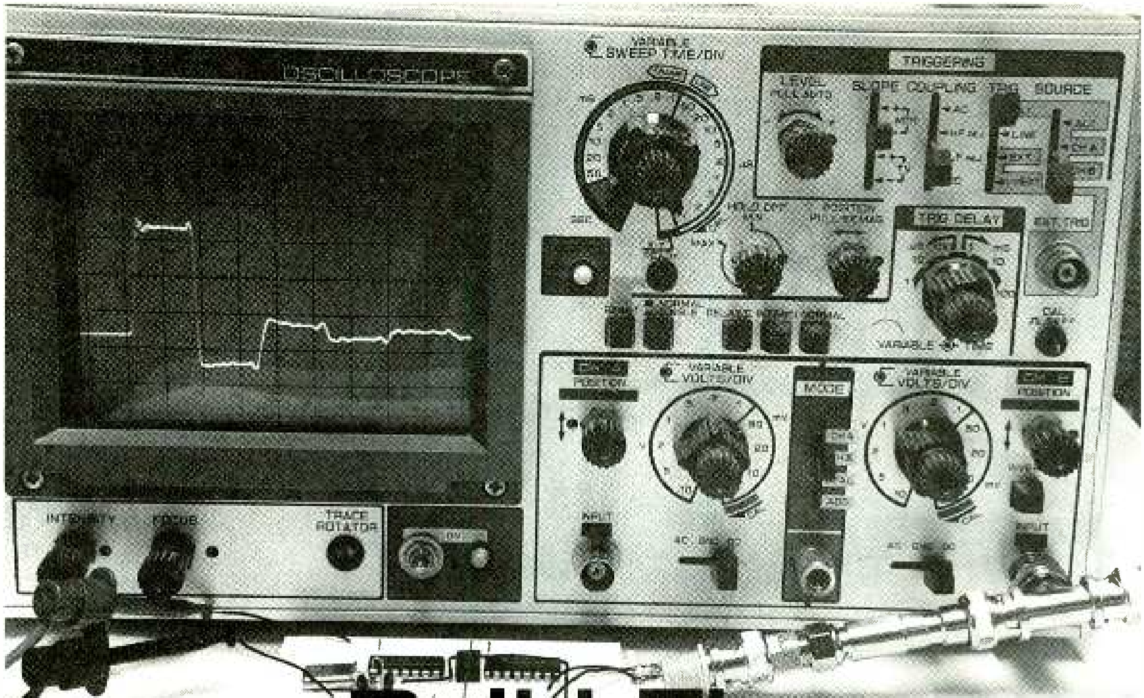
Sound Cards. Sound cards can be separated into two basic types: FM synthesis and wavetable. FM synthesis cards, as their name implies, synthesize music and sound using hardware on the sound card. Wavetable cards, on the other hand, use actual samples of musical instruments stored in memory. Those cards are more expensive than FM synthesis cards, but sound a lot more realistic and pleasing to the ear, at least to most. High-end sound cards will have more on-board memory for sample storage.

Another sound-card variation are the 3D sound cards that trick you into thinking that more speakers are being used or that you are in different locations by digitally manipulating the sound. Finally, when selecting your sound card, make sure it is compatible with the major manufacturers (*i.e.* SoundBlaster) to avoid configuration hassles down the road.

Of course, regardless of the type and quality of the sound card, it will only sound as good as the speakers allow. For full audio range, you might want to consider one of the subwoofer/satellite speaker combinations that are now available.

Modems. A lot of fun and valuable information is tucked away on the Internet and online services, and you need a modem to get at any of it. The modem of choice these days is a true

(Continued on page 114)



Build The CABLE REFLECTION TESTER

Need to test a damaged or suspect coaxial cable? This handy circuit will do the trick without sending you to the poorhouse for buying expensive equipment. If you supply the oscilloscope and about five bucks for parts, we'll supply the know-how.

JAMES E. CICON

You have a spool of coaxial or twin-lead cable and want to know how long it is. Unwinding the cable would be impractical.

After a rainstorm, you sometimes lose the picture on your television set. You figure that the satellite-TV antenna cable probably has a crack in the insulation somewhere along its length. The problem is that the cable is over 250 feet long. It snakes through your walls, across your roof, and then drops down underground for the run to the dish. It would be nice to know how far down the line the crack is.

Your local-area network at work goes down whenever a certain machine is brought on-line. The installation techs say that the LAN administrator has the software configuration fouled up. The LAN administrator says the installation techs had been working too much overtime when they hooked up that particular machine. Can you pinpoint who is right?

Televisions, computer networks, CBs, ham radios, cellular telephones—all of those devices send or receive information using electrical waves that might travel through a cable for at least some distance. If the cable is damaged, defective, or the wrong type for the job, the original signal traveling down the cable will become garbled. That will cause poor picture reception on a TV, data collisions on a LAN, and other problems. Wouldn't it be great if you could easily and quickly diagnose the cause of those types of cabling headaches?

There is an instrument that can do just that. It's called a "Time Domain Reflectometer," or TDR. A TDR can tell you many things about the health of a cabling system. It can quickly and easily tell you the length of cable. It can also tell you if there is an impedance mismatch (such as two different types of cable spliced together) on a cable. It can help you locate a fault in a cable such as a break or a short circuit. A TDR has only one real drawback—its price tag. You can easily pay thousands of dollars for one.

But there is a less expensive alternative. In this article we're going to show you how to build and use the Cable Reflection Tester, or C.R.T. for short—a device that will let you see the effects of the various cable faults mentioned before. Not only does the C.R.T. demonstrate some very interesting properties of electrical waves from a purely academic standpoint, but the project has a very practical side. We'll take you through a few experiments to demonstrate how to use the C.R.T. to measure the length of a cable, and to determine the health of a cable.

Using the C.R.T. requires an oscilloscope, and a handful of inexpensive parts for the C.R.T. itself. If you don't already have most of the parts on hand, you can probably buy them for less than $5. The prototype was originally built and tested on a solderless breadboard. If you really like the C.R.T., there is no reason not to mount it permanently inside the oscilloscope. You could then tie it into the oscilloscope's power supply and be able to use it wherever and whenever you wish.

A fancy scope is not needed for the C.R.T. The scope used here is a beat-up 35-MHz model that is over ten years old. It has been through a flood and dropped several times. Despite the abuse, it works surprisingly well with the C.R.T.

Background Theory. The time-honored way to understand how electricity works is to think of electricity as water and wires as pipes. That mental image has helped many students to understand electrical phenomena, and is also one that is very useful in explaining how the C.R.T. works. The analogy is not perfect and breaks down if pushed too far, but for our needs, it still has a lot of value.

Imagine spilling a glass of water into a tray. The water will start to spread out over the bottom of the tray until it comes to a side. While it is spreading, the puddle will have some depth. That depth depends on how fast the water is being poured into the tray and how fast the water can spread out to fill the tray. Water clings better to some surfaces than to others. If you are pouring the water into a tray made of a material to which water clings, the water will spread more slowly, and the resulting depth of the puddle while it is spreading out will be deeper.

That "clinginess" is a feature of the material of which the tray is made. It "impedes," or restricts, the flow of the water. You could call the clinginess of a tray its *characteristic impedance*. How fast the water spreads across the tray (its *velocity factor*) largely depends on the tray's characteristic impedance. To compare the velocity factor of one tray to another, you could pick one tray as a standard. If water spreads half as fast in one tray than in the tray that is the standard, you could say that the velocity factor of the tray under test is 0.5 or 50%.

What happens when the water reaches the side of the tray? It will slosh back, of course. Ripples will travel back from the side to the center where the water is being poured into the tray. The level of the water in the tray will now start to rise. Remember that before the water reached the side of the tray, the level of the water was determined only by how fast the water could spread out. Now the level of the water is determined by how much water you pour in. Another way to think of it is that, at first, the water level is determined by the characteristic impedance of the tray. After all the waves and ripples have settled down, the level is determined by what the original potential of the water was to fill the tray.

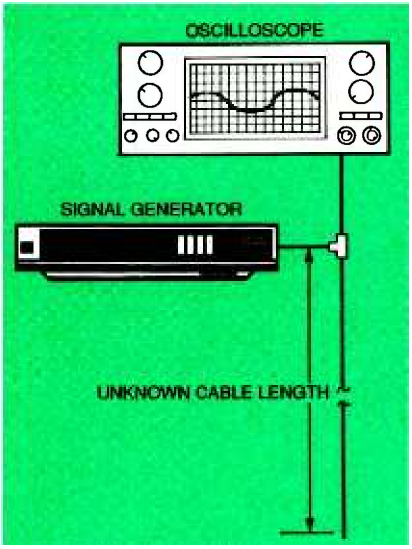


Fig. 1. This setup will let you easily measure the length of a cable without using a tape measure. Connect a signal generator to one end of the cable and measure the amount of time it takes to see the steps in the waveform on an oscilloscope.

Let's say that you want to know the distance from the center of the tray to the side of the tray. However, you are limited to two measurements: the height of the water in the center of the tray, and time. You also know the tray's velocity factor.

To find out how far the side of the tray is from the center where you are pouring water in, you could start pouring water into the center. Keep an eye on the height of the water in the center of the tray. The water height will stay constant for a while and then start to rise. Time how long it took for the water to start rising from the moment you started pouring the water in. That is the time that it took the water to reach the side of the tray plus the time it took for the returning wave to bounce back to the center.

Divide the time in half, and then multiply that result by the tray's velocity factor. That gives the distance from the center of the tray to its nearest side. If you are wondering why you divided the time in half, it is because the water traveled out to the side of the tray and then back again, actually traveling twice the distance you want to measure.

We can take that procedure and express it as an equation:

$$L = t/2 \times V_f \times V_r$$

where L is the distance to the side of the tray, t is the time for the wave to travel to the side of the tray and back again, V_f is the tray's velocity factor, and V_r is the velocity of a wave traveling in the reference tray.

How the C.R.T. Works. The C.R.T. works in a very similar way to the example of pouring water into a tray. Substitute the pouring water with a signal generator and the tray with a cable. Instead of watching the water level with your eyes, use an oscilloscope to help you monitor the electrical voltage level on the cable. Figure 1 shows the basic block diagram of the C.R.T.

When a squarewave from the signal generator goes high, you will see that on the oscilloscope. Notice that the voltage level doesn't immediately rise to the level that the signal generator is producing. It initially steps to some intermediate value. After a short delay, the level changes to either a higher level or a lower level, depending on whether the far end of the cable is open- or short-circuited. That will show up as a stair-step waveform on the oscilloscope.

Let's think about why that happens. The first step in the waveform is equivalent to just starting to pour the water into the tray in our example. The voltage level is determined largely by the characteristic impedance of the cable. If the end of the cable is open, the voltage wave has nowhere to go when it reaches the end of the line. That is the electrical equivalent of hit-

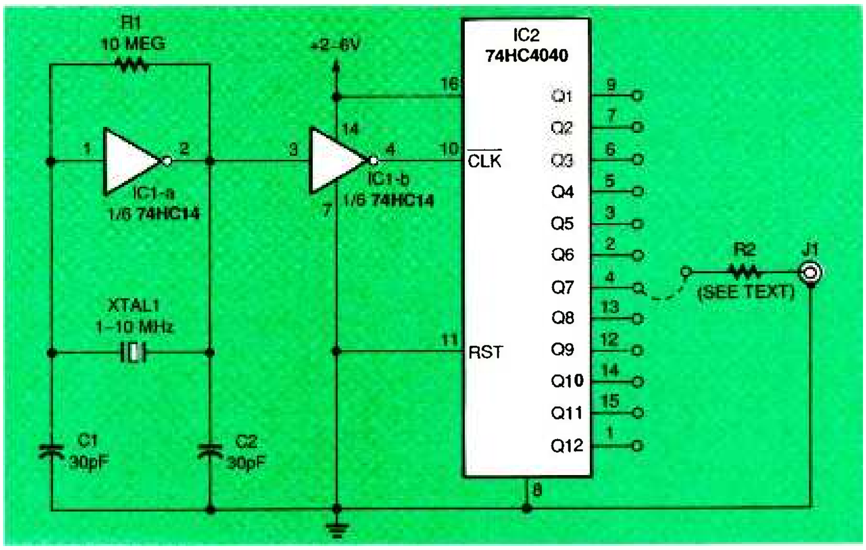


Fig. 2. Here's the schematic diagram for the Cable Reflection Tester. The components shouldn't cost more than $5, and it can be built up on a solderless breadboard in only a few minutes.

TABLE 1

Cable Type	Velocity Factor	Characteristic Impedance
RG-58/U	66%	52 ohms
RG-59/U	66%	75 ohms
RG-6/U	75%	75 ohms
RG-8/U	66%	52 ohms
RG-8/M	75%	52 ohms
RG-174	66%	50 ohms
RG-62A/U	84%	93 ohms

ting the wall of the tray and the voltage wave is reflected back, which is seen as a second step up as it reaches the scope. Eventually, after all the ripples settle down, the cable "fills" up, and the final voltage level is equal to the level being produced by the signal generator.

If, on the other hand, the end of the cable is shorted, something different happens. The water analogy does not work as well as when the cable is open. As the signal generator drives the line high, the initial step up will appear on the scope as the voltage wave starts to travel down the cable. When the wave gets to the end of the cable, it sees a short circuit. Electrically speaking, the short circuit acts like a reverse wall. The wave striking it is bounced back upside down, canceling out some or all of the forward-traveling wave. When that negative-traveling wave finally travels back to the scope, it will be seen as a step down.

Those stair-step waveforms can be used in many different ways. You can measure the width of the first stair step to determine the length of the cable. Remember that the width of the first stair step is the time it takes the initial wave to travel to the end of the line and back, just like measuring the length of the tray in the water analogy. The other thing you can determine is if the end of the line is open or shorted. We'll do those experiments later. First, we need to build the C.R.T. itself. Generating and viewing the waveforms on an actual cable is a lot better than just talking about them.

Designing and Building the C.R.T.

The C.R.T.'s design is so simple, building it is almost trivial. All we need is a squarewave signal generator that has a very short rise time. A crisp squarewave will result in nice, sharp stair-step display, making it easier to see the effects that we're looking for. The schematic in Fig. 2 shows how simple the design actually is.

Integrated circuit IC1-a is an inverter. It is the active component in an oscillator that generates the C.R.T.'s squarewave. The rest of the oscillator consists of R1, XTAL1, C1, and C2. Resistor R1 provides a DC feedback path for IC1-a. The value of R1 is not critical, but should not be too large. The suggested value of 10 megohms will work quite well. Capacitors C1 and C2 stabilize the oscillator, and their values are also not critical, but should be between 10 and 60 pF. The smaller their value is, the more quickly the oscillator will start, but the less stable it will be. XTAL1 sets the frequency of the oscillator. Its value is also not critical, but should be between 1 and 10 MHz for good results.

The output of IC1-a is buffered by IC1-b and fed to IC2, whose purpose is to divide the signal frequency down so that cables of various lengths can be measured. Without IC2, the reflected waves in very long cables may not return in one complete oscillator cycle. By slowing the clock frequency down with IC2, it is easier to measure longer cables. If you are only working with short cable runs, it might be possible to omit IC2.

The oscillator is matched to the cable being tested with R2. Its value should be equal to the characteristic

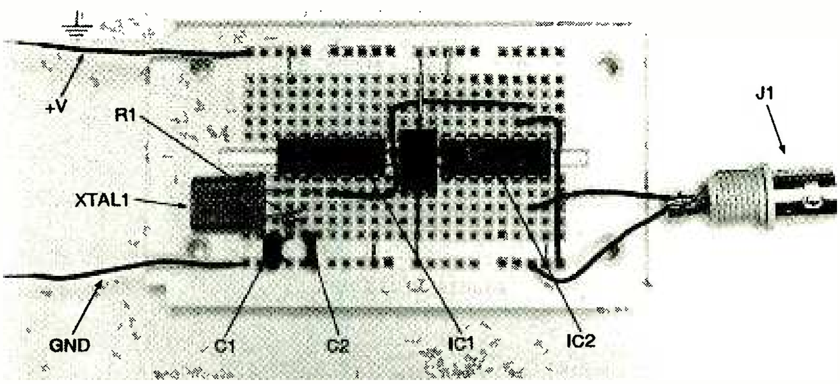


Fig. 3. If you want to build the C.R.T. on a solderless breadboard first, you can follow this photo as one way to locate the components. Resistor R2 is not being used in this version of the C.R.T., and an additional .01–0.1-µF capacitor has been added between IC1 and IC2 to smooth out the power supply from ripples caused by the integrated circuits.

impedance of the cable being tested. That match helps prevent multiple reflections, and helps make the stair-step response easier to see. Resistor R2 is not absolutely needed, especially if you are concerned with only the first step of the stair-step waveform.

All of the components for the C.R.T. can be mounted on a small breadboard. The photograph in Fig. 3 shows both the completed prototype and placement of the parts. Assembly can be finished in 5 minutes or less. The power supply for the circuit can be anywhere between 2 and 6 volts, so the C.R.T. can be powered with your choice of either batteries or a bench-top power supply.

Experiments. We've already seen (from the water-tray example) a method that allows us to measure the distance the water travels to the side of the tray. That method can be applied to electrical waves traveling in cables as well. An oscilloscope can be used to measure both the time that a wave takes to travel the length of a cable, and what the voltage level of that wave is. Some common types of coaxial cable are listed in Table 1 along with their velocity factors and characteristic impedances.

An electrical wave's velocity factor (how fast the water spreads across the tray in our analogy from before) is related to the speed of light in a vacuum. For example, according to the information in Table 1, a wave in RG-58/U cable travels at 66% of the speed of light. We can use the characteristic impedance of the cable to tell us what value we should use for R2.

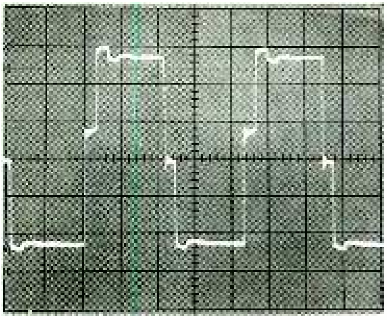


Fig. 4. Here's the C.R.T. hooked up to 50 feet of RG-59/U coaxial cable. The plateau halfway up the pulse is the effect of the signal bouncing back from the end of the cable. The length of time of that plateau measures how long it took for the signal to travel to the end of the cable and back.

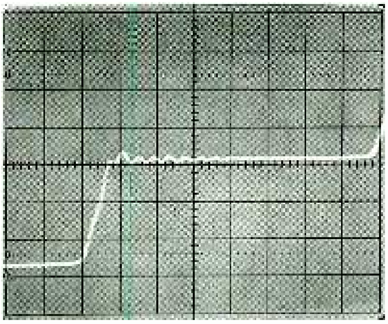


Fig. 5. In this photo, the scope is magnifying the plateau mentioned in Fig. 4. Since we know how fast electricity travels in this particular cable, half the distance shown here is how long it takes for the signal to go from one end of the cable to the other. It's now a simple matter to apply Distance = Time × Speed to figure out the length of the cable.

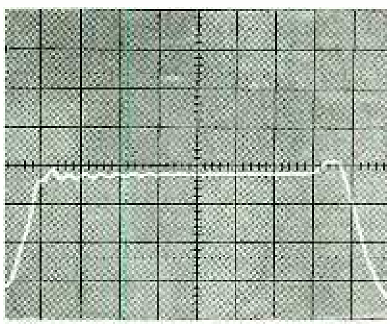


Fig. 6. Now we've shorted the far end of the cable. Instead of going higher, the reflected signal makes the display drop down. Not only does that tell us that the cable is shorted, it also can tell us the distance to the short.

PARTS LIST FOR THE CABLE REFLECTION TESTER

SEMICONDUCTORS

IC1—74HC14 hex HCMOS inverting Schmitt trigger, integrated circuit
IC2—74HC4040 HCMOS 12-stage binary counter, integrated circuit (optional, see text)

RESISTORS

(All resistors are ¼-watt, 5% units.)
R1—10-megohm
R2—optional, see text

ADDITIONAL PARTS AND MATERIALS

C1, C2—30-pF ceramic-disc capacitor
J1—BNC female connector (Digi-Key ARFX1063-ND or similar)
XTAL1—1-10 MHz crystal, see text
Printed-circuit board or breadboard, wire, battery, etc.

Now for some experiments. Connect the C.R.T. to an oscilloscope as shown in Fig. 1 using a 50-foot length of RG-59/U coaxial cable. Leave the long end of the cable unconnected. The waveform on the scope should be similar to that shown in Fig. 4.

You can easily see the very obvious stair-step effect in both the leading and trailing edges of the squarewave. Figure 4 is interesting because it shows several complete cycles of the squarewave and the overall effect of the reflected wave upon it.

In order to get a useful measurement however, you must zoom in on just the first step on either the leading or trailing edge. Figure 5 shows the waveform of Fig. 4 with the scope's magnifier turned on. That will, unfortunately, decrease the accuracy of the measurement. Count the divisions on the scope's screen. The example in Fig. 5 has a stair-step about 8 divisions wide. Make sure that you don't just measure the width of the step itself (which is only 7 divisions wide). Include time it took to rise up to that step (another division). The scope in Fig. 5 is set to .02 µs/division. The velocity factor from Table 1 for the cable (type RG-59/U) is 66%.

Now we can pull out our equation and plug in the numbers. A stair-step of 8 divisions at .02 µs/division is .16 µs long. Dividing that by 2 gives us .08 µs. We then multiply by both the cable's velocity factor (66%, or .66) and the speed of light, which is 186,284 miles/second. Since our time measurement is in µs, we need to change the speed-of-light constant to µs, also. That conversion alone would be fine if we needed the length in miles, but the cable being tested is only 50 feet long, so multiply the speed-of-light constant by 5280. The final speed-of-light constant we will use in the length formula is now how many feet light travels in 1 µs, which is about 983 feet.

Let's substitute into the formula:

$$
\begin{aligned}
L &= t/2 \times V_f \times V_r \\
&= {}^{.16}\!/_{2} \times 0.66 \times 983 \\
&= 51.9
\end{aligned}
$$

The distance of the cable works out to be 51.9 feet. Considering the second-rate accuracy of the scope being

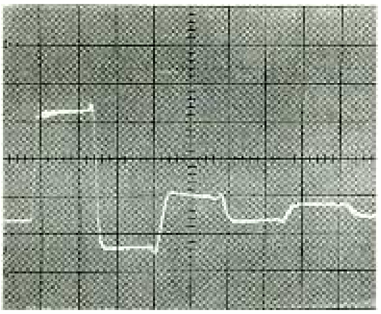


Fig. 7. If you don't use the proper value for R2, the reflected signal will keep echoing back and forth in the cable.

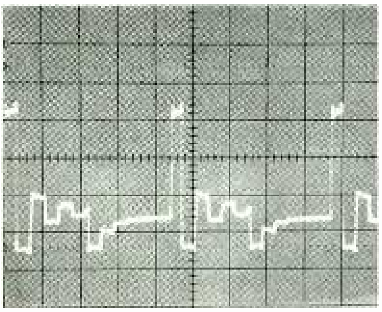


Fig. 8. Multiple echoes and reflections caused by bypassing R2 will mix with the original signal, distorting it badly.

used and the simple carpenter's tape measure used to check the actual length of the cable, the results are suprisingly accurate.

What happens if the end of the cable is shorted instead of left open? The results of that are shown in Fig. 6. Notice that instead of a stair-stepping-up waveform, the waveform steps up, then down. The down step is the result of the wave being reflected off of the shorted end of the cable. An additional change to the setup used for Fig. 6 is that R2 has been bypassed. That means that the signal generator is not matched to the cable, so when the reflected wave comes back it is once more reflected out. That back and forth reflection continues on and on like a pendulum with the waveform getting smaller each time. Additional views showing the reflected waves can be seen in Figs. 7 and 8.

Practical Applications. While digging in your yard, you accidentally severed a length of your satellite-TV cable. You had a repairman come out to replace it, but your reception has been terrible since then. The cable in your system is RG-58/U. You suspect that the repairman may have put in RG-59/U by mistake. How would you use the C.R.T. to diagnose that problem?

To simulate that situation, make up a cable from two 25-foot lengths of RG-58/U cable with a 25-foot length of RG-59/U cable spliced in between them. The overall cable length is 75 feet. Attach the C.R.T. to one end of the cable assembly and watch what

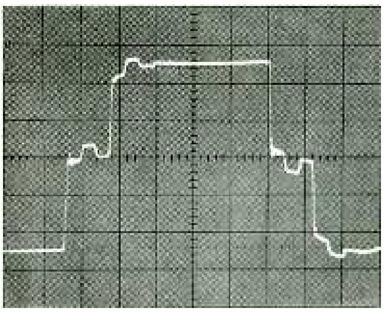


Fig. 9. If there is an impedance mismatch in the cable, the plateau will have an odd "hiccup" as the signal changes speed.

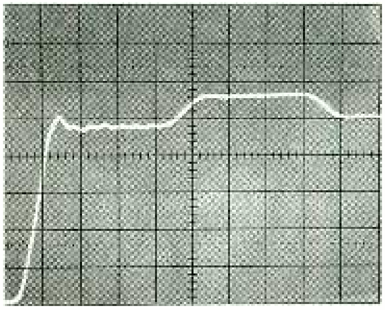


Fig. 10. This magnified view of a mismatched impedance can easily tell us not only how far up the cable the mismatch is, but the length of the offending portion of the cable.

happens on the scope when a squarewave is sent down the cable. The scope in Fig. 9 is set to display one complete cycle of the squarewave that was driving the cable.

The squarewave will initially step up as it travels down the RG-58/U. However, 25-feet later, it hits the RG-59/U. Since RG-59/U has a higher characteristic impedance than RG-58/U, a small positive reflection occurs. That causes the waveform to step up higher. The waveform travels another 25 feet when it hits RG-58/U again. The impedance mismatch (a mirror image of the first mismatch) causes a small negative reflection, which results in the step back down to the value appropriate for RG-58/U. The waveform continues on to the end of the line, and is then reflected back.

The scope has been set in Fig. 10 to zoom in on the leading edge of the stair-step waveform. If you don't know where the RG-59/U was spliced in, you can easily calculate the location using the length calculations from before. The first part of the waveform is about 4 divisions long. That is the initial length of cable before the splice, which works out to be about 25.9 feet.

The length of the spliced cable causes the short step up, which is also

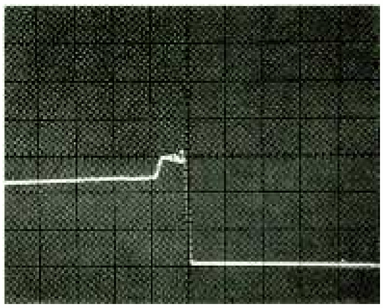


Fig. 11. A step down usually means an impedance mismatch, but the mismatch shown here is a problem of extreme proportions: using the wrong impedance cable! In this test of a computer-network cable, using the wrong type of cable results in garbled data that the interface card cannot read.

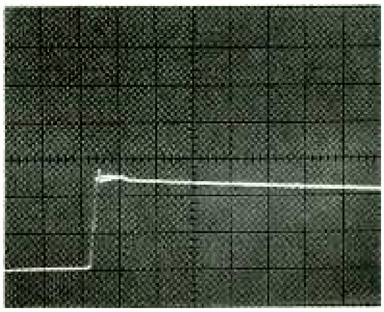
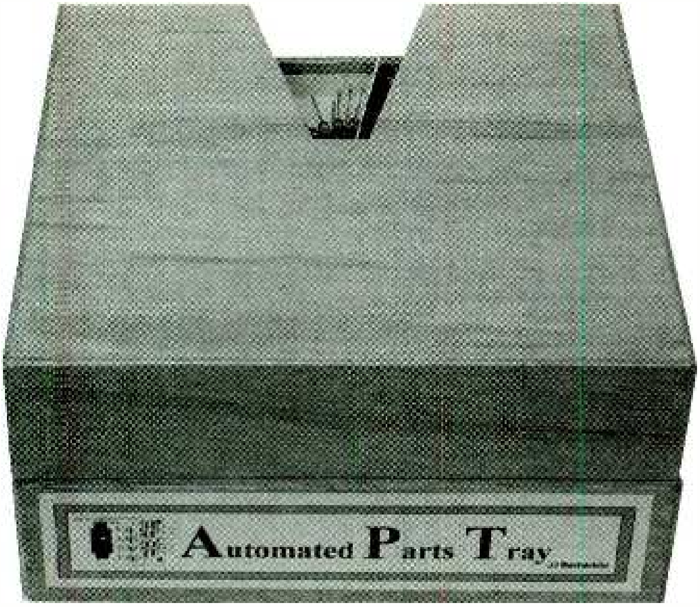


Fig. 12. After the computer-network cable in Fig. 11 is replaced with the proper type, the signal becomes much cleaner. The slow droop in the signal is caused by the capacitor-like quality of the cable: two conductors separated by an insulator.

about 4 divisions long. Since RG-58/U has the same velocity factor as RG-59/U, the same calculations as before can be used, so the length of the spliced cable is also about 25.9 feet.

Don't lose sight, however, of the most important part of that measure-

(Continued on page 68)



BUILD THIS

AUTOMATIC PARTS TRAY

Here's the software that makes our board-assembly system work, and an optical encoder to make sure it works perfectly.

JAMES J. BARBARELLO

Last time we built a PC-based stepper-motor controller, and an automated parts-dispensing system called the APT (Automated Parts Tray). This time, we'll present the format of the data file that specifies the parts to use in populating a PC board. Then we'll discuss the software (including a complete listing), and show how to use it to populate a sample PC board—the stepper-motor controller presented last time. As a bonus, we'll provide hardware and software details for adding an optical encoder that will allow your PC to sense when bin 1 of the APT is in place.

Data File Format. The APT data file is simply an ASCII text file that lists every part that is to be mounted on a board. The format of the file is shown in Listing 1. (Note: All listings contain line numbers for reference only. If you type a file in, do not enter the line numbers.) Line 1 of the data file provides a description of the board; the description is displayed at the bottom of the screen whenever the APT program is running. Line 2 provides the board's horizontal and vertical dimensions. All dimensions are in inches. Values in the data file should be separated by commas.

Line 3, which contains only a backslash ("\"), says to begin a new part. Following that is one line for every part hole. Each line contains three items: *x* and *y* coordinates, and a third value (polarity), which is normally 0, and should be set to 1 for the key point of a polarized component. For example, the cathode of a diode, pin 1 of an IC, or the positive end of an electrolytic capacitor could be used to help ensure correct part orientation. Each part may have as many as 20 holes. For parts with more than 20 holes (such as a 40-pin IC), simply identify the perimeter holes that define the location and orientation of the part.

After the line of the last hole for the current part comes a line containing only an asterisk ("*"). The following line contains a comment about the part, such as its name, its value, its placement, etc. The next line contains the bin number, and that completes the first part. The next line contains a backslash, which marks the beginning of the next part.

To see how this works in practice, let's examine a sample data file for the stepper-motor PC board, presented last time. Listing 2 shows an abbreviated version of the data file, and Fig. 1 shows the foil pattern. To help identify the *x* and *y* coordinates of each hole, we have overlaid a 0.1-inch × 0.1-inch grid on the pattern. The positive *x* direction may be opposite of what you expect. The reason is that the APT program displays things looking down on the component side of the board, but we have only the foil side to work with. You could work with a component side view, in which case *x* would increase in the positive direction from left to right.

The first set of hole coordinates (lines 4–12) is followed by a comment that indicates those are non-part holes. Typical of that variety would be mounting holes, or holes used for options that are not being installed. Here, the first two sets of coordinates are for the holes where J1 mounts. The last three are for the holes indicated (in the original article) as "Future Optical-Encoder Input," along with holes for ground and +5 volts. None of those holes will have a part inserted, so the bin number (following the asterisk) is zero. That tells the program to display the holes for reference purposes, but not to consider them as part holes, *i.e.*, not to rotate the parts tray.

As shown in lines 13–27, the first part to be installed is J1. Note that 11 holes are specified, and the last hole is shown as the polarity indicator. That is folllowed by the asterisk separator, and a comment line. Since J1 is relatively heavy, the comment indicates that it should be obtained from sup-

LISTING 1

```
1. Board Description (79 characters max)
2. Board Dimensions (x, y)
3. Backslash (\)
4. x,y,p Part1 Hole1(horizontal, vertical,
     polarized (1=yes))
5. x,y,p Part1 Hole2
 ...
n. x,y,p Part1 Hole n
n+1. * (Asterisk)
n+2. Part Description (79 characters max)
n+3. Bin Number (1–12, or 0 to skip)
n+4. Backslash (\)
n+5. x,y,p Part2 Hole1
 ...
```

LISTING 2

```
001. STEPPER CONTROLLER,
     V951003 - JJB
002. 2.85,2.8
003. \
004. .2,.5,0
005. .2,2.35,0
006. .7,.35,0
007. 2.6,1,0
008. 2.6,1.25,0
009. *
010. Non-Part Holes. Bin 0 means
     skip as a part to be placed.
011. 0
012. \
013. .6,.75,0
014. .5,.8,0
015. .6,.95,0
016. .6,1.05,0
017. .5,1.45,0
018. .6,1.6,0
019. .6,1.73,0
020. .6,1.84,0
021. .5,2,0
022. .6,1.95,0
023. .6,2.07,1
024. *
025. J1 - DB25 Conn, Pin 1 Red.
     GET FROM SUPPLEMENTARY
     BIN A.
026. 1
027. \
...
100. .9,.8,0
101. 1.3,.8,0
102. *
103. R7 - 2.2Kohm
104. 2
105. \
...
208. 2.6,.75,0
209. *
210. STEPPER MOTOR PHASE A
211. 1
212. \
...
228. 2.6,1.3,1
229. 2.65,1.6,0
230. *
231. POWER - RED IS +5V,
     WHITE IS GND
232. 1
232. \
```

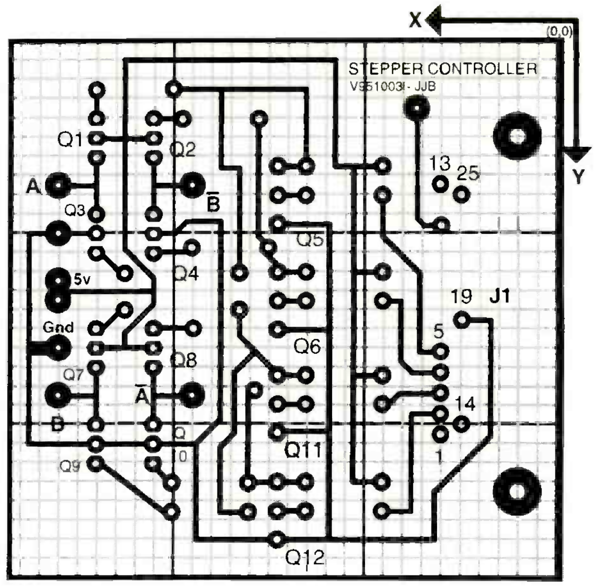


Fig. 1. Here's the foil-side view of the Stepper Motor Controller presented last time. The superimposed grid helps locate component positions accurately.

LISTING 3

```
1 REM** STEPPER.BAS (c) 1995 JJ Barbarello,
      Manalapan, NJ (908) 536-5499
2 REM** V951013
3 DEF SEG = 64
4 DEFINT A: DIM a(4), h(500, 1), p(20, 1), comment$(500), bin(500)
5 abinold = 1: ainit = 12: OUT add, ainit
6 a(1) = 5: a(2) = 3: a(3) = 10: a(4) = 12
7 add = 888
8 OPEN "stepper.fil" FOR INPUT AS #1
9 LINE INPUT #1, file$: CLOSE 1
10 OPEN file$ FOR INPUT AS #1
11 LINE INPUT #1, title$
12 LINE INPUT #1, boardsize$
13 h(0, 0) = VAL(boardsize$)
14 comma = INSTR(boardsize$, ",")
15 h(0, 1) = VAL(MID$(boardsize$, comma + 1, 20))
16 REM******* READ SIZE OF PCB AND LOCATION OF HOLES
17 ctr1 = 1
18 WHILE NOT EOF(1)
19 LINE INPUT #1, a$: B$ = LEFT$(a$, 1)
20 SELECT CASE B$
21 CASE "0" TO "9", "."
22 h(ctr1, 0) = VAL(a$)
23 comma1 = INSTR(a$, ",")
24 h(ctr1, 1) = VAL(MID$(a$, comma1 + 1, 20))
25 ctr1 = ctr1 + 1
26 CASE IS = "*"
27 LINE INPUT #1, a$
28 comment$ = a$
29 LINE INPUT #1, a$
30 bin = VAL(a$)
31 CASE IS = "\"
32 CASE ELSE
33 END SELECT
34 WEND
35 REM** CLOSE & RE-OPEN FILE, DUMMY READ INITIAL DATA
36 CLOSE 1
37 OPEN file$ FOR INPUT AS #1
38 LINE INPUT #1, title$
39 LINE INPUT #1, boardsize$
40 LINE INPUT #1, backslash$
41 REM******* CALCULATE SCALE FACTORS FOR PCB DISPLAY
42 IF (h(0, 1) + 2) > h(0, 0) THEN
43 ystep = 28 / h(0, 1)
44 xstep = ystep * 7 / 5
45 adjust1:
46 IF (xstep * h(0, 0) * 10 > 540) OR (ystep * h(0, 1) * 10 > 280) THEN
47 ystep = ystep - .1: xstep = ystep * 7 / 5: GOTO adjust1
48 END IF
49 ELSE
50 xstep = 56 / h(0, 0)
51 ystep = xstep * .68
52 adjust2:
53 IF (xstep * h(0, 0) * 10 > 540) OR (ystep * h(0, 1) * 10 > 280) THEN
54 xstep = xstep - .1: ystep = xstep * .68: GOTO adjust2
55 END IF
56 END IF
57 REM******* START-UP SCREEN
58 SCREEN 9: CLS
59 LINE (3, 3)-(630, 335), 7, B: LINE (5, 5)-(627, 333), 7, B
60 LINE (230, 30)-(386, 65), 15, B
61 LOCATE 4, 35: COLOR 15, 9: PRINT "APT SYSTEM"
62 PAINT (235, 35), 9, 15: LOCATE 6, 18: COLOR 7, 1
63 PRINT "(c) 1995, JJ Barbarello, Manalapan, NJ 07726"
64 LOCATE 7, 33: PRINT "(908) 536-5499": COLOR 15, 1
65 LOCATE 13, 20: PRINT "Position Tray at Bin 1,
      then press Enter...";
66 OUT add, ainit
67 a$ = INPUT$(1)
68 REM******* WORK SCREEN
69 CLS
70 LINE (1, 1)-(630, 293), 3, BF
71 LINE (1, 1)-(630, 293), 7, B
72 LINE (1, 322)-(630, 334), 3, BF
73 LINE (1, 322)-(630, 334), 7, B
74 titleoffset = (80 - LEN(title$)) / 2
75 LOCATE 25, titleoffset: COLOR 8, 0: PRINT title$; : COLOR 15, 0
76 REM******* CALCULATE WORKING VARIABLES & DISPLAY PCB
77 x = h(0, 0) * 10 * xstep: y = h(0, 1) * 10 * ystep
78 xoffset = (620 - x) / 2: yoffset = (292 - y) / 2
79 LINE (xoffset - 4, yoffset - 2)-(xoffset + x + 4, yoffset + y + 8), 8, BF
80 FOR i = xoffset TO xstep * h(0, 0) * 10 + xoffset STEP xstep
81 FOR j = yoffset TO ystep * h(0, 1) * 10 + 2 + yoffset STEP ystep
82 PSET (i, j), 12
83 NEXT j
84 NEXT i
85 FOR i = 1 TO ctr1 - 1
86 CIRCLE (h(i, 0) * 10 * xstep + xoffset, h(i, 1) * 10 * ystep + yoffset), 1, 14
87 NEXT i
88 REM******* READ PART LOCATION DATA FROM FILE AND DISPLAY
```

plementary bin A. However, the bin identifier is cited as 1. There's still no need to move the tray.

Bin 1 contains the 100-ohm resistors. When we need a new value (R7, 2.2K, lines 100–105), note that the bin number increases to "2." Parts identification continues until it's time to attach the stepper-motor wires (lines 208–212). Here, only a single hole is identified, and the tray stays "parked" at bin 1. The file ends with the power connections (lines 228–232).

The APT Software. Now let's see how the software puts the data file to use. The program, STEPPER.BAS, is shown in Listing 3. (Line numbers are included for reference only. They must not be included in the run-time file). Lines 8 and 9 open a one-line file called STEPPER.FIL. That file contains the name of the text file that contains the PC-board data. You can create the file using any text editor or from a DOS command line as follows:

```
C:APT>copy con stepper.fil
    <Enter>
datafile.txt <Enter>
<Ctrl> <Z> <Enter>
C:APT>
```

In the above, replace "datafile.text" with the name of the file with the PC-board data that you created. The term <Enter> means press the Enter key. <Ctrl> <Z> means press and hold the CTRL key while you press the Z key.

The program then opens the PC-board data file and reads all the component location information (lines 10–40). The program uses that information to calculate the scale at which the PC board will be displayed (42–56). The next step is to display basic program information (57–75). Lines 77–87 then display the PC board. Note that the program runs in screen mode 9 (see line 58), which is a screen resolution of 640 × 350. Nearly all EGA, VGA, and SVGA adapters support that mode, but earlier adapters do not, so don't plan on using that old 8088-based PC you have lying around for this project unless it has an appropriate video adapter.

Next, the program (lines 89–125) displays the holes associated with each part, calling subroutine HWCONTROL (from 113) to position the APT tray at the designated bin.

HWCONTROL. The purpose of HWCONTROL is to find the shortest route between the current and the next bin positions, and then move the tray to the new position.

HWCONTROL actually does three

```
89 hole = 1: partno = 1
90 WHILE NOT EOF(1)
91 LINE INPUT #1, a$: B$ = LEFT$(a$, 1)
92 SELECT CASE B$
93 CASE "0" TO "9", "."
94 x = VAL(a$)
95 comma1 = INSTR(a$, ",")
96 comma2 = INSTR(comma1 + 1, a$, ",")
97 y = VAL(MID$(a$, comma1 + 1, comma2 - comma1 + 1))
98 positive = VAL(MID$(a$, comma2 + 1, LEN(a$) - comma2))
99 x = x * 10 * xstep + xoffset: y = y * 10 * ystep + yoffset
100 p(hole, 0) = x: p(hole, 1) = y: hole = hole + 1
101 IF positive = 1 THEN highlight = 12 ELSE highlight = 15
102 CIRCLE (x, y), 3, highlight
103 PAINT (x, y), highlight, highlight
104 CASE IS = "*"
105 LINE INPUT #1, a$
106 comment$ = a$
107 LINE INPUT #1, a$
108 bin = VAL(a$)
109 LOCATE 22, 1: PRINT SPACE$(79);
110 LOCATE 23, 1: PRINT SPACE$(79);
111 LOCATE 22, 1: PRINT comment$
112 LOCATE 23, 1: COLOR 7, 0: PRINT "Part"; partno; "in BIN:"; bin:
      COLOR 15, 0
113 IF bin > 0 THEN GOSUB hwcontrol: a$ = INPUT$(1)
114 FOR i = 1 TO hole - 1
115 CIRCLE (p(i, 0), p(i, 1)), 3, 10
116 PAINT (p(i, 0), p(i, 1)), 8, 10
117 CIRCLE (p(i, 0), p(i, 1)), 3, 8
118 CIRCLE (p(i, 0), p(i, 1)), 1, 14
119 NEXT i
120 hole = 1
121 CASE IS = "\"
122 IF bin > 0 THEN partno = partno + 1
123 CASE ELSE
124 END SELECT
125 WEND
126 SOUND 600, 1: SOUND 875, 2: SOUND 800, 2
127 bin = 1: GOSUB hwcontrol
128 SCREEN 0: CLS : LOCATE 10, 38: PRINT "Done"
129 LOCATE 18, 1
130 END
131 '****************************************
132 REM** SUBROUTINE HWCONTROL
133 hwcontrol:
134 abin = bin
135 IF abin < 1 OR abin > 12 THEN ERROR 5
136 abin2 = abin
137 IF abin2 < abinold THEN abin2 = abin2 + 12
138 asteps = abin2 - abinold
139 SELECT CASE asteps
140 CASE 1 TO 6
141 lo = 1: hi = 4: steps = 1
142 CASE IS > 6
143 lo = 4: hi = 1: steps = -1: asteps = 12 - asteps
144 CASE IS < 0
145 lo = 4: hi = 1: steps = -1: asteps = -asteps
146 CASE ELSE
147 SOUND 675, 1: SOUND 500, 1
148 RETURN
149 END SELECT
150 OUT add, ainit
151 binold = abinold
152 FOR i = 1 TO asteps
153 FOR j = lo TO hi STEP steps
154 OUT add, a(j)
155 IF i > 1 AND i < asteps THEN delay = .075 ELSE delay = .125
156 START! = TIMER
157 WHILE (TIMER - START!) < delay: WEND
158 NEXT j
159 binold = binold + steps
160 SELECT CASE binold
161 CASE IS = 0
162 binold = 12
163 CASE IS = 13
164 binold = 1
165 CASE ELSE
166 END SELECT
167 NEXT i
168 IF steps = -1 THEN
169 OUT add, a(lo)
170 ainit = a(lo)
171 ELSE
172 ainit = a(hi)
173 END IF
174 START! = TIMER
175 WHILE (TIMER - START!) < 1: WEND
176 OUT add, 0
177 abinold = abin
178 SOUND 500, 1: SOUND 675, 1
179 RETURN
```

things: It decides whether to move the tray, decides how to move the tray, and actually moves the tray. Table 1 shows the motion-control sequence. By performing steps 1–4 sequentially, the tray rotates clockwise (CW). By performing the sequence backward (4–1), the tray rotates counterclockwise (CCW).

TABLE 1—MOTION CONTROL SEQUENCE

Step	A(5)	B*(4)	B(3)	A*(2)	Decimal
1	1	0	1	0	10
2	0	0	1	1	3
3	0	1	0	1	5
4	1	1	0	0	12

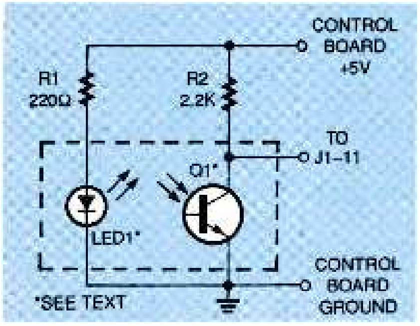


Fig. 2. The optical encoder consists of little more than an IR emitter and detector.

Line 134 saves the bin number to a temporary variable (abin). Line 135 ensures that a valid bin number is being processed. Line 136 creates another copy (abin2) of the current bin number. Then, if the value of the new bin is less than the value of the last bin (*i.e.*, the current tray position), line 137 adds 12 to abin2. To understand why, let's look at an example.

If we are at bin 6 (abinold = 6) and we want to go to bin 4 (abin2 = 4) we want to go backward two positions. So, adding 12 to abin2 gives 16. The number of steps is thus 16 − 6 = 10.

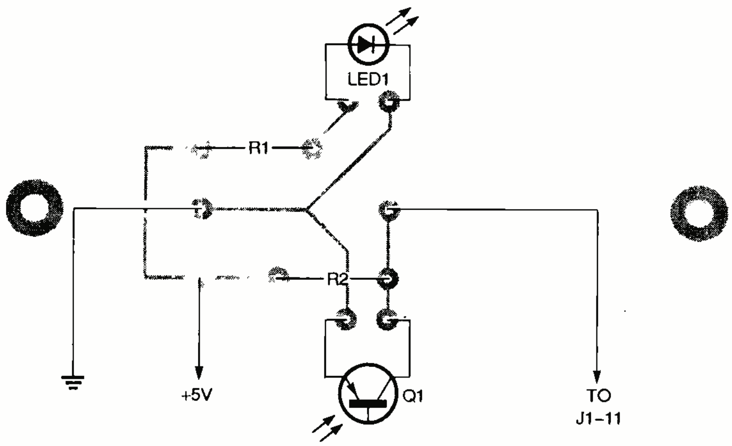


Fig. 3. Mount all components for the optical encoder board as shown here. Note that though shown off board, LED1 and Q1 are mounted as discussed in the text.

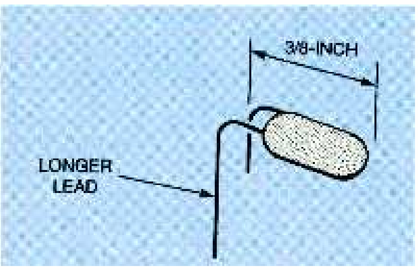


Fig. 4. Bend the leads of LED1 and Q1 to keep the bodies of those devices about a half-inch above the PC board.

Now look at the SELECT CASE routine (139–149). If the number of steps we need to take is between one and six, we simply set up to rotate clockwise (CW) the specified number of steps. If we need to go more than six steps, we set up to go counterclockwise (CCW). Likewise, if the number of steps is less than zero, we also set up to go CCW.

In our example, line 143 does three things. First, it sets variable lo to 4 and hi to 1. Second, it sets the stepping value to −1, so the For-Next loop will count backward. The result of the first two steps is CCW rotation. Third, it subtracts the current astep value (which is 10) from 12 to arrive at 2. As a result, the tray will move two steps CCW, from bin 6 to bin 4.

To continue the example, assume we now want to move to bin 7. Line 137 does not come into play, since 7 is greater than 4. Line 138 calculates the difference as 3, which is handled in lines 140–141. The result is CW rotation, so the tray moves CW three positions to bin 7.

It's also worth pointing out that if the number of steps needed to change bins is zero, the CASE ELSE statement takes effect, so the routine returns without performing any action. That's important to remember when building the data file, since sequencing parts with identical values speeds up the assembly process.

All that's left now is to perform the actual motion. Line 150 outputs a decimal 12, which is always the start of the movement sequence. Then the For-Next loop (153–158) cycles through the four steps. Lines 155–157 provide a variable delay that allows the motor time to spin up the first time through the loop. Subsequently, a shorter delay suffices, thus speeding movement.

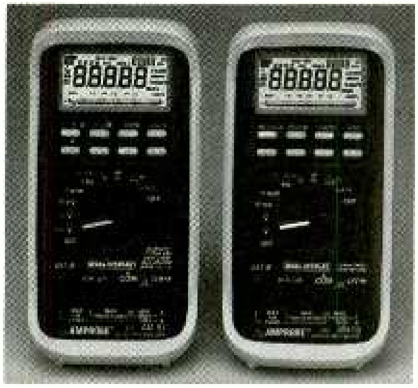
Lines 174–175 provide a one-second delay, after which line 176 sends a value of zero. The delay keeps the stepper energized to ensure that it

PARTS LIST FOR THE OPTICAL ENCODER

Q1—Infrared detector, 940nm, T1 case (Jameco 112176 or equivalent)
LED1—Infrared LED diode, T1 case (Jameco 112150 or equivalent)
R1—220 ohms, ¼-watt, 5% resistor
R2—2200 ohms, ¼-watt, 5% resistor
Poster board, PC board, wire, mounting hardware, etc.

NOTE: The following are available from James J. Barbarello, 817 Tennent Road, Manalapan, NJ 07726. PC Board: APT-PC ($12.00). Software including source and executable code for all software in the series, sample data files, and an enhanced version of the APT software (including the optical encoder application): APT-S ($12.00). All prices include shipping. International orders add $5.00 (U.S. funds only). NJ residents must add sales tax. The author will accept phone calls 6–8:00 PM EST, Monday through Friday ONLY (Tel: 908-536-5499). The author will gladly answer written questions if accompanied by a self-addressed stamped envelope.

handheld, professional-quality digital multimeters that offer the benchtop features used for today's complex electrical and electronic system diagnostics and troubleshooting. The AM-90 is an average-sensing DMM. The AM-91 offers true RMS AC measurements and a backlit LCD readout.



CIRCLE 22 ON FREE INFORMATION CARD

Both meters feature dual-display LCDs that allow the user to view two variables at the same time. Measuring functions include DC voltage, adaptor input, frequency, duty cycle, resistance, capacitance, continuity test, conductance, diode test, DC and AC current. The Model AM-91 adds duty-cycle and dBm measurements, as well as a true-RMS AC+DC mode with a 20-kHz bandwidth that gives you accurate readings for non-sinusoidal waveforms.

Pushbutton functions include a 4000-count fast-measuring mode, a 40,000-count high-resolution slow-measuring mode, data hold, a 41-segment bar graph that updates 128 times per second, auto polarity, data store and recall, relative zero mode, relative percentage change mode, relative per unit mode, and three min/max/avg modes, as well as secondary function selection. The AM-91 also offers a dBm reference impedances selection.

Each DMM is housed inside a gasket-sealed, heavy-duty casing made of a high-impact, fire-retardant material that keeps out dirt, grease, oil, and moisture. Each comes with a rubber holster, test leads with alligator adapter clips, a 9-volt battery, and an instruction manual.

The Models AM-90 and AM-91 have list prices of $249.85 and $299.85, respectively.

AMPROBE INSTRUMENTS
630 Merrick Road
Lynbrook, NY 11563
Tel: 516-593-5600
Fax: 516-593-5682

Satellite-TV Power Controller And Surge Protector

CIRCLE 23 ON FREE INFORMATION CARD

Electrical problems on the power, satellite-dish, cable, and telephone lines—due to environmental disturbances, problems in the power-distribution system, and poor or aging wiring—can create problems and degrade satellite home-entertainment system components. According to its manufac-

continued on page 82

BY DON LANCASTER

Solving Linear Equations, Induction Heating, and More

THERE SURE WAS A LOT OF EMAIL OVER OUR SIMPLIFIED TRISAMP DIGITAL-FILTER STORY FROM LAST MONTH. THOSE DIGITAL FILTERS CONTINUE TO AMAZE ME. PROPERLY USED, DIGITAL FILTERS CAN COMPLETELY BLOW AWAY ALL OLDER analog designs. With digital technology, it is trivially easy to make a "gentle" filter with a slope of, say, two-decibels-per-octave for high-end audio enthusiasts. Or a "violent" filter that easily provides stop-band slopes of hundreds of decibels-per-octave, which, to the signal, gives the effect of hitting a brick wall. And the filters will provide both "perfect" tuning and "distortionless" phasing.

At any rate, a lot of you asked for extra details on a "real" digital-filter design. I guess we can attack this in a future column. But first, we will need to explore certain math topics.

Linear Equations

The key to any digital filter design is finding coefficients. Hopefully, you find what you want in a book or an applications note. If not, you start with a pile of equations that describe the amplitudes and frequencies you desire. Then you solve the equations to find your coefficients. The tricky part is that you will typically be solving for lots of frequencies and amplitudes. The math usually involves linear equations. Such as:

$$x - 3y = 9$$
$$x + 2y = -1$$

That is one example of a pair of linear algebraic equations. The idea here is to find the value or values of x and y that makes both equations true. The solution in this relatively simple example is $x = 3$ and $y = -2$. It can be found in a number of different ways. You could subtract the second equation from the first, leaving one equation in y. Or solve the first equation for x and substitute its value into the second.

The system is linear because the only power of x or y involved is the first. When the number of equations equals the number of unknowns, you can usually find all the unknowns.

Often, you'd expect one solution for x and y, but in special cases, there can be zero or many solutions.

You could evaluate these oddball cases by graphing your equation as a pair of straight lines. If the lines cross only one time, you have one solution. If the lines are parallel, you have no solution. And if the lines extend into one longer

A pile of numbers is called a *matrix*. A matrix is *two dimensional* if it can be arranged into rows and columns. A matrix is *square* if the number of rows equal the number of columns. Math that takes a pile of numbers and creates a new number or pile of numbers is called a *matrix operator*.

One popular matrix operator is called a *determinant*. A determinant takes a pile of numbers and calculates *one* new number from that pile.

The determinant for a 2X2 matrix is the difference of the cross product of its diagonals...

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix} = ad - bc$$

Higher order determinants are found by *reducing* them. A selected row and column is crossed out, leaving a *subdeterminant*. The value at the crossout is multiplied by the subdeterminant. Note that signs alternate across the row as the products are summed. Here is how a 3X3 is reduced...

$$\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix} = a\begin{vmatrix} e & f \\ h & i \end{vmatrix} - b\begin{vmatrix} d & f \\ g & i \end{vmatrix} + c\begin{vmatrix} d & e \\ g & h \end{vmatrix}$$

The process continues for higher orders. Such as this 4X4...

$$\begin{vmatrix} a & b & c & d \\ e & f & g & h \\ i & j & k & l \\ m & n & o & p \end{vmatrix} = a\begin{vmatrix} f & g & h \\ j & k & l \\ n & o & p \end{vmatrix} - b\begin{vmatrix} e & g & h \\ i & k & l \\ m & o & p \end{vmatrix} + c\begin{vmatrix} e & f & h \\ i & j & l \\ m & n & p \end{vmatrix} - d\begin{vmatrix} e & f & g \\ i & j & k \\ m & n & o \end{vmatrix}$$

FIG. 1—DETERMINANTS ARE A POWERFUL method for solving complex linear equations such as those needed for digital-filter designs.

Consider this set of four linear equations in four unknowns...

$$3w - 2x + 1y + 4z = -9$$
$$4w + 4x - 6y + 9z = 1$$
$$2w - 2x + 1y + 4z = 6$$
$$5w + 4x - 3y - 7z = -3$$

Make a 4x4 *system determinant* out of the numbers in front of the variables. Then make four *variable determinants* by selectively *substituting* the right side result in each *w, x, y,* or *z* column. Then divide variable by system...

$$w = \frac{\begin{vmatrix} -9 & -2 & 1 & 4 \\ 1 & 4 & -6 & 9 \\ 6 & -2 & 1 & 4 \\ -3 & 4 & -3 & -7 \end{vmatrix}}{\begin{vmatrix} 3 & -2 & 1 & 4 \\ 4 & 4 & -6 & 9 \\ 2 & -2 & 1 & 4 \\ 5 & 4 & -3 & -7 \end{vmatrix}} \qquad x = \frac{\begin{vmatrix} 3 & -9 & 1 & 4 \\ 4 & 1 & -6 & 9 \\ 2 & 6 & 1 & 4 \\ 5 & -3 & -3 & -7 \end{vmatrix}}{\begin{vmatrix} 3 & -2 & 1 & 4 \\ 4 & 4 & -6 & 9 \\ 2 & -2 & 1 & 4 \\ 5 & 4 & -3 & -7 \end{vmatrix}}$$

$$y = \frac{\begin{vmatrix} 3 & -2 & -9 & 4 \\ 4 & 4 & 1 & 9 \\ 2 & -2 & 6 & 4 \\ 5 & 4 & -3 & -7 \end{vmatrix}}{\begin{vmatrix} 3 & -2 & 1 & 4 \\ 4 & 4 & -6 & 9 \\ 2 & -2 & 1 & 4 \\ 5 & 4 & -3 & -7 \end{vmatrix}} \qquad z = \frac{\begin{vmatrix} 3 & -2 & 1 & -9 \\ 4 & 4 & -6 & 1 \\ 2 & -2 & 1 & 6 \\ 5 & 4 & -3 & -3 \end{vmatrix}}{\begin{vmatrix} 3 & -2 & 1 & 4 \\ 4 & 4 & -6 & 9 \\ 2 & -2 & 1 & 4 \\ 5 & 4 & -3 & -7 \end{vmatrix}}$$

FIG. 2—THIS EXAMPLE SHOWS how determinants are used to solve a system of four linear equations with four unknowns.

line, you will have an infinite number of solutions.

In a digital filter, you might want to solve ten linear equations for ten amplitudes at ten frequencies. While you can still solve your first equation for one variable, plug that into the second, plug that solution into the third, and so on, that "Gausian" elimination gets ugly in a hurry. Instead, we can turn to a super elegant (though obscure and awful-sounding) process. Let's look at that next.

Determinants

When mathematicians face a messy number problem, often they'll start working with entire piles of numbers instead. A pile of numbers is called a matrix. A matrix arranged into rows and columns is two dimensional. And those having an identical number of rows and columns are square.

A matrix operator takes one pile of numbers and generates a new pile of numbers from it following some rule or set of rules. Matrix operators are often dumb-witted, orderly, and very repetitive.

One extremely important matrix operator is known as a determinant. Determinants excel at ridiculously simplifying the solution of high-order linear equations. Consider the following 2 × 2 square matrix:

$$\begin{vmatrix} a & b \\ c & d \end{vmatrix}$$

Its determinant is found when you multiply the diagonals together and subtract them

$$D = ad - bc$$

A determinant for a larger square matrix is found per all the details in Fig. 1. For example, a 3 × 3 determinant:

$$\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix}$$

will evaluate as follows:

$$D = a(ei-fh) - b(di-fg) + c(dh-eg)$$

The game can continue for larger

1. Avoid long floating point multiply times. Use a newer microprocessor, a DSP chip, or consider adding a math coprocessor.

2. Brute force your 4X4 code. This can reduce the overhead on your critical innermost timing loop.

3. Force zeros in all but one top row entry by using an obscure rule that says *"A determinant remains unchanged if any row is added to another row multiplied by a constant"*. There is no need to evaluate a subdeterminant if it is only going to get multiplied by zero in the next step. Like so...

$$\begin{vmatrix} a & b & c \\ d & e & f \\ g & h & i \end{vmatrix} = \begin{vmatrix} a+Kg & b+Kh & c+Ki \\ d & e & f \\ g & h & i \end{vmatrix}$$

First, let constant K1 = $-b/h$ so that $b+Kh = 0$. Substitute these new values into your determinant. Then let a new constant K2 = $-c/i$. Substitute again. This leaves you with zeros in the "b" and "c" column positions. Thus, only the "a" subdeterminant needs evaluated. Speedup is substantial.

4. Solve the highest order equations for only *one* variable. Then substitute this into a lesser solution. For instance, suppose we want to solve...

$$\begin{aligned} aw + bx + cy + dz &= J \\ ew + fx + gy + hz &= K \\ iw + jx + ky + lz &= L \\ mw + nx + oy + pz &= M \end{aligned}$$

Solve this 4X4 linear equation *only* for *w*. Since variable *w* is now known, we can call it *constant* W. And combine it with constants J through M. Leaving this much faster solving set of 3X3 equations...

$$\begin{aligned} fx + gy + hz &= K - We \\ jx + ky + lz &= L - Wi \\ nx + oy + pz &= M - Wm \end{aligned}$$

FIG. 3—TO KEEP COMPUTATION TIMES from getting out of hand, these speed-up tricks are used in the author's LINAREQ.PS utility.

determinants. Find a value in some row and column. Find the subdeterminant that is left when you strike out the row and the column of that value. Evaluate your subdeterminant and multiply by that value. Be sure to alternate the sign when you continue across (or down) your chosen row or column.

A determinant is just a series of multiplications and additions that accept a square matrix and determine a single numeric from its rows and columns.

Now for the neat part. Figure 2 shows us how determinants can solve linear equations. Such as:

$$\begin{aligned} Ax + By + Cz &= J \\ Dx + Ey + Fz &= K \\ Gx + Hy + Iz &= L \end{aligned}$$

Assume we know constants A through L and want to find unknowns x, y, and z. The system determinant is found using elements A through I. Your x determinant can be found by substituting for J, K, and L in the x column positions. Your y determinant is similarly found by substituting J, K, and L in the y column. And the same is done for z.

Our messy linear equations then simply becomes:

$$\begin{aligned} x &= (\text{xdet})/(\text{sysdet}) \\ y &= (\text{ydet})/(\text{sysdet}) \\ z &= (\text{zdet})/(\text{sysdet}) \end{aligned}$$

All you are doing here is simple multiplications and additions, followed by a single division for each variable. Note that whenever the system determinant is zero, the equations blow up, and you have no solutions at all. In other words, an indeterminate determinate.

Additional details on determinants can be found in almost any advanced algebra textbook.

Faster! Faster!

With PostScript, you can easily do an 8 × 8 determinant in 70 milliseconds or less. Directly solving an 8 × 8 linear equation will take nine times as long. One determinant is used as the system denominator; eight for the variables.

Call the 8 × 8 determinant time t. If you blindly go to a 9 × 9 solution, you will need 9t for the determinant. And 10 × 9 = 90t for the full solution. Thus, solving the raw 9 × 9 would take 10 times as long. A 10 × 10 would take 10 × 11 = 110 times as long, and so on. As you can see, things quickly can get way out of hand.

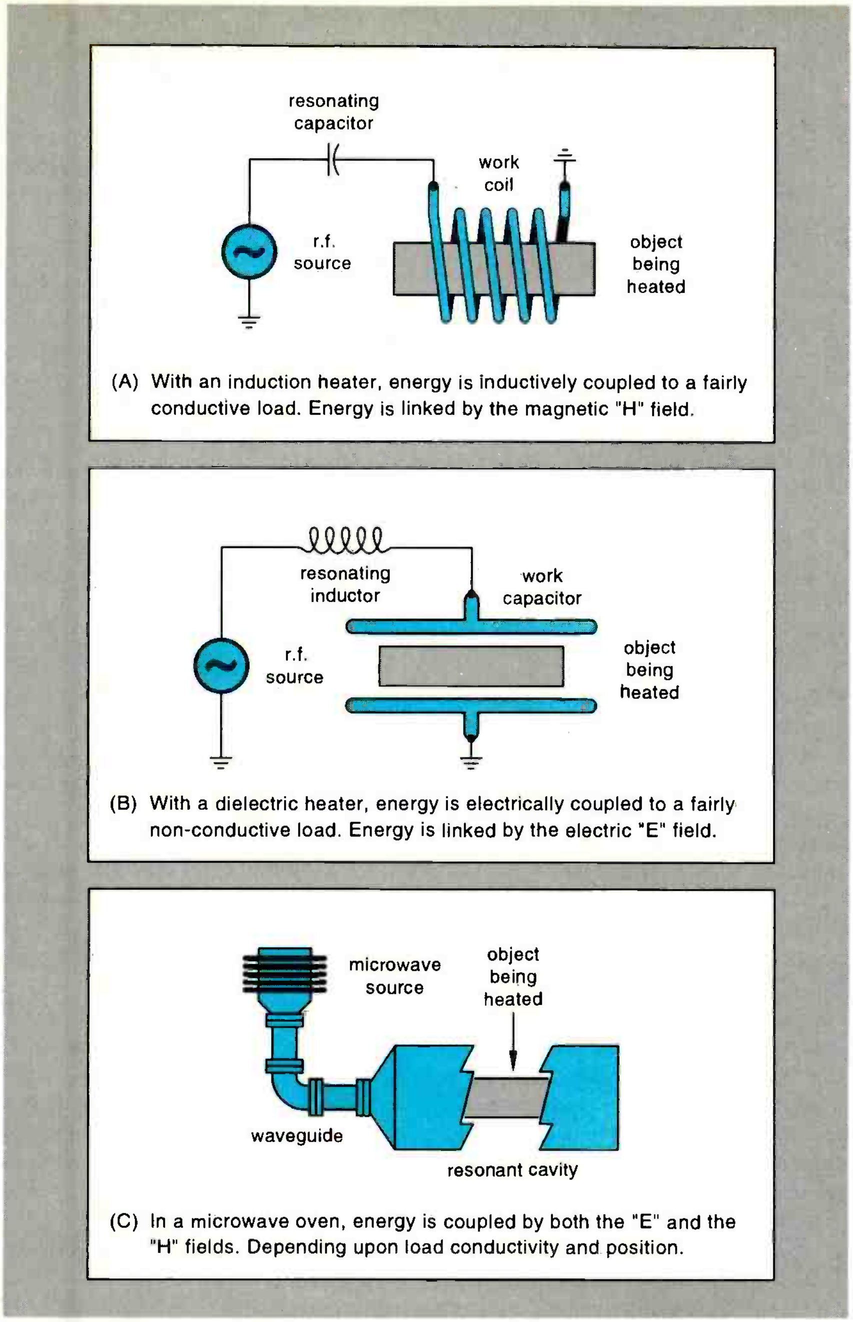
So, we'll think smarter instead of harder. Figure 3 shows us some handy speedup tricks. Those get real important when dealing with anything above 8 × 8.

First and foremost, use a computer system that does not take forever to do some floating-point multiplications. Any newer microprocessor, any DSP, or a math coprocessor should help bunches. Second, brute-force linear code your 4 × 4. Instead of using four 3 × 3s that call 12 2 × 2s. That reduces the overhead on your innermost (and most often called) service loop.

Third is the real biggie. There's a sneaky and off-the-wall rule that tells us: A determinant stays unchanged if you replace the value in a row with itself added to a constant multiplied by the value. Use that rule to force zeros as there is no need to solve any subdeterminant if you are just going to multiply it by zero in the next step. Therefore, if you force zeros first, an 8 × 8 determinant only has to calculate one 7 × 7, not eight of them.

Similarly, we know a full 9 × 9 is going to take much longer than an 8 × 8. So why not use the 9 × 9 to solve for only one variable? Then substitute that one variable value back into the eight remaining equations and solve a faster 8 × 8. That last trick lets you find a 9 × 9 in 1.2 times that of an 8 × 8. You can do a PostScript 10 × 10 determinant in 2.1 seconds.

The speedup details can be a tad system specific. You have to take into account system overhead versus multiplication times and so on. And a few new divisions may be needed. Thus, linear coding a 5 × 5 or zero forcing a 6 × 6 may or may not help you much, and could actually slow you down. But those speedup tricks certainly help a lot for larger matrices. I've posted my PostScript code for all this as file LINEAREQ.PS to my www.tinaja.com.



(A) With an induction heater, energy is inductively coupled to a fairly conductive load. Energy is linked by the magnetic "H" field.

(B) With a dielectric heater, energy is electrically coupled to a fairly non-conductive load. Energy is linked by the electric "E" field.

(C) In a microwave oven, energy is coupled by both the "E" and the "H" fields. Depending upon load conductivity and position.

FIG. 4—HERE ARE THREE approaches that could be used for induction heating using radio frequencies.

Induction Heating

Considering that this topic is something of an arcane backwater, I've sure gotten a lot of calls about it. In brief, most induction heaters are really nothing more than a transformer with a shorted turn. A long time ago, someone noticed that transformer and coil cores sometimes got painfully warm. They then decided to try and do that on purpose, and the rest is history.

An induction heater places a fairly conductive object inside a resonant coil. Radio-frequency energy routed through the coil gets transferred by induction to the conductive object, heating it.

A non-magnetic conductor heats by way of the eddy effect. Magnetic conductors heat through an additional hysteresis loss. Either way, energy is mostly transferred by the magnetic, or the "H" field.

Induction heating is most popular with iron or steel objects. But nearly any lossy but otherwise fairly strong conductor can work.

Somewhat related are dielectric heaters. A dielectric heater places an object that is only somewhat lossy between the plates of a resonating capacitor. Radio-frequency energy is transferred by dielectric coupling to the object. Energy is transferred by the electric or "E" field.

Dielectric heating works best with glues, or similar lossy but otherwise fairly good insulators. Those conductive capacitor plates can also optionally apply pressure.

A microwave oven can be both an induction heater and dielectric heater. The target is put inside a waveguide or cavity. Energy can be transferred using either or both fields. Unfortunately, due to mismatch and reflected power, the magnetron in the oven blows up when you try actually using the induction part of the field by putting any metal inside.

I've shown three radio-frequency heating approaches in Fig. 4. The advantages of induction or dielectric heating are that you'll heat only the object, not the environment. You exactly control the temperature and its rate of heating or cooling, as well as the heating-depth profile and the total energy transferred. The (usually) contactless process also avoids contamination, and can even be done inside a vacuum.

A few important uses for induction heaters include heat treating of metals, brazing or soldering, and for shrink-fit assembling. Thanks to the frequency-sensitive skin effect, you can carefully control the depth of heat penetration. Therefore, induction is ideally suited for surface hardening of running parts such as crankshafts or CV universal joints.

Some of the new "cool-top" stove designs also use induction heating. In addition to warming your lunch, dielectric heating is used to make plywood, for materials research, and in various medical treatments.

Since they emit RF, the FCC regulates all induction and dielectric heaters. The applicable regulations can be found in Part 15, which covers virtually every type of emission and device, and in the short and obscure Part 18, which covers industrial electronics. One source for those regs are the US Government Bookstores in many cities. I was unable to find any of the less common FCC regs on line.

A popular operating frequency for those devices used to be 27.12 MHz, with a tolerance of 326 kHz. However, at that frequency the harmonics of an improperly shielded induction heater might totally trash TV-Channel 2, and much of the FM band.

Newer induction heaters often oper-

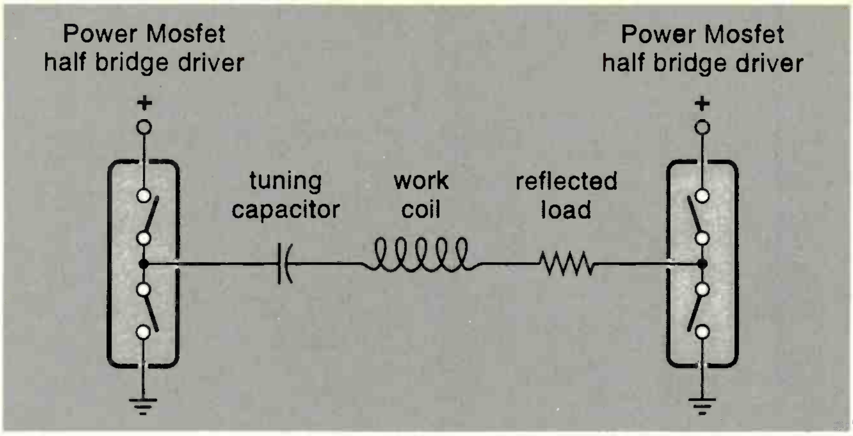


FIG. 5—HERE IS A SIMPLIFIED SCHEMATIC for an induction heater. In it, diagonally opposite switches are alternately closed, creating a squarewave drive at the heater's resonant frequency.

ate in the 50—200 kHz range. The frequency chosen is carefully optimized for the size of the load and the depth of penetration desired, but even raw 60-Hz AC power can be used to heat massive objects such as aluminum billets.

Earlier induction heaters required humongous vacuum-tube transmitters or motor-generator sets. These days, an induction heater is a variation on a switching-mode power supply, where power FETs or whatever squarewave drive a lossy but series-resonant load. Parallel-current modes are also possible. Figure 5 shows a simplified induction heater schematic.

Way back in high school, I worked with an early induction heater. It was just a tube-style 11-meter transmitter with an output of a few hundred watts driving a largish load coil. Inside the coil was a highly temperature-resistant glass tube. If a large nail was placed in the tube, it would light up to a bright cherry red within a few seconds.

You could also cook hot dogs in the thing, but you had to roll the hot dogs in iron filings first. We finally opted for a central coat-hanger wire through the hot dog. Even then, it usually burned the middle and left the outside cold.

While all this might sound like fun, the dangers inherent in home-lab induction-heat experiments are too numerous to mention here. As such, if you decide you want to pursue this topic further, be very careful, and make sure you do your homework first.

Getting Info

Induction-heating system design is tricky. Your frequency, power level, and coils have to be carefully matched to the objects being heated, and to the reasons for the heating in the first place. For one thing, tuning is critical.

It is fairly easy to find useful info on induction heating, but you'll have to dig around in some pretty obscure places.

A good place to start is the Web. I've just added a link for a super searching service to www.tinaja.com that simultaneously lets you access many dozens of the more popular search engines.

I've also gathered some resources for you into this month's sidebar. The best books seem to be the two volumes of the oldie but goodie *Basics of Induction Heating* by Chester Tudbury. The only source for this text I have been able to find is through InductoHeat. The better Volume One concerns itself with coil and load fundamentals and heating calculations. Volume Two is on 1960 transmitter-circuit designs, tuning, and matching.

A 1988 book is titled *Elements of Induction Heating*.It is available from ASM Press. I also found a Franklin reprint about the 1969 *Industrial Applications of Induction Heating* text.

There is also the specialized *High Frequency Plasma Heating* from the American Institute of Physics. I have not seen this one, though.

I was unable to find any specific trade journal or association. However, you could try the IEEE *Transactions on Industrial Applications* or their *Transactions on Industrial Electronics*. For heating apps in general, check into *Industrial Heating* or *Process Heating*. For the new cool stovetops, check into *Appliance* and *Appliance Manufacturer*. For power electronics, try *PCIM*.

Information from seminars on the topic are also available. InductoHeat is one source for that. In particular, check out their two-volume proceedings from the Sixth Annual Induction Heating Seminar. That consists of two thick, self-published volumes that cover heat treating and mass heating, with lots of solid design details. Dozens of free app notes are also newly offered. The ASM also promotes induction heating seminars and courses.

One high-profile induction-heating supplier already mentioned is InductoHeat. Competitors include Tocco, Fuji, Huttinger, and American Induction Heating.

Useful sources for coils and flux concentrators include Alphaform and Lepel. Lepel is part of InductoHeat. Raychem is big on induction-heated shrink tubing.

One used induction-heater buy/sell service is Tocco, but more brands are found in the *Used Equipment Digest* or *Surplus World*.

On your own, you could probably pick up a re-workable ham or military

Names and Numbers

Batelle Pacific Northwest
Box 999 RL Conger
Richland WA 99352
(509) 372-4274

Leonard's Distributors
4125 Prospect Dr.
Carmichael CA 95608
(916) 967-6401

Maher Messinger
Box 420
Littleton CO 80160
(303) 798-6830

Planax North America
15 E 26th St. #1908
New York NY 10010
(212) 532-1988

Power Engineering
1421 S Sheridan Road
Tulsa OK 74112
(918) 835-3161

Synergetics
Box 809
Thatcher AZ 85552
(520) 428-4073

Thomson Industries
2 Channel Drive
Port Washington NY 11050
(800) 554-8466

Wood Machining News
PO Box 476
Berkeley CA 94701
(510) 943-5240

Induction Heating Resources

Alphaform
1525 Old Alum Creek Drive
Columbus OH 43209
(614) 253-8900

Am Induction Heating
33842 James Pompo Dr.
Frazer MI 48026
(810) 294-1700

Appliance
1110 Jorie Blvd. CS 9019
Oak Brook IL 60522
(708) 990-3484

Appliance Manufacturer
29100 Aurora Rd. #200
Solon OH 44139
(216) 349-3060

ASM International
9639 Kinsman Rd.
Materials Park OH 44073
(800) 368-9800

Fair Radio Sales
PO Box 1105
Lima OH 45802
(419) 227-6573

Franklin
7804 Montgomery Avenue
Elkins Park PA 19117
(215) 635-5252

Fuji Electric
Park 80, West Plaza
Saddlebrook NJ 07663
(201) 712-0555

HuttingerRF VII
1041 Glasboro Rd.
Suite F2
Williamstown NJ 08094
(609) 875-2121

IEEE Transactions
445 Hoes Lane
Piscataway NJ 08855
(908) 981-0060

InductoHeat
32251 N Avis Drive
Madison Heights MI 48071
(800) 624-6297

Inductotherm
10 Indel Avenue
Rancocas NJ 08073
(609) 267-9000

Industrial Heating
Box 2600
Troy MI 48007
(313) 362-3700

PCIM
2472 Eastman Ave. #33-34
Ventura CA 93003
(805) 658-0933

Process Heating
3150 River Road
Suite 101
Des Plaines IL 60018
(708) 297-3450

Raychem
300 Constitution Drive
Menlo Park CA 94025
(800) 227-7040

Surplus Record
20 N Wacker Drive #2500
Chicago IL 60606
(800) 622-5449

Tocco
1506 Industrial Blvd.
Boaz AL 35957
(205) 593-7770

US Government Bookstore
720 N Main St.
Pueblo CO 81003
(719) 544-3142

Used Equipment Digest
1100 Superior Ave.
Cleveland OH 44144
(216) 696-7000

surplus transmitter at Fair Radio Sales. Better still, modify a high level switching-mode power supply or PWM motor driver.

Book-on-Demand Binding

The Unibind people just came up with an interesting new home-binding solution. It's called the Binding Spine, and is basically a "U"-shaped plastic channel with some hot glue in it and a temporary positioning tag.

You pop your text and your front and back covers in it and drop it in a Unibind "toaster." The results look fairly sharp and the cost is under a dollar each.

There are three gotchas with this: You have to adjust your content to fit one of the fixed sizes (they are available in 1/8-inch increments). Second, you can not easily letter your spine. And, third, it looks much different than a "real" binding from a "real" printer.

Nonetheless, a new home-binding option is certainly welcome. I still like Unibind's Pentabind best of all. But all we really need is a sanely priced, prescored sheet of self-stick hot glue on a carrier. Planax comes close, except for its high price.

There is no reason such a product cannot be offered at seven cents per binding (user retail). And as the new Hewlett Packard 5SiMX makes full wraparound covers trivial, there are some great new opportunities out there. Contact Ron Leonard at Unibind for more details.

New Tech Lit

Electric-power generators reaching a stunning 60 percent efficiency are described in the July, 1966 issue of **Power Engineering**. The big trick, it seems, is to start off with a gas turbine, put a steam generator in the middle, and bottom out with an ammonia cycle.

Wood Machining News is a pricey newsletter on precision sawing for cabinet makers and such. *Maher Messenger* is a ventriloquism catalog and newsletter.

Free samples of Nyliner polymer bearings are offered by Thomson. Inventor-assistance source lists are available from R.L. Conger of Battelle Pacific Northwest. One is intended for non-commercial help, and a second for commercial services. But these days, only a total idiot would purposely call themselves an inventor. To do so is precisely the same as wearing a big animated neon talking sign that says "Please rip me off". Much more on this in my *Case Against Patents* package.

More on BOD binding options and opportunities in my book-on-demand publishing kit, which can be obtained per my nearby Synergetics ad. And don't forget to visit my new Web site, www.tinaja.com

As usual, most of the mentioned items appear either in the Names and Numbers or the Induction Heating Resources sidebars. Be sure to check there before calling our no charge technical helpline listed in the Need Help? box. EN

NEED HELP?

Phone or write all your US Tech Musings questions to:

Don Lancaster
Synergetics
Box 809-EN
Thatcher AZ, 85552
Tel: 520-428-4073

US email: don@tinaja.com
Web page: http://www.tinaja.com

BY CARL J. BERGQUIST

Visual Productions and Light Shows

LIGHTING IS NOTHING NEW TO THE ENTERTAINMENT INDUSTRY. SIMPLE CANDLE REFLECTORS, USED AS "FOOTLIGHTS", DATE BACK TO THE 1800s. WHENEVER NEW LIGHTING TECHNOLOGY CAME ALONG, IT WASN'T LONG BEFORE IT BECAME a part of entertainment presentations. Few forms of lighting, however, have offered the versatility of laser light effects. The ability to effectively control beams of light gives professional lighting technicians a tremendous edge over most other types of illumination.

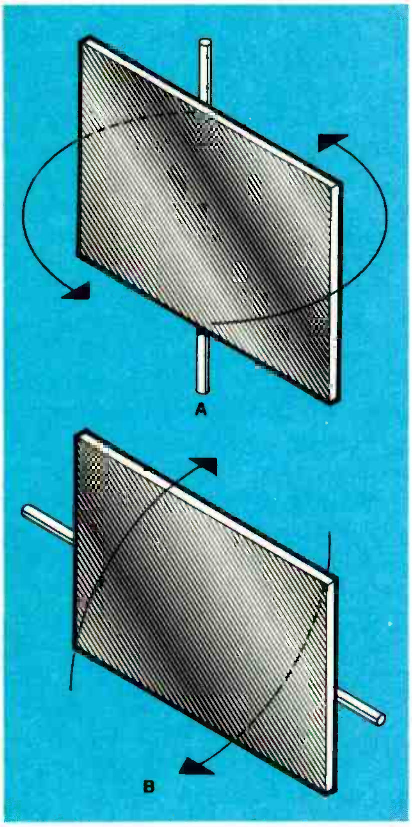


FIG. 1—X- AND Y-AXIS MOVEMENT is easy to understand. X axis movement revolves around the vertical plane—east to west (A); Y axis revolves around the horizontal plane—north to south (B).

Although dye lasers have been used in entertainment applications, this realm belongs almost exclusively to the gas lasers because of their visible beams of bright color. Copper-vapor tubes produce a pretty green with up to 150 milliwatts of power. Argon lasers emit anywhere from 10 milliwatts to 35 or 40 watts of blue. By using them with prisms or dichroic filters, other colors can also be produced. And don't forget the industry workhorse, the ruby-red helium neon, with outputs of 0.25 milliwatt to 25 or 30 milliwatts. Some HeNe tubes, due to an abnormal gas mixture, can produce 1 or 2 milliwatts of green radiance.

The choice of which type or combination of types to select depends upon a number of factors. The nature of the effects wanted, the intensity of the show, and the color or colors needed are all considerations, but the primary concern is probably going to be the size of the location where the production is to occur. For a small lounge or high-school dance, low-power lasers can be effective. However, when it comes to full-scale light shows, in large rooms or concert halls, there is little alternative to high-power argon tubes.

However, remember that those high-power units can be dangerous.

WARNING! ! !
This article deals with and involves subject matter and the use of materials and substances that may be hazardous to health and life. Do not attempt to implement or use the information contained herein unless you are experienced and skilled with respect to such subject matter, materials and substances. Neither the publisher nor the author make any representations as for the completeness or the accuracy of the information contained herein and disclaim any liability for damages or injuries, whether caused by or arising from the lack of completeness, inaccuracies of the information, misinterpretations of the directions, misapplication of the information or otherwise.

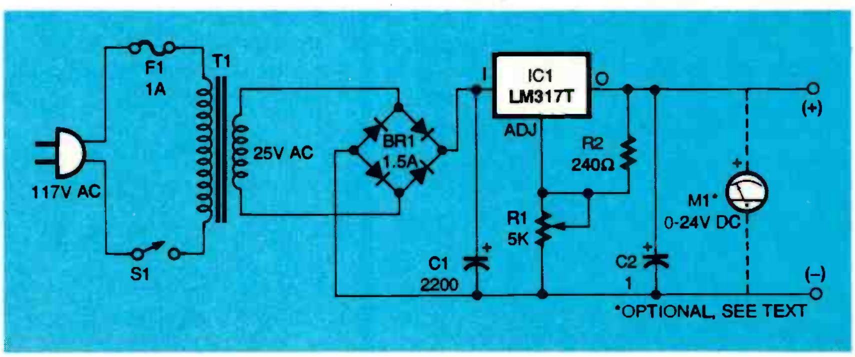


FIG. 2—A REGULATED VARIABLE-OUTPUT POWER SUPPLY is used to drive the mirror motors. Add a potentiometer in series with each motor to provide speed control.

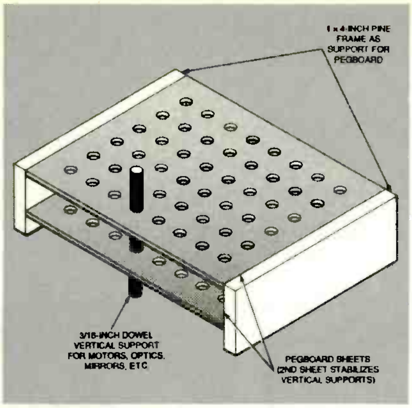


FIG. 3—YOU WILL NEED at least two of these optical tables. They are made from sheets of 3/16-inch pegboard and 1 × 4-inch pine. Be certain to align the holes in the two layers precisely.

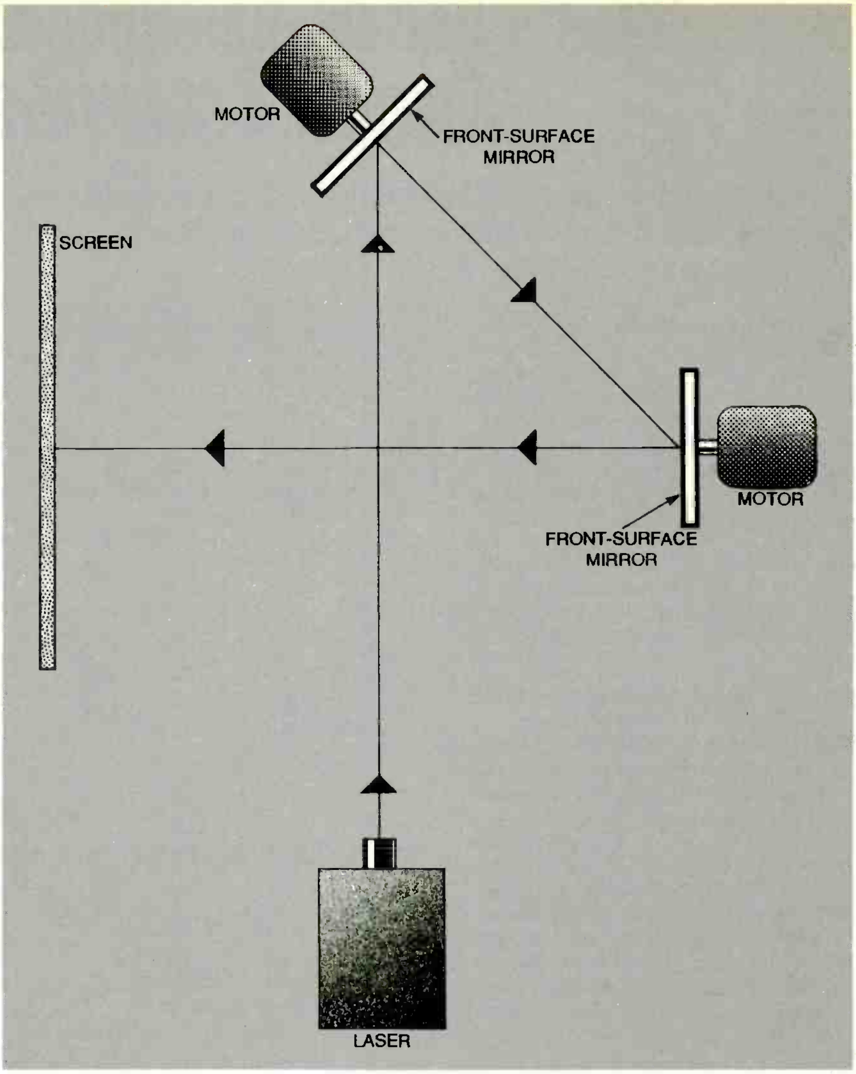


FIG. 4—A BASIC PATTERN-GENERATING setup is shown here. Two rotating mirrors are used. One affects the horizontal movement of the laser beam, the other the vertical movement.

There is an adage about peering directly into the beam of an argon laser. You'll only do it twice; once with each eye. So, if you work with argon lasers, a great deal of planning is needed in terms of beam direction, reflective surfaces, and optics, to keep the show safe for spectators, performers, and operators.

With that warning tucked away where you won't forget it, let's look at some of the ways exciting effects are obtained. We will explore simple equipment, and look at the principles behind sophisticated commercial machines. So let's get right to it.

Some Basics

The basis for any light-show equipment is a controlled method of moving and shaping the light. Throughout this discussion, references will be made to the X axis and Y axis. Those terms indicate the direction of the movement. Looking at a compass, X-axis motion is from east to west or west to east and is illustrated in Fig. 1A. The Y axis will be north to south or south to north and is shown in Fig.1B. Movement around those axis can be continuous in one direction, oscillate back and forth, or be a combination of both, depending on the desired effect. As a general rule, motion on the X-axis produces a horizontal line, bar, or sheet of light. Y-axis motion produces the same effect, but on a vertical plane. Experiment with rotating the X axis and Y axis individually to be sure you understand the basic principles before moving on to the first practical assembly.

Controlling the speed of movement has an additional influence on the visual image. For example, reflecting the beam into a very slowly revolving mirror will create a "dashing line" effect. As the speed of rotation is increased, the line will become solid. Aiming the laser at a mirror revolving in a circle will produce a circle or oval, depending on the angle of incident.

Speed can be controlled with commercial electronic units, but you can get acceptable results with the adjustable-output regulated power supply shown in Fig. 2. That power supply produces a very stable voltage output that can be varied between 1.2- to 24-volts DC by R2 . Potentiometers, wired in series with the motors but not shown in the diagram, are used to regulate the speed; they work by varying the voltage to the motor. The system is efficient and inexpensive, and the regulated power supply could be useful in a number of other applications.

The Optical Table

Before going further, you will need to build a couple of simple optical tables. Don't worry if you are inexperienced with woodworking as they are easy to make. Use standard pegboard (3/16-inch holes) and pieces of 1 × 4 pine (see Fig. 3). The smaller table should be 12 × 20 inches, and the larger one 24 × 30 or 36 inches. Between the two you should have all the room you'll need to set up the optics, motors, etc. needed for the various demonstrations.

Note that two sheets of pegboard are used for each table. The top one acts as a guide, and the lower sheet stabilizes the vertical supports. For that to work properly, you must line up the holes in both sheets precisely and maintain accurate right angles. Use 3/16-inch wood dowels for many of the supports; they are inexpensive and easy to work with.

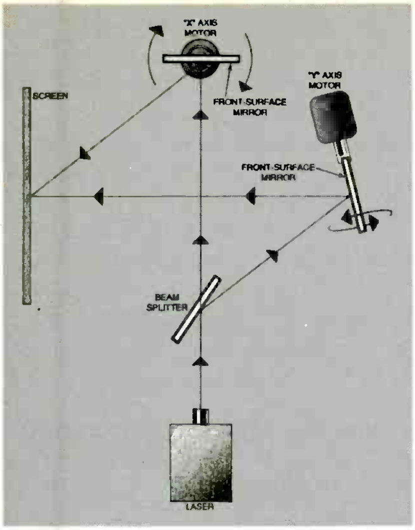


FIG. 5—INSERTING A BEAM-SPLITTER further enhances the variety of light patterns that you can create.

The height of a particular component can be adjusted by raising or lowering the dowel. You will find these tables handy when we explore holographic and scientific experiments later on in this series.

Some Experiments

The first, and simplest, assembly uses two motors. Each one has a round front-surface mirror mounted perpendicular to its shaft. Align the first mirror at about a 45-degree angle to the laser beam so that it reflects to the second mirror, positioned parallel to the beam. Figure 4 shows the correct orientation. The reflection from the second mirror projects back across the laser beam onto a screen made from an 8 × 10-inch sheet of cardboard with a sheet of white paper glued onto it.

With everything arranged as shown and the laser turned on, start one of the motors. A laser-light circle will appear on the screen. Next, adjust the angle of the motor, and watch how the circle shape becomes an oval. Now, start the second motor. A second, out of sync, circle will join the first, producing a "spirographic" effect on the screen. Add a 10,000-ohm potentiometer in series with each motor, and use them to vary the speeds of rotation. As you do, the pattern created on the screen will vary, providing a wide range of patterns.

While that is a very simple assembly, it provides the basics for more complicated layouts that will produce a fascinating number of pattern variations. For an immediate application, merely remove the screen, and aim the table, laser, motors, and all, at a nearby wall or ceiling.

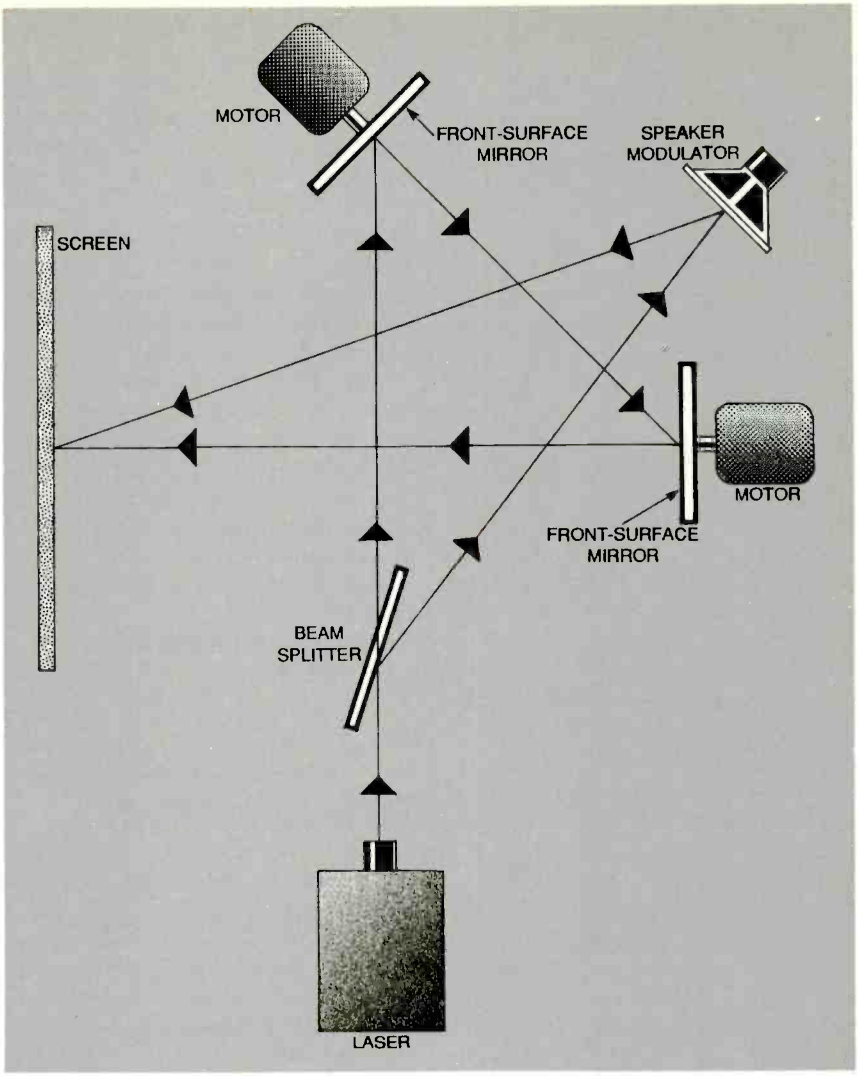


FIG. 6—COMBINING THE BEAM-SPLITTER with a speaker modulator produces an even greater variety of light patterns to add to your repertoire.

For a second experiment, we'll go to the X/Y-axis concept. Figure 5 shows a layout using two motors; one rotating a mirror on the X axis and the second on the Y axis. A 50/50 beam splitter sends half the laser beam to the first mirror, and, the rest to the other mirror. The two beams come back together at the screen, restoring the original intensity. When both motors turn at the same speed and the mirrors are in a vertical position, the projected laser light will form a solid cross.

If the X-axis mirror is angled to one side or the other, the line will follow the angle, and the image will change to a vertical line with a diagonal. Angling the Y-axis mirror will result in a similar variation of the vertical plane, and further distort the original cross. Now, slow one of the motors down. The line that it creates will become broken or dashed, giving you another distinctive pattern. It is easy to see the numerous kinds and varieties of patters that you can create by simply changing motor speed and mirror angle.

After you have run this setup though its patterns, you can add a second beam splitter and a speaker (used as a modulator), for another way to modify the patterns you produce on the screen. Figure 6 shows how that is done. Now the graphics you can create will include not only the spirographic designs, but a synchronized audio pattern as well. That third dimension is particularly effective when music is involved, as it provides continuous spiral patterns accented by the music's beat.

The beam splitter can be a 50/50 type that divides the light equally, or some other ratio, such as a 30/70, 40/60, etc. You can connect the speaker/modulator to a spare monitor output from the

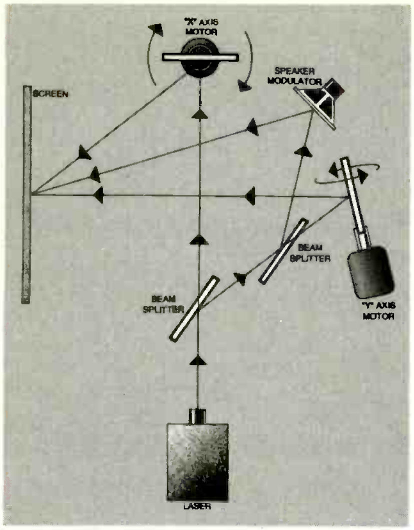


FIG. 7—IT MIGHT LOOK COMPLICATED, but as you continue to work with light effects, you will want to try this arrangement, too.

sound source. Optionally, it can be fed from a separate portable amplifier. The same additions can be made to the X/Y assembly for similar effects (see Fig. 7).

You can also make use of mechanical pattern generators. Using the arrangement shown in Fig. 6, replace the top motor with a revolving mirror ball.

You can use all of those methods of moving the laser beam to add excitement to the projected image. Work with a variety of combinations; the results will be fascinating and quite surprising.

Next time we will look at how a galvanometer coil can be added to your bag of tricks to provide an ever greater and perhaps more interesting variety of laser-light effects. Before you know it, you'll be producing outstanding light shows of your own. EN

NEW PRODUCTS

continued from page 71

turer, Newpoint Corporation's Satellite Smart Model DBS100P multipath power controller and surge protector is designed specifically for the special needs of the digital satellite system marketplace.

Satellite Smart combines a multipath power controller that simplifies the operation of a satellite entertainment system with a surge protector that is designed specifically to protect satellite receivers from power hazards. The power controller allows users to turn on and off up to four components with one touch. It is recommended that the television be designated as the master power component. When the TV is turned off or on, the rest of the components follow suit.

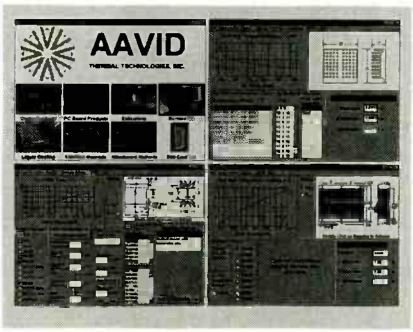
Satellite Smart provides shielded cable-TV protection to eliminate double images; protects pay-per-view telephone lines from power surges (with a clamping level of 275 volts); and provides a 20:1 reduction of EMI/RFI noise. In addition, three-line fusing prevents fire hazards, a right-angle plug saves space, a recessed power switch eliminates accidental turn-off, and a protection-status indicator warns of a lapse in protection. Newpoint offers a $15,000 "lightning insurance policy"—if the user's satellite equipment is damaged by a power disturbance or lightning strike while properly connected to the Satellite Smart, Newpoint will repair or replace the equipment up to $15,000.

Satellite Smart has a suggested retail price of $179.95.

NEWPOINT CORPORATION
6370 Nancy Ridge Drive
San Diego, CA 92121
Tel: 1-800-639-7647

Thermal Solution Software

Aavid Thermal Technologies' Cool Cat software provides design engineers with a powerful search engine and a complete palette of thermal-management solutions. When the end user selects from Windows-driven menus or enters data in response to prompts, Cool Cat assembles thermal components including interface materials and attachment methods (in the case of PGA and PC-board-level applications) into thermal solutions ranked in descending performance or height. It takes less time to develop multiple thermal solutions using Cool Cat than it does to select a single heat sink out of a catalog.



CIRCLE 24 ON FREE INFORMATION CARD

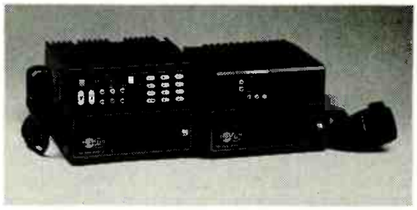
Cool Cat supports development of thermal solutions incorporating liquid cooling; stamped, die-cast, extruded, and cross-cut heat sinks; and heat sinks with bonded fins and integrated fans. It also takes into account interface materials, adhesives, and attachment methods. The software calculates complex algorithms, deriving thermal solutions under forced-versus-natural convection on the fly. It displays performance in an easy-to-view graphical format.

Cool Cat thermal solution software—which requires a 486 or higher process running Windows 3.1 or higher, and a minimum of 4 megabytes RAM and 9 megabytes of free hard disk space—costs $19.95, including free upgrades for one year.

AAVID THERMAL TECHNOLOGIES
One Kool Path
Laconia, NH 03247-0400
Tel: 603-528-3400
Fax: 603-528-1478
Web site: http://www.aavid.com

Base-Station Power Supply

Tripp Lite's TL 11 and TLC 11 DC power supplies are designed to match all popular two-way radios on the market and work as an integrated base-station installation. The 11-amp models are housed in compact, dark-metal cabinets. The TLC 11 features a metal enclosure designed to house and protect a radio, giving an integrated, professional appearance to any radio console.



CIRCLE 25 ON FREE INFORMATION CARD

The TL Series can be used to power practically any type of 12-volt DC equipment, including radios, test equipment, and other electronic gear. Continuous duty performance stands up to extended periods of operation. Both models provide excellent voltage regulation, automatic overcurrent protection, and full line isolation, to provide connected equipment with clean, stable DC power.

Suggested retail prices for the TL Series DC power supplies begin at $85.

TRIPP LITE
500 N. Orleans
Chicago, IL 60610
Tel: 312-755-5400
Fax: 312-644-6505
FaxBack: 312-755-5420
E-mail: info%tripplite@mcimail.com
Web site: http://tripplite.com EN

Electronic SHOPPER®

TUBES

SOVTEK

	1	10	25+	USED BY:
300B	$69.00	$59.00	$49.00	
5881/6L6WGC	7.90	6.90	6.20	Fender, Marshall, Soldano, VTL
5881WXT	8.90	7.90	6.90	Full size base, Fender
5AR4/GZ34	6.90	5.90	4.90	Matchless, Holland
5U4G	4.90	4.50	3.90	Mesa Boogie Dual Rectifier
5Y3GT	3.90	3.50	2.90	
6922	7.50	6.60	6.10	Audio Res., Melos, Convergent
6CA7	9.90	8.90	8.20	
6CG7	7.50	6.60	6.10	
6EU7	8.90	8.50	7.80	
6L6GB	4.90	4.20	3.75	
6L6GC	3.40	2.90	2.65	
6LQ6+	18.90	17.50	16.40	
6SL7	4.90	4.20	3.75	
6SN7	4.90	4.20	3.70	
6V6GT	3.90	3.15	2.90	Crate, HIMU
7199	10.90	9.90	8.90	
12AX7WA/7025	3.40	2.90	2.50	Fender, Hartke, SLM, Orange
12AX7WB/7025	4.25	3.75	3.40	Bedrock, Carvin, Demeter
12AX7WXT	3.90	3.40	3.10	Conrad-Johnson
12AX7WXT+	4.90	3.95	3.50	Telefunken "diamond" sound
12AX7WXT+ SELECT	6.90	5.95	5.50	Selected for gain & symmetry
EL34G	7.50	6.80	6.30	Quicksilver, Marshall, Orange
EL34G+	7.95	7.25	6.75	Improved reliability
EL84/6BQ5	3.25	2.75	2.30	Peavey, Crate, Fender
EL84M/6BQ5WA	7.50	6.60	6.10	Matchless

SINO-CHINA

	1	10	25+
300B	$49.00	$42.00	$38.00
807	6.90	5.90	4.90
811	7.90	6.20	5.30
812	12.00	10.75	9.70
813	25.00	23.00	21.50
845	27.00	25.50	22.00
2A3	12.90	11.90	10.90
211	21.90	19.50	17.80
5AR4/GZ34	7.90	6.90	5.90
6L6GC "Coke"	6.40	5.90	5.40
12AT7	3.70	3.40	3.25
12AX7A	2.90	2.20	1.95
12AU7	3.90	3.50	2.90
KT88	14.90	13.50	11.90
KT100	21.00	19.50	17.75

LIMITED SUPER SPECIAL!

12AX7a CHINA In individually marked boxes.

100 pcs $1.78 ea **1000 pcs $1.49 ea**

STANDARD MATCHING available on most octal power tubes. *75¢ extra per tube.* **Pairs, Quads, Sextets FREE** on 26 (same type) tubes or more.

PLATINUM MATCHING available with 24 hour test and burn-in, ensuring premium match. *$2.00 extra per tube.*

MasterCard VISA Visa/MasterCard.

Check out the Sovtek World Wide Web Site, http://www.turnstyle.com/sovtek

TESLA-CZECHOSLOVAKIA

	1	10	25+
KT88	$33.90	$30.90	$29.50
KT88BL sky blue glass	43.00	37.00	34.60
E34L	9.25	8.65	8.10
E34BL sky blue glass	15.90	14.80	13.70
E34RL light rose red glass	12.50	11.70	10.90
EL34	9.00	8.40	7.80
ECC83/12AX7	5.90	5.60	5.25
EL84/6BQ5	5.70	4.95	4.40

EI - YUGOSLAVIA

	1	10	25+
6CA7 "big bulb"	$11.50	$10.50	9.50
6CG7/6FQ7	6.50	5.80	5.20
12AT7/ECC81	4.90	3.90	3.60
12AU7/ECC82	4.60	3.80	3.20
12AX7/ECC83	4.50	3.60	2.90
12BH7	6.90	5.90	5.50
12DW7/7247	7.90	6.90	5.90
EL34	7.50	6.50	5.90
EL519/6KG6	11.90	10.90	9.90
KT90	28.50	25.80	23.90
PL519/40KG6	11.90	10.90	9.90

SVETLANA

	1	10	25+
EL34	$9.70	$9.30	$8.60
SV6550C	16.90	15.90	14.90

SOLID STATE RECTIFIER

BUILT INTO TUBE SOCKET.	1	10+
Direct Plug-in replacement for all 5Y3, 5U4 and 5AR4 types	$5.90	$5.50

2

NEW SENSOR CORPORATION

20 Cooper Square, New York City, NY 10003 • (212) 529-0466 • 1-800-633-5477 • Fax (212) 529-0486

CIRCLE 258 ON FREE INFORMATION CARD

FREE CATALOG
CALL TOLL FREE
1-800-338-0531
E-Mail: xpress@parts-express.com

Parts Express™

30 DAY MONEY BACK GUARANTEE!

340 E. First St., Dayton, OH 45402-1257
Phone: 513-222-0173 • Fax: 513-222-4644

Amplified Indoor FM Antenna

17" tall, amplified FM antenna. Improves reception with weak FM signals. 18 dB of gain. Includes AC adaptor, gain control, and 75 ohm coaxial cable terminated with an "F" connector.

HOT NEW ITEM!

#EN-219-055 .... $12.90

Cable TV Stereo Decoder

When used in conjunction with a cable TV converter or cable ready VCR, this handy device allows you to feed the cable TV stereo signal into your home sound system for superb audio reproduction of your favorite shows, movies, and sporting events.

#EN-189-110 .... $19.90

Digital Video Stabilizer

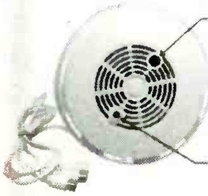
The digital video stabilizer will eliminate the constant picture distortion caused by the copyright protection on movie videotapes. This unit is fully automatic and operates on one 9V battery which is included.

#EN-180-320 .... $17.95

Decoy Cameras

These 1/3" CCD cameras offer a clever means of disguise. Both feature a 3.6mm wide angle lens, built-in electronic shutter, and a 12 VDC power supply. Minimum illumination: 0.3 lux. 400 line resolution. Smoke detector decoy camera includes an audio output.

AFFORDABLE HIGH TECH SURVEILLANCE!



Part #	Description	Price
EN-335-535	Smoke detector decoy	$249.50
EN-335-540	Decoy clock camera	299.95

"The Sound Bridge" FM Stereo Wireless Transmitter

The Sound Bridge is a mini FM wireless transmitter that can be used to broadcast stereo sound from any audio source like portable CD players, TVs, electronic games, CD-ROM, even computer soundcards, to your home stereo receiver! Adjustable from 89 to 95.5 MHz.

HOT NEW ITEM!

#EN-249-220 .... $14.95

Portasol/Weller Butane Soldering Tool

NO CORDS, NO BATTERIES!

This cordless, refillable, butane powered soldering tool is ideal for any on-site soldering job. Provides up to 35 watts with a temperature range up to 700 degrees F. Includes flint ignitor in plastic case, safety cut off switch, and C-2 chisel tip.

#EN-372-150 .... $25.95

150 MHz Oscilloscope Probe Kit

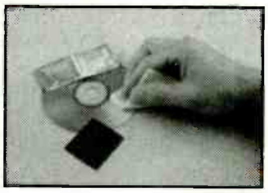
Deluxe probe kit features a modular design for longer life, switchable 10:1 probe with 150 MHz bandwidth, 2.8 ns rise time, and adjustable capacitance from 10-35 pF. 60" in length.

GREAT VALUE!

#EN-390-100 .... $29.95

Memorex CD Repair And Maintenance Kit

Don't throw away expensive CDs because of annoying mistracking and skipping errors! The Memorex CD Repair kit contains enough solution and materials to clean and repair 12 compact discs.



#EN-249-032 .... $1.95

5" Sealed Back Midrange

5" heavy duty sealed back midrange with deluxe mesh grill. 1" aluminum voice coil. Popular midrange for auto sound installations. •Power handling: 35 watts RMS/50 watts max •Voice coil diameter: 1 inch •Impedance: 8 ohms •Frequency response: 800-10,000 Hz.

#EN-280-030 .... $7.50

3 Channel Color Organ Kit

This sound to light unit features three separate outputs, which can be controlled independently. Each output reacts to three different bands of the musical spectrum: bass, midrange, and treble. Has built-in microphone, so no connection is required to music source, but a line input is provided.

SUPER QUALITY KIT!

velleman-kit

#EN-320-210 .... $59.95

1", Titanium Dome Tweeter

Features a ferro fluid cooled Kapton voice coil and a rubber surround. Very natural sounding high frequency reproduction with extended response to 30KHz.
•Power handling: 50 watts RMS/75 watts max
•Voice coil diameter: 1", •Impedance: 8 ohms
•Frequency response: 2500-30,000 Hz.

RESPONSE TO 30KHz!

Dayton Loudspeaker Co.®

#EN-275-050 .... $16.50

6-1/2" Woofer

Polymer resin treated paper cone with poly foam surround. Long throw voice coil design helps to deliver powerful bass output. Perfect for bookshelf type speakers. Mfg. #C16L020-51F. •Power handling: 60 watts RMS/120 watts max. •Voice coil diameter: 1-1/4 inches •Impedance: 8 ohms •Frequency response: 57-7000 Hz.

PIONEER®

#EN-290-023 .... $19.95

VISA | MasterCard | DISCOVER NOVUS

•30 day money back guarantee •$20.00 minimum order •We accept Mastercard, Visa, Discover, and company C.O.D. orders •24 hour shipping •Shipping charge = UPS chart rate + $1.90 ($5.00 minimum charge) •Hours 8:00 am - 8:00 pm ET, Monday - Friday •9:00 am - 5:00 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. •Quantity pricing available.

CIRCLE 262 ON FREE INFORMATION CARD

1-800-338-0531

TOP SECRET

CONSUMERTRONICS
P.O. Drawer 537
Alamogordo, NM 88311

Fax: (505)434-0234
Phone: (505) 439-1776
Tech & Customer Service:
(505)439-8551 (8AM-6PM,Mon-Sat)
For orders or prospective orders only!

Web Site
users.aol.com/wizguru/hi-tech.html

10% Off orders $100+ 15% Off over $200+
Add $5 total S/H (US, Canada). All items in stock. Postal M.O. is fastest. VISA, MC CC OK. COD ($49-$999), add $8. New Catalog (200+ offers) $2 w/ order, $5 w/o (no CC), $19/foreign.
Sold for educational purposes only.
*Software supports all IBM-PC systems

OFF-THE-SHELF HARDWARE

Van Eck Systems★Data Card Reader/Writers★ ATM3★Security/Surveillance★RF/EM/μWave/Radar/Ultrasonic/IR/Light/Sound Detectors/Receivers/Xmitters/Jammers/Blasters★Neurophone/Rife/Hieronymus/Resonant Crystal Radionics★ EM Lab/Weaponry/Countermeasures★ESS Infinity Devices ★Voice Disguisers★ Lineman's Handsets★ Bug/Tap Detector/Blaster ★Phone Color Boxes★ DTMF Decoders ★ Carjack/Kidnap Foiler★ Bumper Beeper/Child Finder ★Panic Button★Shriek Module★TENS ★Subliminal Mixer/Amp (Ultrasound & Infrasound) ★ Electronic Dowsers★Hidden Presence Detectors ★Hearing Assistor★Vortex Generator★6th Sense Communicator★Noise Cancel. System★Levitator - many more! See our New Catalog!

SPECIAL PROJECTS

We design/build/repair/modify/maintain/consult on any device/system/process/project - electronic/computer/mechanical/optical (eg: phone/auto/security/radionic/lab/energy/HV/EM/RF/radar/ultrasonic/IR/UV/commo/consumer) for business/personal/invention needs. Describe & include $30 pre-engineering fee (no obligation). Time & cost estimates 7-10 days. Confidentiality guaranteed.

CELLPHONE MODS

See our Catalog for our infamous cellphone modification guide ($69) - detailed, comprehensive, covers all makes - 10 times more info than competitor's "guide"). (Do Special Projects for up-to-date hardware/software). Free Data Search: As a special service to our C&CP customers, we will perform one FREE search of our massive cellphone database if requested within 30 days of your purchase of C&CP. Data now on cellphones is so great, we can fit in C&CP only that in greatest demand. Search results not guaranteed. Request by mail (don't fax); include a #10 SASE.

PAGER (BEEPER) MANUAL

Describes in detail how Pagers work, different types and uses, frequencies, advantages over and uses with cellphones, and tips and tricks. And how Pagers are hacked and countermeasures. Includes the plans for your own Personal Pocket Paging System (transmitter and receiver). $49.

HACKING FAX MACHINES

Describes in detail how Fax machines are hacked and countermeasures. Includes Fax protocols, commo parameters, compression, commands, spy switch. And insights into designing Fax interception devices and modifying existing Faxes into Stealth Faxes. $49.

VOICE MAIL HACKING

How Voice Mail Box systems are used and the ways they are hacked. Includes ASPEN, MESSAGE CENTER, BIX, GENESIS, EZ, SYDNEY, PHONE MAIL, AUDIX, CINDY, CENTAGRAM, SPERRY LINK, RSVP, etc. A must for users, sysops, security types! $29.

PBX HACKING

PBXs are hacked to the tune of $ Billions/yr! While "VOICE MAIL HACKING" details how VMSs are hacked- including VMS methods for hacking PBXs themselves - "PBX HACKING" addresses ALL issues relating to PBX hacking, including countermeasures! Can you afford a $90,000 phone fraud loss (avg. loss of hacked PBXs)? As described in Forbes. $29.

BEYOND VAN ECK PHREAKING

Eavesdropping on TV and computer video signals using an ordinary TV described in detail. Includes security industry reports. Range up to 1 KM. Plans include our and original Top Secret Van Eck designs! $29.

STOPPING POWER METERS

As reported on CBS "60 Minutes": How certain devices can slow down - even stop - watthour meters - while loads draw full power! Device simply plugs into one outlet and normal loads into other outlets. Also describes meter creep, overload droop, etc. Plans $29. I.G. MANUAL: External magnetic ways (applied to the meter itself) to slow down and stop watthour meters while drawing full loads. Plans. $25. KW-HR METERS: How watthour meters work, calibration, error modes (many), ANSI Standards, etc. Demand and Polyphase Meters. Experimental results to slow and stop meters by others. $25. Any 2, $47. All 3, Only $69!

PHREAKING CALLER ID & ANI

Details on how they work and dozens of ways of defeating Caller ID, ANI, *69, *57, and Call Blocking & *67. Describes Caller ID, Orange, Beige, Cheese and CF Boxes, ESS, SS7, E-911, various CLASS services, CN/A, NON PUB DA, CAMA, DNR, 800-ECR, Diverters, Extenders, Centrex - more. $29.

COMPUTER PHREAKING

Describes in detail how computers penetrate each other, and how VIRUSES, TROJAN HORSES, WORMS, etc are implemented. Dozens of computer crime and abuse methods and countermeasures. Includes disk filled with hacker text files and utilities, and the legendary FLUSHOT+ protection system (Ed. Choice, PC Magazine). BBS advice, password defeats, glossary - much more! Manual + Disks* $39.

BEYOND PHONE COLOR BOXES

Dozens phone color boxes described - many circuits. Plus Call Forwarding, Conferencing, Phreak History, Glossary, Diverters, Extenders, Loops, REMOBS, Bridging Heads & Cans, Optocom, 3rd Party and many other non-box methods - more. $39.

HACKING ANSWERING MACHINES

How answering machines are hacked to listen to - even erase - messages, and to convert them into mini-VMBs. And countermeasures - protect yourself from snoops, stalkers, burglars and pranksters! $29.

AUTOMATIC TELLER MACHINES

ATM crimes, abuses, vulnerabilities and defeats exposed! 100+ methods detailed, include: Physical, Reg. E, cipher, PIN compromise, card counterfeiting, magnetic stripe, false front, TEMPEST, Van Eck, tapping, spoofing, inside job, super-cool, vibration, pulse, high voltage - others. Case histories, law, countermeasures, detailed security checklist, labeled internal photos, figures. Recent $350,000 ATM crime spree still unsolved! $39.

CREDIT CARD SCAMS

Cardholders, merchants, banks suffer $ Billions in losses annually because of credit card fraud. Describes every known means of credit card fraud and scams. Protect yourself! $29.

CONS & SCAMS

Cons and related swindles fleece victims of $100+ Billion per year! The most comprehensive survival manual on cons & scams of all kinds - from the classic to hi-tech. Details on 100s and many variations. And countermeasures. Protect yourself! $39.

INTERNET CONS & SCAMS

Internet scams and related frauds rake in $2+Billion annually! Most are done anonymously and with little fear of prosecution (hard to prove or find perpetrators). Described in detail, includes countermeasures. $29.

THE HACKER FILES

Compilation of 100s of the best articles written (in ASCII) by top hackers & phreakers. Covers every major topic in hackerdom! 3 HD Disks* $59.

MIND CONTROL

Concern and fear increases over EM and ultrasonic mind (and body) control technologies - especially implants! Unfortunately, there is much more disinformation published than facts. Some victims are controlled and exploited by armchair "experts" and so-called victims' groups! $39. Visit our site at:
users.aol.com/wizguru/mindcontrol.html

UNDER ATTACK!

Electromagnetic Interference and Electronic Weapon Attacks cause: Cancer, birth defects, and profound psychological and physiological disorders! Destructive to people, plants, equipment! Includes ACTUAL CASES OF EM ATTACKS (we investigated)! Includes how to verify and pinpoint EMI and electronic attack sources, and effective countermeasures. $29. EM BRAIN-BLASTER: Tutorial and plans for powerful ELECTROMAGNETIC WEAPONS and LAB DEVICES. Optimum circuits, freqs, waveforms, duty cycles, intensities. Thorough. $29. Both Only $49!

HIGH VOLTAGE DEVICES

Plans: Stun Gun, Taser, Prod, Cane, Blaster, Flasher, Zapper, Audio/RF/Radar Jammer, Fence Charger, Plasma & Van de Graaff Gens., Jacob's Ladder, Geiger Counter, Ozone Gen., Fish Stunner, Plant Stim., Kirlian, more! All plans for only $29.

CIRCLE 226 ON FREE INFORMATION CARD

RF POWER
TRANSISTORS AND TUBES

In depth stocking of popular and hard-to-find Electronics Parts for Transmitters & Linear Amplifiers

Popular Transistors
2SC1969
2SC2166 • 2SC2290
2SC2312C • 2SC2879
MRF454 • MRF455
MRF455A • MRF477
MRF492 • MRF497
SRF3749 • SRF7000-90

Popular Tubes
6KD6 • 6JS6C • 6LQ6
M2057 • 6146B • 6146W
3-500Z • 3-500ZG
811A • 572B • SV6550C
7558 • 8417 • 8873
8874 • 8875 • 8877 • 8975

Order your FREE copy of our new Catalog by writing or calling us now.

(619) 744-0700 • (800) 737-2787
Fax: (619) 744-1943

RF PARTS
435 SOUTH PACIFIC STREET
SAN MARCOS, CA 92069

The **Smallest**, Most **Secure**, Best **Range**, **3 Channel** Remote Receiver.

Security Receiver for... Home Automation, Garage Doors, Home Security Add On, Auto Convenience Package (Door Locks, Trunk Pop, Windows-Up/Down, Car Start), N/O or N/C Contacts.

Security - 70 billion hopping codes with anti-scan processing. Unbreachable security; never repeats the same code twice. Double EEPROM memory.
Incredible Range - No cross talk or blockage. Range up to 1000 feet.
3 Channel - Our universal receiver controls up to 3 items with only one receiver (optional relay needed). Push both buttons together for third channel output.
Interfaces with most home and auto security systems for easy remote integration.
Comes with (1) three channel receiver, (1) long range three channel remote, (1) universal 120 VAC transformer.

ALL FOR ONLY $99.95 + shipping & sales tax.

Street Smart Security
619) 462-1167
7147 University Avenue • La Mesa, CA 91941
Send, Fax or Call Order In - Use Credit Card or Check. Fax (619) 462-0652

BLOWOUT! **TIMELINE INC.** BLOWOUT!

Over 10 years and 27,000 customers and still growing

LIQUID CRYSTAL DISPLAYS

240x64 dot LCDs with built-in controller.

AND 4021ST-EO. *Unit is EL back-lit.* $79.00 or 2 for $149.00
OPTREX. DMF5005 $69.00 or 2 for $129.00

160 x 128 dot LCD with built-in controller (T6963C)
20 character x 16 line **$79.00 or 2 for $149.00**
Mfr.: Toshiba TLX-1013-EO. *Unit is EL back-lit. Dim: 5⅛"L x 4⅛"H.*
The built-in controller allows you to do text and graphics.

Alphanumeric—parallel interface

16x1 ....3 for $25.00	20x2 ....$12.00	40x1 ....$8.00
16x1 (lg. char.)....$12.00	20x4 ....$25.00	40x2 ....2 for $25.00
16x2...................$8.00	20x4 (lg. char.)....$25.00	40x4 ....$25.00
16x2 (lg. char.)....$12.00	24x2 ....$12.00	4x2 ....$5.00
16x4.................$15.00	32x4 ....$10.00	

5V power required • Built-in C-MOS LCD driver & controller • Easy "microprocessor" interface • 98 ASCII character generator • *Certain models are backlit, call for more info.*

Graphics and alphanumeric—serial interface

size	Mfr.	price	size	Mfr.	price
640x480 (backlit)	Epson	$35.00	480x128	Hitachi	$15.00
640x400 (backlit)	Panasonic	$25.00	256x128	Epson	$20.00
640x200	Toshiba	$15.00	240x128 (backlit)	Optrex	$20.00
480x128 (backlit)	ALPS	$15.00	240x64	Epson	$20.00
			160x128	Optrex	$15.00

LASER PRODUCTS

HeNe Laser Head (10Mw max. output) TEMOO. 15.5" long MFG: NEC **$99.00**
Laser Power Supply (for HeNe tube) **$89.00**

LASER SCANNER ASSEMBLY $29.00
Assembly intended for a laser printer. Includes laser diode, polygon motor (6 sided) and misc. optics and lenses.

LASER DIODE (5mW) with collimator $20.00

VISIBLE LASER DIODE: 5mw at 670nm **$15.00**
Index guided. Threshold current 40 ma typical.

POLYGON MOTOR UNIT & DRIVER $79.00
Ten-sided first surface mirror mounted on an armature that spins at 125 revolutions per second yielding a beam sweep rate of 1250 sweeps per second. The driver for the polygon unit requires 24 volts and plus and minus 12 volts to operate. There is also an f-theta lens in front of the polygon scanning mechanism with a three inch diameter. Great for optical experiments, etc. Very high quality units. (MFR: JAPAN ELECTRONICS)

NETWORK

Proteon ProNet-4 Model p1347 Token Ring Board $49.00
16 bit • 4 Mbps • IEEE 802.2 and 802.5 compatible • twisted pair • interoperable with IBM Token Ring network

POS & BAR CODE

MAGNETIC CARD READER $25.00
Includes: • 20 character dot matrix display with full alpha-numeric capability • keypanel with full alpha-numeric entry • separate 7.5 VDC/0.5 Amp power supply • standard telephone interface extension cord • lithium battery and flat-cone speaker.

HP bar code wand (HBCS 2300).....................$25.00

POWER SUPPLYS

SWITCHING POWER SUPPLYS $12.00 or 2 for $20.00 115/230 Volts

73 WATT (2) 4 pin power connectors attached • Dim: 8.5" L x 4.5" W x 2" H
Output: +5V @ 2-9.75, A, +12V @ 0-1.5 A, -5V @ 0-0.4 A, -12V @ 0-0.5 A
68 WATT Dim: 5.5" L x 3.2" W x 1.7" H • Output: 5V @ 4 A, 12V @ 4A
60 WATT Dim: 8¾ x 4¼ x 3 • Output:5V @ 6A + 12V @ 1A - 5V @ 1A - 12V @ 1A

CHARGE COUPLED DEVICES

"The Spy In The Sky" $29.00 — **MATRIX TYPE**

Sony CCD Imager - designed for black and white composite video cameras. Picture elements: 384 (H) x 491 (V)
Chip size 10.7 (H) x 9.3 (V) mm² • Unit cell size 23.0 (H) x 13.4 (V) um².
Ceramic 24 pin DIP package • Mfr: Sony, Part# 016AL

LINEAR TYPE

4096 element CCD $19.00
1024 element CCD $15.00
2048 element CCD $15.00 • 1728 element CCD $15.00

MONITORS

Non-Enclosed TTL

Comes with pinout. 12V at 1.4 Amp input • Horizontal frequency 15Khz. • Ability to do 40 and 80 column.
5 inch Amber $29.00 • 7 inch Amber $39.00
9 inch Amber or Green $29.95

5" COLOR MONITOR $49.00

• Flat Faceplate • 320 x 200 Dot Resolution • CGA & Hercules Compatible
• 12 VDC Operation • 15.75 KHz Horiz. Freq. • 60 Hz Vert. Sync. Freq.
• Open Frame Construction • Standard Interface Connector • Degaussing Coil included • Mfr. Samtron

MISCELLANEOUS

ADAPTEC 4070A (RLL) OR 4000A (MFM), SCSI Controller, your choice $25.00

IBM 370 option XT and AT emulation boards $35.00

HACKER CORNER

POINT OF SALE BANK TERMINAL $49.00 or 2 for $89.00
• LCD Display 20 Char. x 4 Line • Printer 16 Column Dot Matrix - Epson • 24 Key Domed Membrane Keypad • Intel 80C32 Processor • 2 PCMCIA Sockets (ICC Slots) • Dallas DS1287 Realtime Clock • 2 Solid State Buzzers (Piezo Electric) • 4 Crystals • Rockwell Modem Chip • Telephone Line Interface (4 Pin "RJ" Connector) • RS-232 Interface (8 Pin "RJ" Connector) • NI-CAD Battery Pack Inside
Note: We have not been able to bypass an access code in the software. Thus, while time of day and other introductory things are displayed on LCD, the full original capabilities of this unit cannot be guaranteed. Also, we do not have a source for the smart cards that were to go in the PCM CIA sockets. Requires 12 volt adapter for power. (Not included) Dimensions: 9-1/2L x 6-1/4W x 2-1/2 D • Original cost over $450.00

CAMERA BLOCK $149.00

FOR ROBOTICS AND EVERYTHING ELSE

Unit is for Hi Band 8mm CamCorders, includes 8X zoom lenses, D/D converters, built-in CCD 2/3 in, 420 thousand picture elements, complementary mosaic filters. Excellent performance. High resolution, high sensitivity, low lag, low smear, good color reproduction, no distortion, 1/60-1/10000sec variable speed digital shutters, TTL auto focus, auto white balance, one-push auto white balance, auto/manual iris and gain up switch. Can be controlled by a 4bit micro computer. Remote controlling is possible for zoom and focusing. NOTE: These are PAL (European Standard) Units. **SONY PART #EVI-101 (PAL)**

CELL SITE TRANSCEIVER $79.00 2 for $149.00

These transceivers were designed for operation in an AMPS (Advanced Mobile Phone Service) cell site. The 20 MHz bandwidth of the transceiver allows it to operate on all 666 channels allocated. The transmit channels are 870.030-889.980 MHz with the receive channels 45 HMz below those frequencies. A digital synthesizer is utilized to generate the selected frequency. Each unit contains two independent receivers to demodulate voice and data with a Receive Signal Strength Indicator (RSSI) circuit to select the one with the best signal strength. The transmitter provides a 1.5 watt modulated signal to drive an external power amplifier. channel selection is accomplished with a 10 bit binary input via a connector on the back panel. Other interface requirements for operation are 26 VDC (unregulated) and an 18.990 MHz reference frequency for the digital synthesizer. The units contain independent boards for receivers, exciter, synthesizer, tunable front end, and interface assembly (which includes power supplies and voltage-controlled oscillator). Service manual, schematics and circuit descriptions included.

Encased Black & White Composite CCD Camera with Adapter
IR viewing to 1000 nm 7 ½ L x 2 ¾ W x 1 ¾ H
Comes complete with CCD camera, mounting nut on bottom of casing, 12VDC power supply. Excellent low light capability, standard RCA NTSC video out. **$89.00**
Great for: entryway security/remote monitoring, video conferencing/desktop video conferencing **2 for $159.00**
This miniature camera is perfect for multimedia computer applications as well as security and surveillance. NTSC output allows use with all popular video digitizing boards for Apple Macintosh and Microsoft video for Windows. Connects directly to any composite monitor or VCR with "video" input. Its razor-sharp wide-angle lens focuses from two inches to infinity and its state-of-the-art CCD technology accurately captures 16 level grayscale images for Quick Time movies and still pictures. Records at 30 frames per second and 260 lines resolution with excellent low light capability. Uses 12VDC (adapter supplied) and standard RCA cable.

Portable Micro Terminal $99.00 or 2 for $149.00 SOLD OUT

Flip up LCD display (9-16 VDC) • Can communicate with any computer having RS 232 port • Can communicate with another Microterminal ... microprocessor, data RAM (32K) and Video RAM (64K) • ... and set up capabilities. • Original intention for POS applications. • display size 40x16 (256 x 128 pixels.) Dimensions: 6.3" W, 11"L, 2"H. (With LCD up height is 7.1")

BAREBONES 286-12 COMPUTER $49.00 (2 FOR $79.00)
Slimline desktop case, 100 watt supply, math co-processor support. On board IDE, & Floppy controllers. 2 COM ports and 1 parallel port with software setup. Supports up to 8 Megs using standard 30 PIN SIMMs. Internal room for (1) 3 1/2 inch IDE hard drive and (2) 3 1/2 inch floppies. Four 16 BIT ISA slots, accepts full length AT size cards. Keyboard can be set to no test at boot. Case size is 15.5'W x 16'D x 4"H.
(Motherboard can be purchased separately: $29.00 or 2 for $49.00)

.6" COMPOSITE MINIATURE COLOR DISPLAY $149.00
Fully encased. Dim: 1.3" x 1.3" x 4". 12 Volts DC power. NTSC signal. 250 H x 300 V resolution. Focus adjustable eyepiece. Applications include camcorder viewfinder, helmet mounted display, etc... Original cost over $600.00

2539 W. 237th. St., Bldg. F, Torrance, CA 90505
Order desk only: **USA: (800) 872-8878 CA: (800) 223-9977**
L.A. & Technical Info: **(310) 784-5488** Fax: **(310) 784-7590**
OEM INQUIRIES WELCOME

Minimum Order: $20.00. Minimum shipping and handling charge $5.00. We accept cashiers checks, MC or VISA. No personal checks or COD's. CA residents add 8.25% sales tax. We are not responsible for typographical errors. All merchandise subject to prior sale. Phone orders welcome. Foreign orders require special handling. Prices subject to change without notice. 20% restocking fee for returned orders.

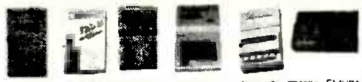
CIRCLE 275 ON FREE INFORMATION CARD

THE COLLECTED WORKS OF MOHAMMED ULLYSES FIPS

#166—By Hugo Gernsback. Here is a collection of 21 April Fools Articles, reprinted from the pages of the magazines they appeared in, as a 74-page, 8½ × 11-inch book. The stories were written between 1933 and 1964. Some of the devices actually exist today. Others are just around the corner. All are fun and almost possible. Stories include the Cordless Radio Iron, The Visi-Talkie, Electronic Razor, 30-Day LP Record, Teleyeglasses and even Electronic Brain Servicing. Get your copy today. Ask for book **#166** and include **$16.00 (includes shipping and handling)** in the US and Canada, and order from **CLAGGK Inc., P.O. Box 4099, Farmingdale, NY 11735-0793.** Payment in US funds by US bank check or International Money Order. Allow 6-8 weeks for delivery. MA05

PROGRAMMERS OVER 50 MODELS

ADVANTECH EETOOLS NEEDHAMS DATA I/O ICE TECHNOLOGY HILO SYSTEM GENERAL CHROMA MODULAR CIRCUIT TECHNOLOGY XELTEK



CALL ADVANTECH LABTOOL	629 EETOOLS SIMMAX
689 ICE TECH MICROLV	795 CHROMA SIMM/SIP
669 EETOOLS ALLMAX +	350 MOD-MCT-EMUPA/R
429 EETOOLS PROMAX	279 MOD-MCT-EMUP/R
439 EETOOLS MEGAMAX	49 EPROM 1G TO 512K
539 EETOOLS MEGAMAX4	79 EPROM 1G TO 1MEG
429 XELTEK SUPERPRO II	99 EPROM 4G TO 1MEG
529 XELTEK SUPERPRO II P	199 EPROM 16G TO 1 MEG
269 XELTEX SUPERPRO L	99 EPROM 1G TO 8MEG
179 XELTEK ROMMASTER II	129 EPROM 4G TO 8MEG
479 MOD-MCT-EMUPA	250 EPROM 8G TO 8MEG

General Device Instruments

Sales 408-241-7376 Fax 241-6375 BBS 983-1234
Web www.generaldevice.com E-Mail icdevice@best.com

Write your PIC programs in BASIC!

Still $99.95

The PicBasic Compiler converts your BASIC programs and BASIC Stamp I programs into hex files that can be programmed directly into a PIC microcontroller. *New* **Peek** and **Poke** instructions let you access PORTA, A/D converter and other on-PIC features in BASIC.

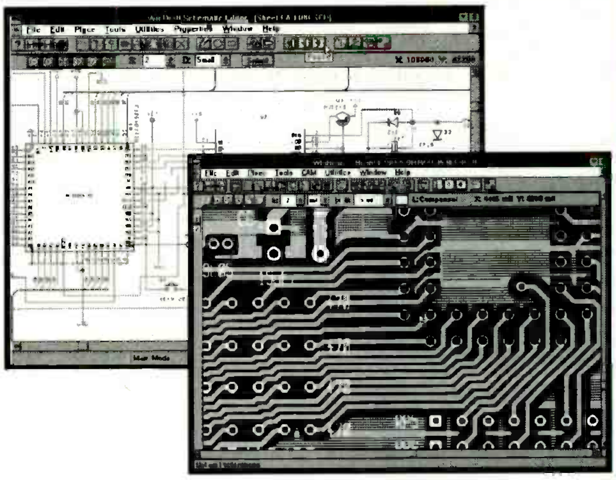
- Expanded BASIC Stamp I compatible instructions
- True compiler provides faster program execution and longer programs than BASIC interpreters
- In-line assembler and Call support
- Supports PIC16C6x, 62x, 7x and 8x micros
- Pocket PIC Programmers from $34.95
- PICProto prototyping boards $9.95 - $19.95

*BASIC Stamp is a trademark of Parallax, Inc.

microEngineering Labs
Box 7532 Colorado Springs CO 80933
(719) 520-5323 FAX 520-1867
http://www.melabs.com

Electronic CAD for Windows

Professional Windows EDA tools at an affordable price with powerful features to make designing faster. WinBoard PCB layout delivers sophisticated interactive routing for complex designs, plus it has the tools needed for high-speed circuits, analog, RF and SMT designs.



WinDraft® Schematics

- Use True-Type fonts. Quickly copy and paste into other applications.
- Supports hierarchical designs, electrical rules checking, Annotation & Bill of Materials.
- Thousands of library parts and symbol editor included.

WinBoard™ PCB layout

- Supports 16 layers, multiple copper pours, and advanced features for RF designs.
- SMD & through hole library with on-line graphical editor.
- CAM outputs include BOM, in-circuit test, NC Drill, Gerber, Pick & Place, & Advanced Design Rule Checking (DRC).

With our unique ***pin capacity*** versions you only pay for what you need. You choose the base configuration to suit your needs today, and expand that configuration to handle increased pin capacity as your design requirements change.

New Versions Available Now

$ 250 WinDraft or WinBoard - P650
$ 495 WinDraft or WinBoard - unlimited

$ 895 WinBoard P650 with CCT Specctra® autorouter.

Thousands of satisfied customers are using this new generation of powerful and affordable Windows EDA tools from Ivex. Your satisfaction is guaranteed!

World Wide Web: http://www.ivex.com

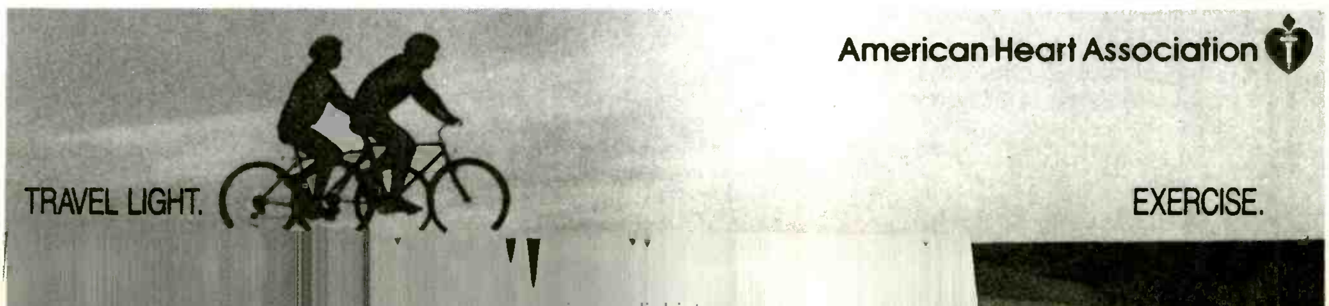
Information and free evaluation version is available on the Ivex WW Web, FTP and BBS.

Tel: (503) 531-3555
Fax: (503) 629-4907
BBS: (503) 645-0576

IVEX™ DESIGN INTERNATIONAL

Ivex Design International. 15232 NW Greenbrier Parkway. Beaverton, Oregon 97006. USA. ADV2_1

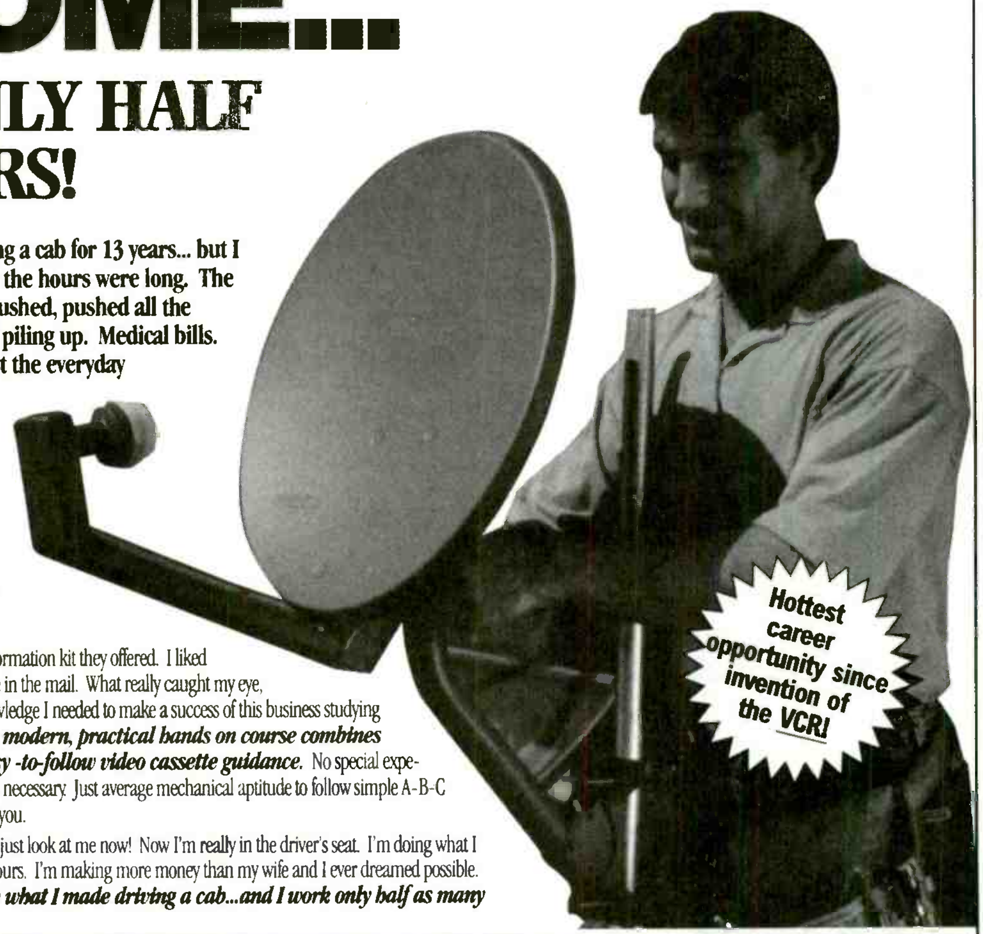
CIRCLE 325 ON FREE INFORMATION CARD



American Heart Association
TRAVEL LIGHT.
EXERCISE.

I DOUBLED MY INCOME...

WORK ONLY HALF THE HOURS!



I covered a lot of miles driving a cab for 13 years... but I sure didn't get anywhere! I mean the hours were long. The pay was short. My boss pushed, pushed, pushed all the time. In the meantime bills were piling up. Medical bills. House repairs. Charge cards. Just the everyday things. I was not just behind the wheel, I was behind the eight ball.

That's when I saw a magazine article that talked about the hottest big money-making career opportunities of the 90's. The one that interested me the most pertained to the ***NEW explosive SATELLITE DISH/TV/ELECTRONICS field.***

I mailed the coupon for the FREE information kit they offered. I liked what I saw when the information packet came in the mail. What really caught my eye, however, was the idea I could gain all the knowledge I needed to make a success of this business studying in my spare time at home. ***Foley-Belsaw's modern, practical hands on course combines simple step-by-step lessons with easy -to-follow video cassette guidance.*** No special experience, education or electronics background is necessary. Just average mechanical aptitude to follow simple A-B-C repair procedures that are clearly outlined for you.

I decided to get in on the action... and just look at me now! Now I'm really in the driver's seat. I'm doing what I want to do. I'm my own boss. I set my own hours. I'm making more money than my wife and I ever dreamed possible. ***Would you believe I'm making twice what I made driving a cab...and I work only half as many hours.***

Get in the *FAST LANE* on the New "INFORMATION SUPERHIGHWAY" Everyone's Talking About!

It's exciting! It's gigantic! The technology of tomorrow is here today! You've been reading and hearing about the amazing INFORMATION SUPERHIGHWAY. ***It's so NEW that few technicians are equipped to service this fast emerging field! Foley-Belsaw gives you SATELLITE DISH technology (including New MINI-DISH)...*** along with the electronics expertise you need to make BIG MONEY servicing TVs and other electronics equipment.

Be Your Own Boss!

It's quick and easy to become an expert at home in your spare time. Earn really BIG money adjusting, installing and repairing *Satellite Dish Systems, TVs, Amplifiers, CD Players, AM/FM Tuners, Home Entertainment Centers.* Every home, every business, every office in your area desperately needs your expertise!

Your Timing Couldn't Be Better!

Never before and probably never again will you have a ground-floor opportunity like this to get into a booming business of your own, make really big money, be your own boss and enjoy financial freedom and security. The fact you're reading this message shows you're smart enough to realize this!

Learn In Spare Time At Home!

It's easy to learn in your spare time at home. And when you complete the course you will receive Foley-Belsaw's official diploma acknowledging your accomplishment

Send Coupon Today for FREE Kit. No Obligation.

Don't miss out on this once-in-a-lifetime opportunity. Send in the coupon NOW. Get all the facts and study them in the privacy of your own home. There's absolutely no obligation and no salesman will call on you. So don't delay. Mail the coupon today.

"Took in over $3,200 in the past 10 days!"
H.H., Denver, CO

"Doubled my income within 6 weeks."
R.B., Bakersfield,CA

Mail for FREE Information Package

Foley-Belsaw Institute
6301 Equitable Road
Kansas City, MO 64120-1395

FOLEY BELSAW
Since 1926

Please Check Only ONE of the Following:

- ❑ Satellite Dish, Dept. 31337
- ❑ Computer Repair, Dept. 64462
- ❑ Gunsmithing, Dept. 92367
- ❑ PC Programming, Dept. 35285
- ❑ VCR Repair, Dept. 62565
- ❑ Vinyl Repair, Dept. 71225
- ❑ Locksmithing, Dept. 12876
- ❑ Small Engine Repair, Dept. 52752
- ❑ Woodworking, Dept. 43623
- ❑ Upholstery, Dept. 81292
- ❑ Saw & Tool Sharpening, Dept. 21691

Name ____________________

Address ____________________

City ____________________

State __________ Zip __________

Call Toll-FREE 1-800-487-2100

CIRCLE 331 ON FREE INFORMATION CARD

AFFORDABLE SOLUTIONS

EPROM EMULATORS Complete systems, ready to use. Test your code thru the printer port without disconnecting equipment. Emulators mounted in a quality case. **STD32**, $109, emulate (2764-27256). **STD64**, $129, (2764-27512). **PRO-SERIES** includes bi-directional communications with PC and 'real time link' to PC for single byte changes. Instant recovery battery back-up. **PRO128**, $199, (2764-27010). **PRO512**, $259, (2764-27040). Use multiple emulators to support 16/32 bit bus. $6 shipping.

8051/8031 SINGLE BOARD CONTROLLER. Only 1.8 X 3.0". Quality bare board with solder mask both sides and component outline. Complete with PC 8051 assembler and schematic. ONLY $19.95. Complete kit, $29.95. Add $4.50 for shipping.

EEPROM PROGRAMMER. Reads EPROMS FOR easy transfer to EEPROMS. Programs 2864-28256. Complete, ready to use. No more 15 minute erase burn cycles! only $49.95. $69.95 with case option. $5 shipping.

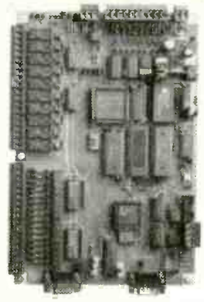
UNIQUE RING DECODER. Look like a big business without the bills. Have up to four numbers on a single line. Only $74.95. $5 shipping.

LOGICAL DESIGN TOOLS, INC.
5403 EVERHART, #55
CORPUS CHRISTI, TX 78411
SALES (512) 888-4535 FAX (512) 883-3711
http://www2.interconnect.net/ldti/hom.htm
Mail in orders welcom.

VISA M/C

FOR THE PROGRAMMER

BAC552ES CONTROLLER



- Enhanced BASIC Language
- Philips 80C552 MCU
- 6"x9" circuit board
- 10 5A relay outputs
- 3 LED or logic outputs
- 16 opto-isolated inputs
- 8 ch. 10 bit analog inputs
- 2 ch. 8 bit analog outputs
- Real Time clock/calendar
- 128K Static RAM
- 128K FLASH memory
- 256 byte serial EEPROM
- 3 serial ports (RS2323/485)
- IIC bus expansion
- Plug-on I/O terminal blocks
- Single 12Vdc operation

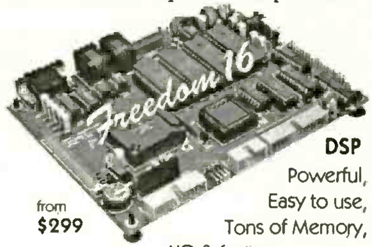
APPLICATION READY ONLY $334.95
Includes $14.95 Connector Package!

APPLICATIONS: Industrial control • HVAC systems • security • home automation • data logging • remote control & monitoring

SYLVA Control Systems a division of Sylva Energy Systems Inc.
519 Richard Street, Thunder Bay, Ontario, Canada P7A 1R2
Ph. 807-768-2487 Fax 807-683-6485 BBS 807-767-0587
WEB PAGE: http://www.sylvacontrol.baynet.net
Email: sylva@mail.baynet.net

16 Bit Control

& Data Acquisition System



DSP
Powerful,
Easy to use,
Tons of Memory,
I/O & features:

from $299

16.8MHz 68HC16
RS-232 & RS-485
RT clock option

34 digital I/Os (7 IRQ)
+ LCD/Keypad port
+ 8 ch 10b fast A/D

Affordable "C" compiler/library
Multi-tasking kernel
Up to 256K ea. SRAM, FLASH memory

INTEC INOVENTURES INC.
Ph: (604) 721-5150 FAX: 721-4191
http://www.islandnet.com/~iii

CONTROL YOUR WORLD

ModCon

32K HC11

Low Cost Microcontroller boards & kits + Applications

ZORIN http://zorinco.com or call (206) 282-6061

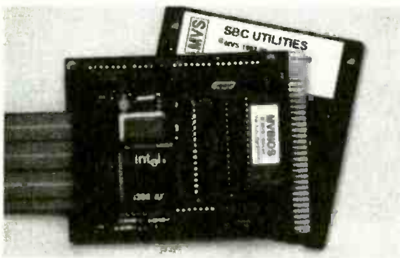
Don't waste another minute, send today for the latest free Catalog and a free sample booklet. Send your name and address to:

Consumer Information Center
Department TH
Pueblo, Colorado 81009

386 SBC $83

OEM (1K) PRICE
INCLUDES:
- 5 SER (8250 USART)
- 3 PAR (32 BITS MAX)
- 32K RAM, EXP 64M
- STANDARD PC BUS
- LCD, KBD PORT
- BATT. BACK. RTC
- IRQ0-15 (8259 X2)
- 8237 DMA 8253 TMR
- BUILT-IN LED DISP
- UP TO 8 MEG ROM
- CMOS NVRAM

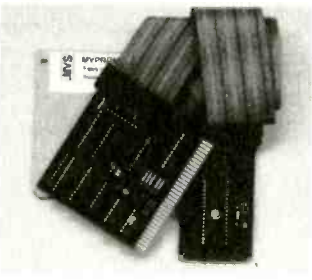
USE TURBO C, BASIC, MASM
RUNS DOS AND WINDOWS
EVAL KIT $295



$95 SINGLE PIECE PRICE

UNIVERSAL PROGRAMMER

- DOES 8 MEG EPROMS
- CMOS, EE, FLASH, NVRAM
- EASIER TO USE THAN MOST
- POWERFUL SCRIPT ABILITY
- MICROCONT. ADAPTERS
- PLCC, MINI-DIP ADAPTERS
- SUPER FAST ALGORITHMS



OTHER PRODUCTS:

8088 SINGLE BOARD COMPUTER	OEM $27	*95
PC FLASH/ROM DISKS (128K-16M)	21	75
16 BIT 16 CHAN ADC-DAC CARD	55	195
WATCHDOG (REBOOTS PC ON HANGUP)	27	95

*EVAL KITS INCLUDE MANUAL BRACKET AND SOFTWARE.
5 YR LIMITED WARRANTY
FREE SHIPPING
HRS: MON-FRI 10AM-6PM EST

MVS
MVS BOX 850
MERRIMACK, NH
(508) 792 9507

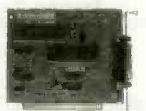
DATA ACQUISITION

Affordable Hardware and Software for PC's

ANA100 Analog I/O .... $ 99

- 8 Channel 8-Bit
- 0 to 5 Volt Input
- 14 TTL I/O lines
- Analog Output
- 400KHz Sampling

DIG100 Digital I/O .... $ 39



- 8255 PPI
- 24 or 48 TTL I/O Lines option
- Selectable Base Address

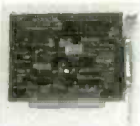
ANA150 Analog/Counter.., $ 89

- 8 Channel 8-Bit 0 to 5 Volt input
- 3 16-Bit Counters
- 400KHz Sampling

DIG200 Counter I/O .... $ 79

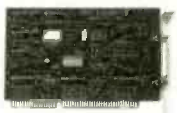
- 3 16-Bit Counters
- 8 TTL Input lines
- 8 TTL Output lines
- Selectable Clock Frequency input

ANA200 Analog I/O .... $ 79



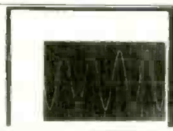
- 1 Channel 12-Bit 0 to 5 Volt input optional bi-polar
- 100KHz / 300KHz Sampling rate
- 24 TTL I/O lines

ANA201 Analog .... $ 129



- 8 Channel 12-Bit
- x1, x5, x10, x50 Programmable Channel gain
- 100KHz/300KHz Sampling rate

<NEW!> PC-SCOPEII - PC Oscilloscope Software
Use with our ANA100, ANA150, ANA151, ANA200, or ANA201 boards, for 1, 2, 4, or 8 channel capture and display of data on your PC. Oscilloscope, Storage, and X-Y modes of data display $49.00

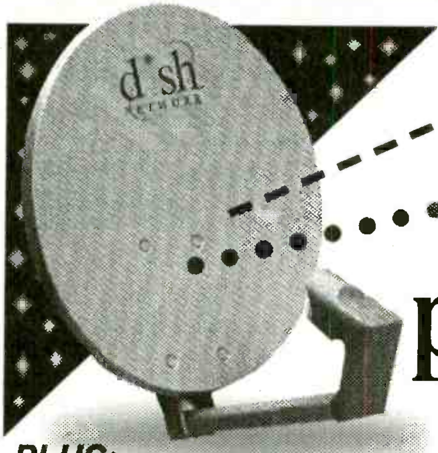


MasterCard/Visa orders accepted
More hardware and software items available, Call for information or
See our catalog on the Internet: http://www.bsof.com
E-mail: sales@bsof.com

BSOFT Software, Inc.

Phone 614-491-0832 * Fax 614-497-9971
444 Colton Road * Columbus, OH * 43207

Skyvision, Inc.®
1046 N. Frontier Dr. Fergus Falls MN. 56537



Small dish, BIG programming!

PLUS:

- Multi-room TV viewing options & accessories
- Mobile systems for RV's & vacation homes

AND MORE!

800·500·9264

Skyvision®
www.skyvision.com

40 of America's Most Popular TV Channels *includes* DISNEY

CALL NOW TO LEARN MORE!

- Makes cable & other 18" dish options obsolete.
- The HOTTEST digital programming available!

dish NETWORK℠

The Best Television Comes on a DISH℠

DISH Network is a registered Service Mark of EchoStar Comm. Corp.

FREE DISCOUNT BUYER'S GUIDE

KEEP YOUR SYSTEM RUNNING STRONG!

MOST COMPLETE SELECTION OF:

- ✓ System Upgrades
- ✓ Parts & Accessories
- ✓ Tune-up Tools & Kits
- ✓ Complete Systems
- ✓ Technical Support Hotline
- ✓ Discount SKYPAC℠ Programming

GET YOUR FREE ISSUE NOW!

800·334·6455

NEED A REPAIR ITEM FAST? WE'LL GET IT OUT TODAY!

Skyvision®
www.skyvision.com

CIRCLE 270 ON FREE INFORMATION CARD

DO-IT-YOURSELF AUDIO AMPLIFIER KITS

Mark V Electronics, Inc.
8019 E. Slauson Ave.,
Montebello, CA 90640
In business since 1985

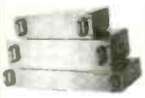
Enclosures at Unbeatable prices !

Free Catalog 213/888-8988 Fax 213/888-6868
Order 1-800-521-MARK / 1-800-423-FIVE

Kit skill levels are specified as ▲ beginner ▲▲ intermediate or ▲▲▲ advanced!

Metal Cabinets with Aluminum Front Panel

Best Buy



LG-1273	3x12x7"	$ 26.50
LG-1684	4x16x8"	32.50
LG-1924	4x19x11½"	38.25
LG-1925	5x19x11½"	42.00
LG-1983	2¼x19x8"	35.25
LG-1923	3x19x11½"	36.50
LG-1927	7x19x11½"	50.50

LG- Black anodized rack cabinet

New

*LL-1923B	2¾x19x12"	69.50
*LL-1925A	5x19x12"	79.50

*LL- High quality full Aluminum Cabinet
*LL- Front panel .157" & other panels .078"
*LL- Gold plated cap screw for front panel
- Dimensions in inches ±.05
- Custom-made for other dimensions if over 100 pcs for single model !

Modular Desktop Consoles

	L x W x H	
LE-453	4x4¾x3"	$ 7.50
LE-653	6x4¾x3"	9.75
LE-853	8x4¾x3"	11.75

LE- Black finished aluminum panel 1mm thick.

Camera Housing

*LD-1244	2¾x10¾x4"	$55.00
**LD-1516	3¾x13¾x4"	29.50
**LD-1565	4x13¾x5¼"	31.75

*LD- Stainless Steel 0.7mm
**LD- Sheet Metal 1mm

Alarm Box with Lock

Mejor Compra !

LB-1085	8¼x10¼x5"	$18.75
LB-1395	9¼x13¼x5"	25.50
LB-1525	12¼x15¼x5"	35.25
*LB-1494	9¼x14¼x4¼"	21.50
LB-1383A	8½x13¼x4"	23.25

*No lock & LB- Sheet Metal 0.8mm

Power Transformers &**Toroidal Transformer

001	28/30V x 2	6A	$ 30.00
002	36V x 2	3A	25.00
003	40V x 2	6A	32.00
**008	28/30V x 2	6A	40.00
**009	48/53V x 2	8A	66.00
**012	33/40/42Vx2	6A	48.00

TA-800MK2 ▲▲ 120+120W Pre & Main Stereo Amp. (4 lbs.)

Kit:$ 67.92
Asmb.$ 86.95

Power Output:120W into 4 ohms RMS. 72W into 8 ohms RMS. Frequency Response:10-20KHZ. THD: <0.01%. Tone Control: Bass ±12dB, Mid & Treble ±8dB. Sensitivity: Phono Input, 3mV into 47K. Line, 0.3V into 47K. Signal to Noise Ratio: 86dB. Power Requirement: 40VDC @ 6A. Suggested Mark V model 001 or 008 transformer. Recommended Metal Cabinet LG-1924.

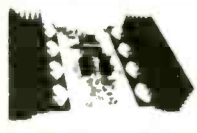
TY-35 ▲ FM Wireless Microphone

Clearance Sale

Kit:$ ~~12.50~~ $ 6.99

This is a low power real FM transmitter. Transmit frequency within 88 to 108 megahertz. Transmit range about 200 ft. It has high sensitivity sound pickup by a capacitance microphone. May be used strictly for series purposes such as remote wireless monitering.

AF-3 ▲▲▲ 300W MOSFET High Power Mono Amp. (7 lbs.)



Kit:$ 165.00 Asmb.$ 195.00

Power Output: 300W into 4 ohms RMS. 200W into 8 ohms RMS. Frequency Response: 10HZ-20KHZ. THD: <0.03%. Signal to noise ratio: 91dB. Input Sensitivity & Impedance at 1KHZ, 1V 47K. Load Impedance 4-16 ohms. Power Requirement: ±55 to ±65VDC 8A. Suggested Mark V model 009 Transformer. Capacitor 10,000uf 80-100V model 016 or 019. Recommended Metal Cabinet LG-1925 for each channel.

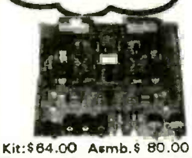
TR-503 ▲ Regulated DC Power Supply

Kit:$ 18.75 Asmb.$ 27.65

It is short circuit proof and has overload protection. Output voltage is variable over a range of 0-50V. Current limit trip is adjustable up to max of 3A. Suggested Mark V 002 transformer. (1 lb.)

TA-388 ▲▲▲ Class A FET Dynamic Buffer Stereo Pre-Amp (1 lb.)

Best Pre-Amp



Kit:$64.00 Asmb.$ 80.00

Frequency Response (at rated output): Overall 10HZ-100KHZ +0.5dB-1dB. THD: Overall <0.007% at or below rated output level. Channel Separation (at rated output 1KHZ): Overall better than 70dB. Hum & Noise: Overall better than 90dB. Input Sensitivity (1KHZ for rated output): 300-600mV. Maximum Output Level: Pre-Amp output 1.8V (0.1% THD). Power Requirement: 30V X 2 AC 500mA.

School Project Kits Source ...

SM-36	Dynamic Noise Reduction ▲	$ 26.00
TA-006	6W Mini-Amplifier ▲	9.50
TA-28	Digital Voice Memo ▲▲	9.90
TA-120	36W Class A Power Amp. ▲▲	32.50
TA-201	Mircophone Mixer Mono Amp ▲	20.79
TY-45	20 Bar/Dot Level Display ▲▲	38.25
TY-2	Flourescent Light Driver ▲	14.75
TA-50	Melody Generator ▲	13.85

SM-100 ▲▲▲ 150 MHZ 8 Digit Frequency Counter (2 lbs.)

Sale

Kit:$ ~~79.00~~ $ 65.00
Asmb.$ 99.00

Frequency Range: 10HZ-150MHZ. Gate Time: 0.01s, 0.1s, 1s, 10s. Input Sensitivity: KHZ range 10HZ-10MHZ 20mV(min.). MHZ range 1MHZ-120MHZ 20mV(min.), 120MHZ-150MHZ 35mV (min.), 150MHZ-200MHZ 40mV(typical). Time Base: 10MHZ crystal, ±10 ppm. Input Impedance: 1M ohm. Response Time: 0.2s. Resolution: 0.1 HZ: 10s gate time, 1HZ: 1s gate time, 10HZ: 0.1s gate time, 100 HZ: 0.01s gate time. Hold the last input signal. Reset counter to 0. DC 9V power adapter not included.

SM-720 AC/DC Stereo Pre & Main Power Amp.

Kit:$ 77.00
Asmb.$ 102.00

120Wx2 Music power. THD: <0.2%. Input Sensitivity: Tape, CD/Aux 300mV 47k ohm, Phono 3mV 47k ohm, Guitar/Mic 3mV (600-47k ohm). Tone Control: Treble & Bass ±8dB. Frequency Response: 20Hz-20kHz. Signal to Noise Ratio: 78dB. Power Requirement: AC 110/60Hz or DC 12-16V. Ready to plug in when assembled. Case & transformer included! ▲▲▲ (9 lbs.)

See our catalog for more kits!

Minimum order $ 20. We accept Visa, MasterCard & Money Orders. Checks allow 2 weeks for clearance. We ship by UPS ground inside US (2 lbs min $ 5.00) and ship by US mail outside US. Please call for orders shipping & handling or fax (foreign) orders. PO Orders are welcome from schools. We are not responsible for typographical errors.

CIRCLE 326 ON FREE INFORMATION CARD

ALL ELECTRONICS CORPORATION

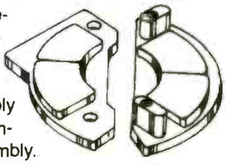
QUALITY PARTS

FAST SHIPPING

DISCOUNT PRICING

CALL, WRITE, FAX or E-MAIL For A Free 64 Page CATALOG. Outside the U.S.A. send $2.00 postage.

POWERFUL NEODYMIUM MAGNET ASSEMBLY



Four neodymium, rare-earth magnets mounted on two metal plates separated by 0.35" spacers. Probably originally part of a computer hard-drive assembly. Magnets are trapezoidal in shape, approximately 0.7" on two sides, 0.55" and 0.9" on the other two sides and 0.115" thick. Quite powerful for their size.

CAT# MAG-20 $3.50 each

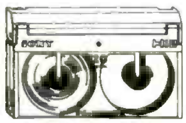
SPECIAL PRICING! 12 VDC MINI-FAN

Sunon # KD1206PTS1 12Vdc, 2.2 W fan. 60mm X 60mm X 25mm. Black plastic housing. Five blade impeller. 18" pigtail leads. While Supply Lasts!

$4.00 each CAT# CF-35

10 for $35.00

(USED) "HI-8" VIDEO CASSETTE

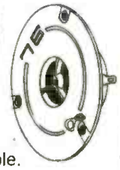


SONY Hi-8 Top quality, metal particle 120 minute video cassettes. Used for a short time, then bulk-erased. Each cassette has its own plastic storage box. Satisfaction Guaranteed.

$3.00 each CAT # VCU-8

10 for $28.00 • 100 for $250.00

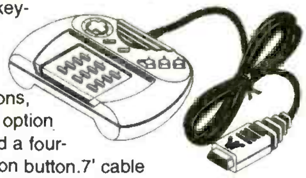
POLYMER DOME TWEETER



Infinity SL
3.7" diameter polymer face plate.
8 ohm impedance. No specs available.
Made for Infinity speaker systems.

CAT # SK-5 $3.50 each

ATARI "JAGUAR" CONTROLLER/KEYPAD



Cool-looking game controller for the Atari Jaguar system. Erogonomically designed black box has 12 button keypad (0-9, * and #), separate A,B,C buttons, pause and option buttons and a four-way direction button.7' cable terminated with hi-density DB-15 connector. 6.5" X 5" X 1.65"

CAT # EX-18 $2.50 each

10 for $20.00

STEREO 3.5 MM EXTENSION CABLE

6' shielded cable with stereo 3.5 mm mini-phone plug one end, 3.5 mm jack on other end.

$1.25 each CAT# CB-357

10 for $10.00

SPECIAL PRICE BI-COLOR LED

RED/ GREEN diffused.
T 1 3/4 (5mm) Three Legs
Center cathode.

CAT# LED-63 35¢ each

100 for $29.00 • 1000 for $250.00

SPECIAL PRICE! TWIST ON F-56 CONNECTOR

We recently made a large purchase of this twist-on co-ax connector for RG-6 cable. Special pricing while the supply lasts.

CAT #FTO-56R

100 for $15.00
500 for $50.00
1000 for $70.00

THERMOELECTRIC COOLER PELTIER JUNCTIONS

These incredible miniature solid state heat pumps raise or lower temperature in a small area almost instantly. Utilizing the Peltier effect these modules perform the same cooling or heating functions as freon based refrigerators but they do it with no moving parts, and are very reliable. Current applied to the device will produce heat on one side and cold on the other side, up to 68° C difference between the two sides. Modules can be mounted in parallel to increase the heat transfer effect or can be stacked to achieve high differential temperatures. 127 thermocouples per device. Operates on 3-12 Vdc. Requires a heatsink to prevent overheating.

1.18" (30 mm) square X 0.15" (3.8 mm) thick.
$17.00 each CAT# PJT-1 5 for $75.00

1.57" (40 mm) square X 0.15" (3.8 mm) thick.
$26.00 each CAT# PJT-2 5 for $110.00

Quantity Pricing Available!

ORDER TOLL FREE 1-800-826-5432

MAIL ORDERS TO:
ALL ELECTRONICS CORP.
P.O. BOX 567
VAN NUYS, CA 91408-0567

FAX (818) 781-2653 • INFO (818) 904-0524
INTERNET http://www.allcorp.com/
E-MAIL allcorp@allcorp.com

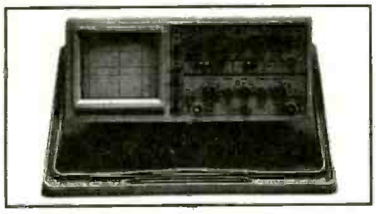
NO MINIMUM ORDER • All Orders Can Be Charged to Visa, Mastercard, American Express or Discover • Checks and Money Orders Accepted by Mail • Orders Delivered in the State of California must include California State Sales Tax • NO C.O.D • Shipping and Handling $5.00 for the 48 Continental United States - ALL OTHERS Including Alaska, Hawaii, P.R. and Canada Must Pay Full Shipping • Quantities Limited • Prices Subject to change without notice.

MANUFACTURERS - We Purchase EXCESS INVENTORIES... Call, Write, E-MAIL or Fax YOUR LIST.

CIRCLE 214 ON FREE INFORMATION CARD

New and Pre-Owned Test Equipment

Goldstar



Model OS-9100P → $899.00

Full 100 MHz Bandwidth!

- Dual-Channel, High Sensitivity
- TV Synchronization Trigger
- Calibrated Delayed Sweep
- Includes Two Probes, 2 Year Warranty

FREE SHIPPING! ON GOLDSTAR EQUIPMENT ANYWHERE IN THE U.S. Excluding AK & HI

BK PRECISION MAXTEC INTERNATIONAL CORP. Model 4040 $499.00

20 MHz Sweep/Function Generator

- 0.2 Hz to 20 MHz, 5 digit LED Display
- AM & FM Internal or External Modulation
- Sine, Square, Triangle, TTL, CMOS Outputs
- Burst Operation
- External 30 MHz Frequency Counter

NEW!

Pre-Owned Oscilloscope Specials

B + K Precision 1476 10 MHz $229.00
Great Starter Scope!

Tektronix 465	100 MHz	$599.00
Tektronix 465B	100 MHz	$699.00
Tektronix 475	200 MHz	$799.00
Tektronix 475A	250 MHz	$899.00

- The Industry Standard of Oscilloscopes
- Dual Channel, Calibrated Delayed Sweep
- Professionally Refurbished
- Aligned & Calibrated to Original Specifications
- 6 Month Warranty - The Longest Available!

LOWEST PRICES EVER!

NEW FLUKE MULTIMETERS & TEKTRONIX OSCILLOSCOPES

The Industry Standard in Multimeters
Model 79 II ..$172.00 Model 87 ..$285.00

NEW! TEKTRONIX TDS SERIES ON SALE!

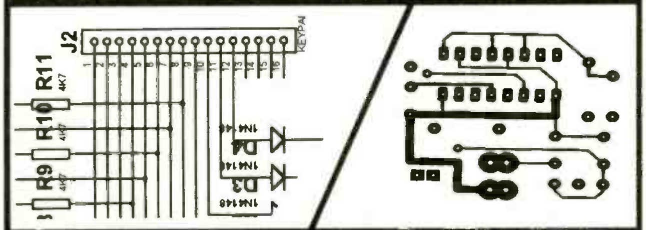
Test Equipment Depot
A FOTRONIC CORPORATION COMPANY
P.O. BOX 708 Medford, MA 02155
(617) 665-1400 • FAX (617) 665-0780

1-800-996-3837

VISA AMEX C.O.D. **TOLL FREE 1-800-99-METER**

CIRCLE 318 ON FREE INFORMATION CARD

EASY TO USE CAD



Now in
Both DOS and Windows

CADPAK *DOS - $159, WINDOWS - $199*
Ideal for New Users, Hobbyists, & Small Businesses! Provides everything for PCB Layout & Schematic Drawing.

PROTEUS *Starts at $425*
Most Powerful on the market
* Schematic Capture * Circuit Simulation
* PCB Layout with Rip-Up & Retry Routing

R4 SYSTEMS INC.
1100 GORHAM ST. Suite 11B-332
Newmarket Ontario, Canada L3Y 7V1
905 898-0665 FAX 905 898-0683

FREE DEMO WRITE OR CALL TODAY

Download Demo - http://www.r4systems.on.ca
Internet email info@r4systems.on.ca

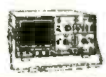
ELECTRONIX EXPRESS

For MORE Low-Priced Items Send For FREE 168-Page Catalog

WELLER SOLDERING STATION – *MODEL WLC 100*
- Variable power control (5 to 40 watts)
- Replaceable heating element
- Quality light-weight pencil iron

Part No. E0603WLC100 $37.95

DUAL-TRACE OSCILLOSCOPE
Goldstar 9020
20MHZ $339.00



DIGITAL MULTIMETER
WITH CAP/FREQUENCY/ TRANSISTOR TESTER $34.95
Part No. E01DM645

BK PRECISION **FUNCTION GEN.**
5 MHZ W/ DIG. DISPLAY
MODEL 4011
$230.00

ALLIGATOR LEADS
SET OF 10 $2.10
Part No. E05ALS1

SCOPE PROBE – 60 MHZ
SWITCHABLE X1, X10
Part No. E05SPAK220 $12.95

SWITCHES
8 POS DIP .... 60¢ ea.
Toggle Mini SPDT .... 50¢ ea. ON-ON

COMPONENTS

LM555	10 Min.	22¢ ea.
LM741	10 Min.	27¢ ea.
74LS00	10 Min.	18¢ ea.
7805 Regulator	10 Min.	30¢ ea.
2N3904	10 Min.	6¢ ea.
PN2222	10 Min.	6¢ ea.
Red LED T 1¾	10 Min.	6¢ ea.
Green LED T 1¾	10 Min.	7¢ ea.

TERMS: Min. $20 + shipping. School Purchase Orders, VISA/MC, Money Order, Prepaid. NO PERSONAL CHECKS, NO COD. NJ Residents: Add 6% Sales Tax.

365 Blair Road • Avenel, NJ 07001-2293
http://www.elexp.com (Email: electron@elexp.com)

800-972-2225 In NJ: 908-381-8020 Fax: 908-381-1572

CIRCLE 320 ON FREE INFORMATION CARD

USE ELECTRONICS NOW CLASSIFIEDS

READ BY ELECTRONIC BUYERS AND SELLERS AND TRADERS

INSTRUCTIONS FOR PLACING YOUR AD!

HOW TO WRITE YOUR AD

TYPE or PRINT your classified ad copy CLEARLY (not in all capitals) using the form below. If you wish to place more than one ad, use a separate sheet for each additional one (a photo copy of this form will work as well). Place a category number in the space at the top of the order form (special categories are available). If you do not specify a category, we will place your ad under miscellaneous or whatever section we deem most appropriate.

We cannot bill for classified ads. **PAYMENT IN FULL MUST ACCOMPANY YOUR ORDER.** We do permit repeat ads or multiple ads in the same issue, but in all cases, full payment must accompany your order.

WHAT WE DO

The first word and company name of each ad are set in bold caps at no extra charge. No special positioning, centering, dots, extra space, etc. can be accommodated.

RATES

Our classified ad rate is $2.50 per word. Minimum charge is $37.50 per ad per insertion (15 words). Any words that you want set in bold are each .40 extra. Indicate bold words by underlining. Words normally written in all caps and accepted abbreviations are not charged anything additional. State abbreviations must be post office 2-letter abbreviations. A phone number is one word.

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.

For firms or individuals offering Commercial products or Services. **Minimum 15 Words.** 5% discount for same ad in 6 issues within one year; 10% discount for same ad in 12 issues.**Boldface (not available as all caps),** add .40 per word additional. **Entire ad in boldface,** add 20%. **Tint screen behind entire ad,** add 25%. **Tint screen plus all boldface ad,** add 45%. **Expanded type ad,** add $4.00 per word.

General Information: A copy of your ad must be in our hands by the 13th of the fourth month preceding the date of issue (i.e. Sept issue copy must be received by May 13th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding work day. Send for the classified brochure.

DEADLINES

Ads not received by our closing date will run in the next issue. For example, ads received by November 13 will appear in the March issue that is on sale January 17. ELECTRONICS NOW is published monthly. No cancellations permitted after the closing date. No copy changes can be made after we have typeset your ad. NO REFUNDS, advertising credit only. No phone orders.

CONTENT

All classified advertising in ELECTRONICS NOW is limited to electronics items only. All ads are subject to the publishers' approval. WE RESERVE THE RIGHT TO REJECT OR EDIT ALL ADS.

AD RATES: $2.50 per word, Minimum $37.50

Send you ad payments to:
ELECTRONICS NOW 500 Bi-County Blvd, Farmingdale, NY 11735-3931

CATEGORIES

100 – Antique Electronics	270 – Computer Equipment Wanted	450 – Ham Gear Wanted	630 – Repairs-Services
130 – Audio-Video Lasers	300 – Computer Hardware	480 – Miscellaneous Electronics For Sale	660 – Satellite Equipment
160 – Business Opportunities	330 – Computer Software	510 – Miscellaneous Electronics Wanted	690 – Security
190 – Cable TV	360 – Education	540 – Music & Accessories	710 – Telephone
210 – CB-Scanners	390 – FAX	570 – Plans-Kits-Schematics	720 – Test Equipment
240 – Components	420 – Ham Gear For Sale	600 – Publications	730 – Wanted

CLASSIFIED AD COPY ORDER FORM

Place this ad in Category #________ **Special Category $30.00 Additional ________________**

1 - $37.50	2 - $37.50	3 - $37.50	4 - $37.50	29 - $72.50	30 - $75.00	31 - $77.50	32 - $80.00
5 - $37.50	6 - $37.50	7 - $37.50	8 - $37.50	33 - $82.50	34 - $85.00	35 - $87.50	36 - $90.00
9 - $37.50	10 - $37.50	11 - $37.50	12 - $37.50	37 - $92.50	38 - $95.00	39 - $97.50	40- $100.00
13 - $37.50	14 - $37.50	15 - $37.50	16 - $40.00				
17 - $42.50	18 - $45.00	19 - $ 47.50	20 - $50.00				
21 - $52.50	22 - $55.00	23 - $57.50	24 - $60.00				
25 - $ 62.50	26 - $65.00	27 - $67.50	28 - $70.00				

Total words ______ $2.50 per word = $______

Bold Face ______ $0.40 per word = $______

Special Heading ______ $30.00 = $______

Other ______ = $______

TOTAL COST OF AD $ ______

Total classified ad payment $______ enclosed

[ ] Check [ ] Mastercard [ ] Visa [ ] Discover Card # _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ _ Expiration Date _ _/_ _

Signature____________________

Name ____________________ Phone ____________________

Address____________________ City State Zip ____________________

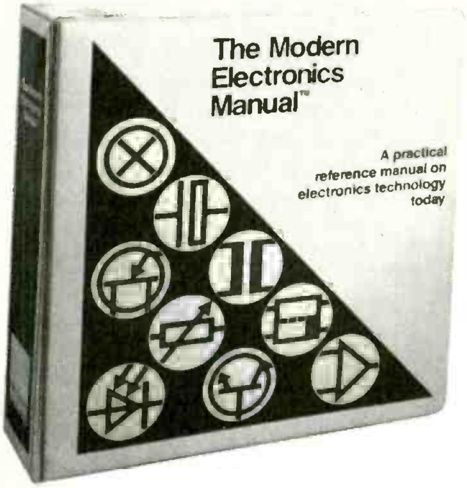
PC TECHNOLOGY

(Continued from page 57)

V.34-compliant, 28.8K (bps) model, though 33.6 models are now appearing on the market. Anything slower can make your online experience a chore, and any immediate savings can easily be eaten up by increased connect-time and telephone charges.

Another nice thing about today's modems is how effortlessly they can be installed in a Windows 95 system. Plug-and-play technology has eliminated much of the drudgery involved with changing jumper settings and resolving system conflicts. For non-plug-and-play systems, most modems ship with Windows and DOS drivers, which usually—though not always—work well. Note, however, that some new modem models are Windows 95 only; be sure of what you are buying if you plan to use your modem in an older system. Ω

Build It Yourself!



- A lifetime of exciting electronics projects
- Complete project plans
- Step-by-step instructions, flow charts, schematics, and photos
- Troubleshoot and repair
- Make your own printed circuit board (acetate board layouts provided)
- Component suppliers' addresses
- Handy 3-ring workbench binder

Electronics Fundamentals...
- Electronic Components and their Characteristics
- The Op-Amp Explained
- General Diagnostic Techniques

...plus much more!

Expand your knowledge while sharpening your skills!

Dozens of Exciting Projects such as...

☐ Simple Logic Probe
☐ Multi-Purpose Gas Detector
☐ Digital Combination Lock
☐ Radiation Detector
☐ Portable Frequency Counter

...and many other projects!

30 Day Free Trial Order Form

☐ Yes! Please rush me my copy of:
☐ Electronics Repair Manual for only $59.95 33014
☐ Modern Electronics Manual for only $59.95 33015
☐ Both Manuals for just $99.95. 33016

I may take $10 off the total price when I enclose my check or credit card authorization by **1/31/97** *. Plus, I get free shipping and handling! I understand that if I am not satisfied, I may return the book(s) within 30 days for a full 100% refund of the purchase price.*

☐ My payment is enclosed. I've deducted $10 if I am ordering by **1/31/97**.
☐ VISA ☐ MasterCard No. ____________ Exp ____
☐ Check Enclosed.
☐ Optional express delivery (available in U.S. only).
Enclose an additional $10 and we'll guarantee delivery within 5 business days from receipt of your order (prepaid orders only; no P.O. Boxes).
☐ Bill me later including $6.50 shipping and handling per book, subject to credit approval. *Signature and phone number required to process your order. P.O. Box addresses must be prepaid.*

Signature (required) ____________

Daytime phone ( ) ____________

Mr./Mrs./Ms. ____________

Company ____________

Street Address ____________

City ____________ State ______ Zip ______

Shipping and handling to Canada, $10 (U.S. Currency); Overseas, $15 (foreign orders must be prepaid); CT residents add 6% sales tax. Supplements will be sent 4-5 times a year on a fully guaranteed, 30-day trial basis. They may be cancelled at any time.

MAIL TO: WEKA Publishing, Inc.
1077 Bridgeport Avenue, P.O. Box 886, Shelton, CT 06484

Call 1-800-222-WEKA or fax to 1-800-256-5915 for fast service!

CIRCLE 311 ON FREE INFORMATION CARD

CABLE CONVERTERS/DESCRAMBLERS

★ ★ ★ ★ SUPER BUYS ★ ★ ★ ★

★ FULLY REFURBISHED UNITS ★

TOCOM™ ★ JERROLD™ ★ SCIENTIFIC ATLANTA™ ★ PIONEER™

"WE SERVICE MOST PRIVATELY OWNED CABLE CONVERTERS"

Phone **(219) 935-4128**

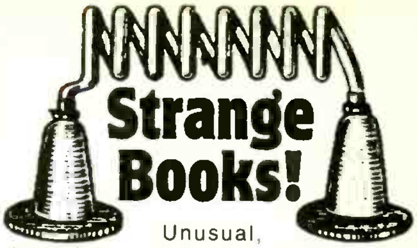
NCCA

SORRY, NO INDIANA SALES

NATIONAL CABLE BROKERS

1801 W. JEFFERSON ST., PLYMOUTH, IN 46563

OUR POLICY: All products carry a two year warranty. Warranty covers parts and labor and return shipping.
WARNING: Theft of cable services is a crime. National Cable will not knowingly defraud any pay TV operator and we will not assist any individual or company in doing the same.



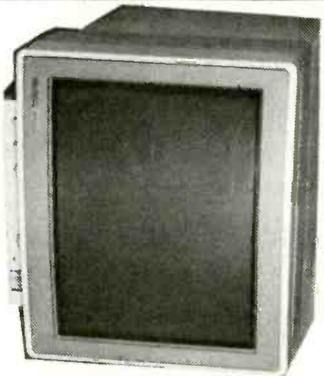
Unusual, detailed how-to books, manuals, references, old & new, for experimenters, builders, and mad scientists on high voltage, Tesla, crystal sets, very early radio and television, vacuum tube gear, plastics, chemistry, lasers, more! Repair cameras! Make neon signs! Make whiskey! Hydrogen fuel! A solar cell! A windmill! Electric bicycle! More! Highest quality! Guaranteed! Big illustrated catalog! Write!

Lindsay's Technical Books

PO Box 538-EBA, Bradley IL 60915

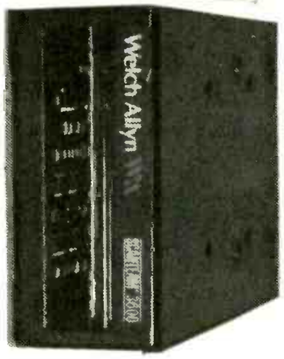
fax:815/935-5477•lindsay@keynet.net

17" Sony Trinitron Monitor



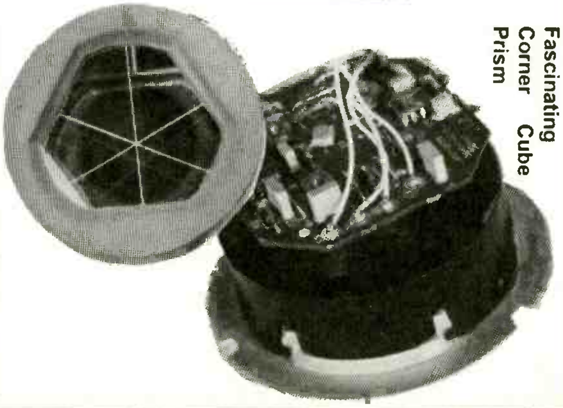
This is our most popular item. In good condition, they meet new unit specs. Not a multisync, works fine with Macintosh, or on IBM with Photon video card Tuned, with cables for Mac **$225.00**. With Photon video **$375.00**. Basic monitor **$175.00** 52 Lbs Shipping.

Welch Allyn Bar Code Reader



Dreaming about using bar code? Here is your big chance. this late model bar code reader is the Welch Allyn Scanteam 3600. Uses standard product barcode, easy to use, requires only 5 VDC. With full technical manual, works with standard bar code software. **$49.00** Postpaid. Unused.

Fascinating Corner Cube Prism



One of the most fascinating optical components, the corner cube directs light back to its source. Used by surveyors, planted on the moon by Apollo astronauts, these beautiful gem-like prisms are usually quite expensive. We have two types available:

1. 60 mm dia. 5 sec accuracy, surveyors type mounted 20mm offset.
2. Military assembly with corner truncated and electronic unit with IR filter, similiar specs. If you know what these were used for, please tell me.

Either type .....**49.00** Postpaid. Unused.

Dear Readers,

Ordering from V&M Surplus is easy. No minimum order, no hidden charges, most items postpaid. Your satisfaction guaranteed, or your money back. I am an avid collector, and right now I am looking for the following items: Norden Bombsight, M209 Converter (crypto-machine), K9 Ball Turret Sight. Cash or trade. *Franklin D. Fink CEO, CC&BW*

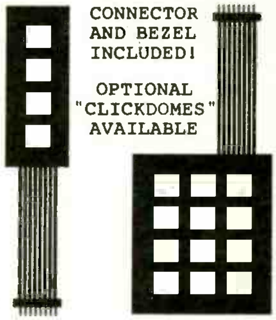
Vision and Motion Surplus
50 Main Street (Rear)
Ashland MA 01721
1-800-471-0747, 1-508-881-4900

CIRCLE 324 ON FREE INFORMATION CARD

MEMBRANE SWITCH KITS!

FLAT PANEL KEYPADS ASSEMBLE IN MINUTES WITH YOUR LEGEND

AVAILABLE IN 4, 12, 16, 24 & 40 KEY TYPES



INDUSTRIAL TYPES AVAILABLE

MORE THAN 30 LAYOUTS TO FIT MOST APPLICATIONS

CALL FOR FREE BROCHURE

SIL-WALKER

880 CALLE PLANO, UNIT N
CAMARILLO, CA 93012

PHONE: (805) 389-8100
FAX: (805) 484-3311

VISA / MASTERCARD

EZ-EP DEVICE PROGRAMMER - $169.95

Fast - Programs 27C010 in 23 seconds.

Portable - Connects to PC Parallel Port.

Versatile - Programs 2716-080 plus EE and Flash (28F,29C) to 32 pins.

Inexpensive - Best for less than $200

- Correct implementation of manufacturer algorithms for fast, reliable programming.
- Easy to use menu based software has binary editor, read, verify, copy, etc. Free updates via bbs or web page.
- Full over current detection on all device power supplies protects against bad chips and reverse insertion.
- Broad support for additional devices using adapters.

Adapters Available

EP-51 (8751,C51)	$39.95
EP-11 (68HC11 E/A)	$59.95
EP-PIC (16C5x,61,62x,71,84)	$49.95
EP-PIC64 (16C62,63,64,65,73,74)	$39.95
EP-PEEL (ICT 22V10, 20G10, 18V8)	$59.95
EP-SEE (93x,24x,85x)	$34.95
EP-16 (16bit 40 Pin EPROMs)	$49.95
EP-49 (8742,48,49)	$49.95
EP-750 (87C750,751,752)	$59.95
EP-Z8 (Z86E03,04,05,06,07)	$39.95
EP-55 (8755)	$39.95
EP-51-PLCC (8751,C51)	$59.95
EP-PIC-SOIC(16C5x,61,62x,71,84)	$59.95
EP-PLCC (PLCC EPROMs)	$49.95
EP-SOIC (SOIC EPROMs)	$49.95
EP-LCC (LCC EPROMs)	$49.95

M²L Electronics

3526 Jasmine #4; Los Angeles, CA 90034

310/837-7818 Fax/BBS: 310/841-6050

http://www.cs.ucla.edu/csd-grads-gs3/loving/www/m2l.html

CA orders add 8.25% sales tax. Ground shipping - $5; 3 Day - $7; 2 Day $10; Overnight $17; COD $4.75

MORE for LESS... Always!

Best Values for Performance, Features and Dependability

DM5050C, 42 Range
DMM + CAPACITANCE METER

- Digital Multimeter
  - Resistance - Up to **2,000** MΩ
- Capacitance Meter, Extended Range
  - Up to **20,000**μF (**9** Range)
  - Zero Adjust Knob
  - Test Leads and Bukit-in Socket
  - Check Motor Starting & Running Capacitance
- Triggering Lamp

DM5100, 45 Range
WIDE RANGE, ELEVEN FUNCTION

- Auto Power Off, Data & Peak Hold
- Measures Wider Range
  - Frequency - Up to **20** MHz
  - Capacitance - Up to **200** μF
  - Resistance - Up to **200** MΩ
  - Current - Up to **20** A AC/DC
- Logic - TTL
- TRhFE

± 0.25% Basic DCV Accuracy
1.5" Big LCD Display
3 1/2 Digit Manual
AC/DC Bolt & Amp
Resistance, Diode
Continuity Beeper
Alligator Clip Test Leads
Double Insulated Jack
Deluxe Holster
• Lead Holders
• Velcro Hanger
Tilt Stand

$89

- **Prices start at $44.95, measuring AC/DC 10 Amp. & Volt, Resistance, more and including protective Holster**
- **Lots more High Standard Test Instruments available**
  All in One Instrument, Oscilloscope, Power Supply, Function Generator, Freq. Counter, Multimeter, Capacitance, Engine Analyzer, Clamp-On, Electrical Tester and More.
- **See your local distributors or Call for Catalog**

Bel MERIT
SOLUTIONS FOR THE TEST INSTRUMENT

26242 Dimension Dr., Suite 110
Lake Forest, CA 92630
(714) 586-3700 • FAX: (714) 586-3399

CIRCLE 335 ON FREE INFORMATION CARD

CABLE TV DESCRAMBLERS

We Carry A Full Line Of Premium Converters And Descramblers Compatible With:

- **Scientific Atlanta™ Systems**
- **Jerrold™ Systems**
- **Tocom™ Systems**
- **Zenith™ Systems**
- **Pioneer™ Systems**

SATISFACTION GUARANTEED OR YOUR MONEY BACK!

BEST PRICES FREE CATALOG

Please have the MAKE & MODEL # of your full premium service cable box ready when you call!

ALLSTAR ELECTRONICS

800-782-7214

HOURS: 9-6 M-F 10-3 Sat EST

It is not the intent of Allstar Electronics to defraud any pay TV operator. Anyone implying theft of service will be denied assistance. All brand names are registered trademarks of their respective owners & are used for reference only. 110-64 Queens Blvd., #465, Forest Hills, NY 11375. NO NYS SALES!

WE HAVE IT ALL!
Surveillance

Infinity Transmitters
FM Wireless Transmitter Kits
Vehicle Tracking Systems
Bug Detectors
Caller I.D.
Wired Mikes
Telephone Register with Printer
Long-play Recorders
Shotgun Mikes
Telephone Recording Adapters
Alcohol Testers
Telephone Scramblers
Hidden Video Cameras
Telephone Tap Detectors
Drug Testers
MUCH, MUCH, MUCH MORE.

Our 27th Year!

Small catalog FREE.
Larger catalog send $5.

Mail Order only. Visa, MasterCard and C.O.D. accepted for equipment only.

Inquire for dealers' prices.

A.M.C. SALES, INC.
193 Vaquero Dr. • Boulder, CO 80303
Mon.-Fri. 8 a.m.-5 p.m. Mtn. Time
800-926-2488
(303) 499-5405 • Fax (303) 494-4924
Internet: http://www.siteleader.com/catalogdepot/AMCSC-home.html
E-mail: amc-sales@siteleader.com

CLASSIFIED

MISCELLANEOUS ELECTRONICS FOR SALE

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

FIBER-Optic Projects — Swing into the new technology by assembling tried and true projects recently published. "Practical Fiber-Optic Projects" - BP374 is only $9.95. (price includes shipping) **ELECTRONIC TECHNOLOGY TODAY INC.,** PO Box 240, Massapequa Park, NY 11762-0240.

GREEN Thumb Alert— Electronics enters the Garden! New exciting book points out how gardeners can build simple gadgets to pomote sucess where the elements work against you. Some of the projects are: over/under temperature monitoring, dusk/dawn switching, automatic plant watering, warming cables, etc. "Electronic Projects for the Garden" only $9.95 (price includes shipping) **ELECTRONIC TECHNOLOGY TODAY INC.,** PO Box 240 Massapequa Park, NY 11762-0240.

CBers Order new CB Trick III CB book. Shows CB tune ups, amplifiers, and expert CB info! Send $19.95 to **MEDICINE MAN** CB, PO Box 37, Clarksville, AR 72830.

RESISTORS 20 for $1.00. LEDs 4 for $1.00. Catalog $1.00. **ZIPFAST,** Box 12238, Lexington, KY 40581-2238.

POOR reception on your A.M. radio? Our Signal Booster will help. Guaranteed! Send $2.00 for details (refundable with order). **FALA ELECTRONICS,** PO Box 1376, Dept. 4, Milwaukee, WI 53201.

New! Surveillance, & PIC microcontroller, project kits.

Most kits use surface mount technology. Among the kits are an ultra small wireless FM mic, and our new phone transmitter SLeach™. All kits include our exclusive surface mount soldering guide. Many kits under $20, call !

Pager Decoder Interface for your PC, Only $19.95 + S&H

Includes shareware software.

We carry the TDA2005 20W Power Amplifier IC. Great for auto alarm projects!

Order 1-800-417-6689

Mon. - Fri. 9AM-5PM ET.
Visa, MC, Money Orders
IEC, P O Box 52347,Knoxville, TN 37950-2347

Sorry, no refund for used kits.
Do not use these devices without authorization from your local officials.
Prices subject to change. No TN sales.
This ad quotes cash discount pricing.
Returns are subject to a restocking fee.
©1996 IEC

INNOVATORS: Create! Measure/Log/Control: physical conditions, machines, mechanical/electrical/medical/scientific/industrial devices, processes. Data/control/alarms via modem. Time interval controller, Etc. Includes comprehensive ***instructional material, programs.*** For **non-computer-experts! Do-It-yourself!** Connects serial port personal computer. Flexible. Programmable. Low cost. **CYBER BOX,** Recording: 800-299-6971. Box 53743, Lubbock, TX 79453.

EEPROM programmers: EEP-1 $49.95 (kit $39.95); PEE-1 $54.95 (kit $44.95). Send check/money order to: **G.Y. Xu,** PO Box 14681, Houston, TX 77021. Add $5.00 ($6.00 Canada) S&H.

TEST chips & Test Aids. All types, most models. **Best products, best prices.** E-mail for your price list (xlent@hi.net). Page your fax no# to 800-401-8841. Full tech support. 30 day trial. Wholesale pricing. Credit card/cod O.K.

BEAUTIFUL solid state electronic clock! 170 LED's give stunning 3D appearance. 3 yr. warranty. Only U.S. $99.00 + $5.00 S&H. Order now! Brochure $1.00. **KROTEK ELECTRONICS,** 726 University Ave., Timmins, ON P4N 5J2. (705) 360-1826.

INVENTORS

REGISTERED Patent Attorney. Free handbook/advice. Patent/trademark protection for your ideas. 1 (800) 876-6670. **J.P. Halvonik.**

CABLE TV TURN-ON CHIPS

SUPER Cable TV "Test Chips". Provides full service activation. Excellent; Instructions & illustrations. **Jerrold Starcom:** DP(V)5..DP(V)7..DPBB7..CFT-2000..CFT-2200 series. **Pioneer:** BA-5000 thru BA-6700. **Pioneer: Custom Programmer** (Clears E2 & rewrites new I.D. codes). **Scientific Atlanta:** 8500 thru 8600. **Tocom:** 5503-VIP..5507. **Zenith:** ST-1000 thru ST-5612. **Call Now!! MASTER COMPONENTS 1 (800) 233-0570.**

THE CABLE TV SUPER CUBE

THE Mobilizer!! External "Test Cube" activator. **Easy plug-n-play** operation. Excellent instructions & illustrations. Supports all DP(V)7..DPBB7..CFT-2000..CFT-2200 series converters. **New enhanced performance features:** Locked box revitalizer! Restore command! Plus much more! **Dealers wanted! Call Now!! MASTER COMPONENTS 1 (800) 233-0570.**

BUSINESS OPPORTUNITIES

EXCELLENT extra income! Assemble easy products at home. Program guaranteed! 1 (800) 377-6000 Ext. 6870. Open Sunday.

PERSONAL computer owners earn thousands part time. Free report. 100 best ways. **C.A.P.A.E.** P.O. Box 12068, Hauppauge, NY 11788.

CONVERTERS & DESCRAMBLERS

TARGET ELECTRONICS
(800) 995-1749
We sell Test Chips!
MC; VISA, AE, C.O.D
DEALERS WELCOME!

SATELLITE EQUIPMENT

FREE catalog of big dish systems, upgrades, and accessories. Warranties, satisfaction guaranteed. **SKYVISION, 800-334-6455.** 1012 Frontier Drive, Fergus Falls, MN 56537. www.skyvision.com. See full page ad in the Shopper Section.

THE best television comes on a **DISH**℠. Digital 18" satellite systems, mobile satellite systems, home entertainment accessories, and more. **SKYVISION 800-500-9264;** 1018 Frontier Drive, Fergus Falls, MN 56537. www.skyvision.com. See our full page ad in the Shopper Section.

VIDEOCYPHER II descrambling manual. Schematics, video and audio. **Explains** DES, EPROM, CloneMaster, Pay-per-view (HBO, Cinemax, Showtime, Adult, etc.) $16.95, $2.00 postage. Schematics for Videocypher II Plus, $20.00. Schematics for Videocypher II 032, $15.00. Software to copy and alter EPROM codes, $25.00. VCII Plus EPROM, binary and source code, $30.00. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

OBTAINING sound for your **VCII** and **VCII Plus** is **easy.** No codes needed. Also **DSS Test Card** information. **Details 1 (800) 211-5635.**

DSS reverse engineering package. Software, schematics, chip programmer plans, reviews & more! $49.95. VISA/MC. **TELECODE,** 1 (520) 726-2833.

SOUND for Videocypher-11 and plus without codes. Free details. SASE. **NASSIRIAN,** Box 382-E, Rio Linda, CA 95673.

KU Satellite systems from $349.50 complete. Legally intercepts network feeds. Sports and news galore! No monthly charge. Free brochure. (520) 624-3907.

CABLE TV

ATTN, cable box owners. Order your ID signal and bullet stopper before it's too late. Send $23.00 to **R.R. ENTERPRISE,** Box 3532, Easton, PA 18043.

CABLE Descrambling New secret manual. Build your own descramblers for cable and subscription TV. Instructions, schematics for **SSAVI,** Gated Sync, Sinewave, (HBO, Cinemax, Showtime, UHF, Adult) $12.95, $2 postage. **CABLETRONICS,** Box 30502R, Bethesda, MD 20824.

CABLE TV Equipment & Accessories Wholesalers welcome! 30 day moneyback guarantee! Free catalog! **PROFORMANCE ELECTRONICS INC.,** 1 (800) 815-1512.

CABLE TV Test Chips for Jerrold, Tocom, Pioneer, Scientific Atlanta, etc...**Quick Installation!** New Multi-Mode modules available. Prices from $5.00 each. **1 (800) 786-9025.**

CABLE-safe. Guarantee cable privacy. The one-way valve for your cable TV signal. Cable signals come in, but they don't go out! $29.95 + $3.00 S&H. VISA/MC/AMEX. **ELECTROMAN,** Box 24474, New Orleans, LA 70184. (504) 482-3017.

"CABLE Unscrambled. Everything you want to know about cable, but are afraid to ask. $10.00. **"Descrambler Schematics Revealed."** A powerful guide to descrambling schemes. $10.00. **"Baseband Video Explained."** Discover what a Baseband Signal is and how it's constructed. $10.00. Special offer. Get all three for only $25.00! VISA/MC/AMEX. **ELECTROMAN,** Box 24474, New Orleans, LA 70184. (504) 482-3017.

UNIVERSAL Descrambler. Unscramble signals using your VCR as the tuner. Works with virtually any system, this is the only one you need. Declare cable box independence! Fully assembled. $129.95 + $5.00 S&H. VISA/MC/AMEX. **ELECTROMAN,** Box 24474, New Orleans, LA 70184. (504) 482-3017.

"BULLET Buster". Protect your cable box against the infamous cable "bullet". The "Bullet" Buster acts as an electronic shield. Installs in-line in seconds. Don't wait until it's too late! $19.95 + $3.00 S&H. VISA/MC/AMEX. **ELECTROMAN,** Box 24474, New Orleans, LA 70184. (504) 482-3017.

CABLE Descrambler! Anyone can build in **seven steps** with **Radio Shack** parts. **Plans/Kit** from **$5.00 plus free bonus!! 1 (800) 818-9103.**

DESCRAMBLER Cable using **simple circuit. E-Z to follow instructions** $10.00. **Complete kit** with **free "Bullet Stopper"**. $20.00.1 **(800) 522-8053.**

CABLE Bullet "Terminator/I.D. Blocker." Electronically shields yourself and your box. Factory direct. **Lifetime Guarantee $14.95. 1 (800) 820-9024.**

CABLE TV notch filters. Request our free brochure by calling our voicemail at 1 (800) 433-6319 or write to **STAR CIRCUITS** PO Box 94917, Las Vegas, NV 89193. Visit our web site at http://ourworld.compuserve.com/homepages/starcircuits

CABLE test modules/cubes. Pioneers, S/A, Tocoms, Jerrolds. Latest technology. Quantity discounts. Voice/Fax (718) 426-8515.

CABLE TV testers/descramblers. All makes/models. Best prices guaranteed! 1 Yr. warr. http://www.concentric.net/rmvideo1 or call (602) 581-1496.

CABLE TV, descramblers, converters. Quantity discounts. 30 day free trial. Competitive prices. Call now! 1 (800) 322-0921 **REGAL SALES, INC.**

DESCRAMBLE cable with simple circuit added to Radio Shack RF modulator and using VCR as tuner. Instructions $10.00. **TELCOM,** Box 832 E12, Brusly, LA 70719.

25+ Master test chip files. Jerrold, Scientific-Atlanta, Tocom, Pioneer, Zenith. Software & book. $79.95. **TELECODE** 1 (520) 726-2833.

CABLE TV descramblers. Pioneer 6310's, Scientific Atlanta, Jerrold. Warranty. Lowest prices anywhere! Houston, TX (713) 691-4610.

DESCRAMBLERS! Build your own with Radio Shack parts! **7 easy steps!!** Plans, + Two **money-saving** reports, send $10.00. **PAUL & CO.,** P.O. Box 100, Des Plaines, IL 60016.

"BULLET Zapper" and "I.D. Killer" Modules! Includes free descrambler plans! VISA/MC/AMEX/COD: $10.00. (3/$22.00). (912) 937-5485 Ext. 5. **BEL-LABS.**

CABLE box, master files & test modules for all types of CATV converter units. (909) 986-0971.

CABLE descramblers - Why rent! Own your own cable equipment. Access **all premium** and basic channels. Have model number of cable box when calling. **CABLE CONNECTION,** at 1-888-83-CABLE.

EDUCATION & INSTRUCTION

ELECTRONIC engineering. 8 volumes complete. $109.95. No prior knowledge required. Free brochure. **BANNER TECHNICAL BOOKS,** 1203 Grant Avenue, Rockford, IL 61103.

LEARN computer programming for windows. Home study. Free literature. **P.C.D.I.,** Atlanta, Georgia. (800) 362-7070 Dept. CPP342.

ELECTRONICS to Languages; US Military courses. Free catalog. **FTP,** Box 1218E, GlenLake, MN 55345.

TEST EQUIPMENT

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 US for catalog. Refunded on first order. **J.B. Electronics,** 3446 Dempster, Skokie, IL 60076. (847) 982-1973.

TECHNICIANS: Electronic component tester for use with oscilloscope. Satisfaction guaranteed. $29.95 plus S&H. Info: **ELECTROHM,** 529 Brentwood, Lawrence, KS, 66049. Fax: (913) 832-2481.

COMPONENTS

RARE blue LEDs 12 for $18.00, includes $4.00 S&H. CA residents add $1.44 tax. Hurry, quantities limited. **DIGITON,** 18620 Hatteras Street, #254, Tarzana, CA 91356-1827.

PLANS-KITS-SCHEMATICS

CRYSTAL set Handbook — Visit antiquity by building the radios your grandfather built. Assemble a "Quaker Oats" rig, wind coils that work and make it look like the 1920's! Only $10.95 plus $4.00 for shipping and handling. **CLAGGK INC.,** PO Box 4099, Farmingdale, NY 11735. US funds only! USA and Canada — no foreign orders.

FREE Catalog. 100 Leading-Edge kits. K1, PIC. Full instructions, source code. 1 (800) 875-3214. **SCIENCE FIRST,** 95 Botsford Place, Buffalo, NY 14216.

BUILD your own DC motor control. 1 to 480 amps w/surplus parts. **BEYOND ELECTRONICS,** 1 (800) 747-2861. Free catalog.

AWESOME kits: Voice changer, levitator, laser, gas sensor and more! Catalog $1.00. **LNS TECHNOLOGIES,** 20993 Foothill Blvd., Suite 307R, Hayward, CA 94541.

ELECTRONIC Project Kits. www.qkits.com 1-888-GO-4-KITS. 292 Queen St., Kingston, ON., K7K 1B8. **QUALITY KITS.**

HACKERS Catalog. **Hard-to-find** kits and assembled equipment **(Red box, spy, cable, etc.) Low prices.** $1.00. **SMITH-04,** Box 371, Cedar Grove, NJ 07009.

CARL'S Electronics - The Cable Hacker's Guide, Electronic Plans and Kits, and much more. Come check us out at http://www.ultranet.com/~carlton, or call for more information (508) 534-3228.

CELLULAR Hackers Package. (3) Hacker Bibles, (2) Videos & Programming software. $179.00. VISA/MC. **TELECODE** 1-520-726-2833.

SCHEMATIC capture, netlists ready for PCB layout. Give your design a professioinal look. (516) 756-9092. Stevef1@juno.com.

GIANT programmable digital house number. You build it. You make it work! Complete schematic and instruction. Send $10.00 to: **TMW ELECTRONIC SPECIALTIES,** 2150N Beachwood Dr., STE 10, Los Angeles, CA 90068. Dept. R&D.

ELECTRONIC Kits: Big selection for hobby/home/car/garden/pets/family security. Save money by assembling everything yourself. Free catalog! **TECHNO LAB,** 1035 S. Hayworth Ave., Los Angeles, CA 90035. Phone (213) 931-8084, Fax: (213) 931-8614.

FM Micro Broadcasting: Transmit many miles. PLL mono/stereo. 88-108 MHz. Fully assembled. 1-100 W.R. F. amps. Call (718) 763-8302. **MICRO BROADCAST NETWORK.**

COMPUTER SOFTWARE

JOYSTICK-To-Mouse. Now run Windows with any joystick! "Fly" the internet! 3.x/95 compatible. Only $29.95! "www.IMGPresents.com" 1 (818) 346-3581, 1 (800) 889-0987.

SECURITY

SURVEILLANCE Privacy security protection. Catalog $5.00. **SPY EMPORIUM,** 6065 Hillcroft, Suite 413, Houston, TX 77081. (713) 774-1000.

REPAIRS-SERVICES

NEED a custom case or special fabricated part for your electronic invention or product? Need design help for the same? Prototypes & production parts. **CUSTOM ALUMINUM CASTINGS,** 5443 Middletown Rd., Waynesville, OH 45068. (513) 897-2769.

AUDIO-VIDEO-LASERS

VIDEO Stabilizer. Eliminates all the latest copyguards on rented videotapes. 30 day moneyback. AC powered. $47.95 + $6.00 S&H. **STAR DEVELOPMENT,** Box 92457, Milwaukee, WI 53202. (414) 860-1471.

Create Your Own Virtual Worlds and Share Them with 10 Million People!

- *Learn How to Build Your Own Virtual Reality "Virtual Worlds" Quickly and Easily!*
- *Explore your Virtual Worlds on Your PC or put them on the Internet for Others to Explore!*
- *Explore your Worlds with your PC monitor and keyboard, or with Greater Immersion using Low-cost Homebrew Virtual Reality Equipment!*

Convert this $69 Mattel Powerglove into a VR Glove! Save $Thousands! We show you how, and where you can buy Powergloves!

VR Goggles with head tracking cost over $4,000 only a few years ago. Now they're under $500! And 3-D VR Shutter Glasses are under $100! Now Immersive VR is affordable!

"A Smorgasborg of info on VR!" -Sid Mirzad

"I love it! At under $5 per book, don't miss out on this Incredible Value!" -Pam Eifert

Desktop VR contains a complete primer on using VR on your PC, plus: • Where to get low cost HMDs (head mounted displays) & other equip • The famous Mattel Powerglove hack (converting a $69 Powerglove for use with VR) • Powerglove sources • Listings of virtual world building software • Comprehensive listings of HMD compatibility with popular games & software • Plus much more! • 36 pp.

VRML Primer explains VRML (Internet's "VR Modeling Language"), plus: • Building virtual worlds on the Internet • Virtual world authoring software & where to get it • Great VR worlds to visit on the Internet • Putting your virtual world on the Internet • More! • 32 pp.

Special Report: Virtual Reality an Exploding Technology Exclusive report on the explosion of VR in medical, amusement, consumer & other arenas • News blurbs on market entry by heavy-weights & Fortune 500's • The VR marketplace • 28 pp.

VR InfoMania Time saving valuable resources including Listings of Internet websites devoted to VR • Listings of VR books • Listings of VR magazine articles & research papers • Listings of Internet FTP download sites & VR-related newsgroups • Article listings from back issues of VR magazines • Where to go to experience real VR • Reviews of popular VR books • Glossary of VR terms • Great VR applications • The future of virtual sex • Plus Much More! • 88 pp.

FREE DOUBLE BONUS!

FREE! ***VR Resource Directory*** is your guide to over 600 companies involved with VR products, software, R&D & consulting, plus professional trade organizations, clubs, more! 80 pp. Yours absolutely FREE!

FREE! ***VR Cartoons*** featuring dozens of funny cartoons about VR! Yours absolutely FREE! Limited printing, don't miss out! Order today!

UNDER $5 PER PUBLICATION! **You Get All 6 Publications!**

~~ONLY $49!~~ Calif. residents add sales tax

OVER 1/3 OFF! **ONLY $29!** Plus $3.50 S&H

Special Introductory Price! Includes All 6 Publications!

2-3 Day Delivery $7.50 Fedex Overnight Air $14.90

30-Day 100% Satisfaction Money-Back Guarantee!

24 HOUR TOLL FREE ORDER LINE **1-800-951-7100**

FAX ORDERS 619-485-8968

Send Check or Money Order to: Virtual Reality Publishing 16486 Bernardo Center Drive. Suite 378. San Diego CA 92128

ORDER TODAY... HAVE IT TOMORROW!**

ADVERTISING INDEX

Electronics Now does not assume any responsibility for errors that may appear in the index below.

ADVERTISING SALES OFFICES

Gernsback Publications, Inc.
500 Bi-County Blvd.
Farmingdale, NY 11735-3931
1-(516) 293-3000
Fax 1-(516) 293-3115

Larry Steckler
publisher (ext. 201)

Christina Estrada
assistant to the publisher (ext. 209)

Arline Fishman
advertising director (ext. 206)

Michele Torrillo
advertising assistant (ext. 211)

Adria Coren
credit manager (ext. 208)

For Advertising ONLY

EAST/SOUTHEAST
Stanley Levitan
Eastern Advertising
1 Overlook Ave.
Great Neck, NY 11021-3750
1-516-487-9357
Fax 1-516-487-8402

MIDWEST/Texas/Arkansas/Okla.
Ralph Bergen
Midwest Advertising
One Northfield Plaza, Suite 300
Northfield, IL 60093-1214
1-847-559-0555
Fax 1-847-559-0562
bergenrj@aol.com

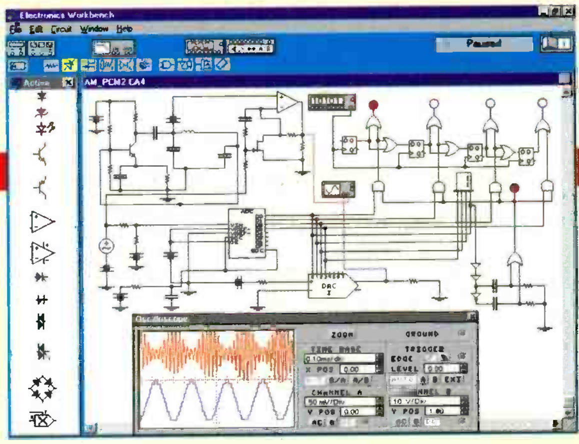
PACIFIC COAST
Janice Woods
Pacific Advertising
Hutch Looney & Associates, Inc.
6310 San Vicente Blvd.
Suite 360
Los Angeles, CA 90048-5426
1-213-931-3444 (ext. 228)
Fax 1-213-931-7309

Electronic Shopper
Joe Shere
National Representative
P.O. Box 169
Idyllwild, CA 92549-0169
1-909-659-9743
Fax 1-909-659-2469

Megan Mitchell
National Representative
1201 N. Rainbow Blvd., #50
Las Vegas, NV 89108-6819
1-702-259-7043
Fax 1-702-259-7043

Customer Service
1-800-999-7139
7:00 AM - 6:00 PM M-F MST

Better Designs –Faster



Guaranteed with Electronics Workbench!

Just click and drag to create and edit schematics. Mix analog and digital devices in any combination with full control over values, models and behavior. Try 'what if' scenarios and fine tune effortlessly. And on-screen waveforms always match actual circuit response. You'll create better designs faster—*Guaranteed!*

Guaranteed Satisfaction

Join over 70,000 customers and experience the power, flexibility and value that only Electronics Workbench offers. Receive unequaled service and free, unlimited technical support by phone, fax, e-mail, WWW, CompuServe and BBS. You'll be delighted. *We guarantee it.* *

True Mixed-Mode Power

Connect any analog or digital device to any other device without limit. Only Electronics Workbench offers this professional power for under $2,000.

Real-World Digital

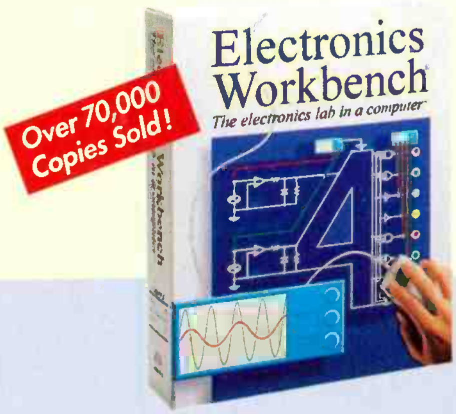
Real-world TTL and CMOS, complete with propagation delays and fanout. Unique at this price.

32-Bit Speed

Integrated SPICE analog and native-mode digital simulation in full 32-bit. Unique at this price.

Real-World Results

Unlimited supply of over 200 components and ICs and 350 real-world models—all perform as real devices.



Electronics Workbench®

$299

***30-DAY MONEY-BACK GUARANTEE**

VERSION 4.1 FOR WINDOWS 95/NT/3.1, DOS AND MACINTOSH.

Ask about our Engineer's Pack with thousands of additional models and more. Version 4.0 users call for your free upgrade.

800-263-5552

INTERACTIVE

Fax: 416-977-1818 Internet: http://www.interactiv.com

CompuServe:71333,3435/BBS:416-977-3540/E-mail:ewb@interactiv.com

INTERACTIVE IMAGE TECHNOLOGIES LTD., 908 Niagara Falls Boulevard, #068, North Tonawanda, New York 14120-2060/Telephone 416-977-5550

Australia: 2-519-3933 • Belgium: 2-384-73-09 • Brazil: 11-453-5588 • Canada: 416-977-5550 • Chile: 2-236-0300 • Cyprus: 9-641-801 • Czech Republic: 4-823-454 • Denmark: 33-25-0109 • Finland: 0-297-5033 France: 1-49-08-90-00 • Germany: 711-62-7740 • Greece: 1-524-9981 • Hungary:1-215-0082 • India: 11-578-7055 • Indonesia: 21-470-0815 • Israel: 3-647-5613 • Italy: 11-437-5549 • Japan: 3-5395-2126 Malaysia: 3-774-2189 • Mexico: 5-593-5260 • Netherlands: 10-450-4949 • New Zealand: 9-267-1756 • Norway: 22-16-70-45 • Philippines: 973-27-0118 • Portugal: 1-814-6609 • Singapore: 777-2303 • Slovenia: 61-317-830 South Africa: 331-6-8309 • South Korea: 2-3452-9757 • Spain: 1-383-8335 • Sweden: 8-740-5500 • Taiwan: 2-366-0080 • Thailand: 2-398-6952 • UAE: 4-453505 • UK: 203-23-3216 • USA: 416-977-5550

CIRCLE 126 ON FREE INFORMATION CARD