48783

Radio-Electronics®

BUILD A SECURITY SYSTEM FOR YOUR HOME

BUILD A SATELLITE RECEIVER FOR $100

$1.95 JAN. 1986
IN CANADA $2.50

TECHNOLOGY - VIDEO - STEREO - COMPUTERS - SERVICE

BUILD THIS SATELLITE TV RECEIVER
Great performance for under $100

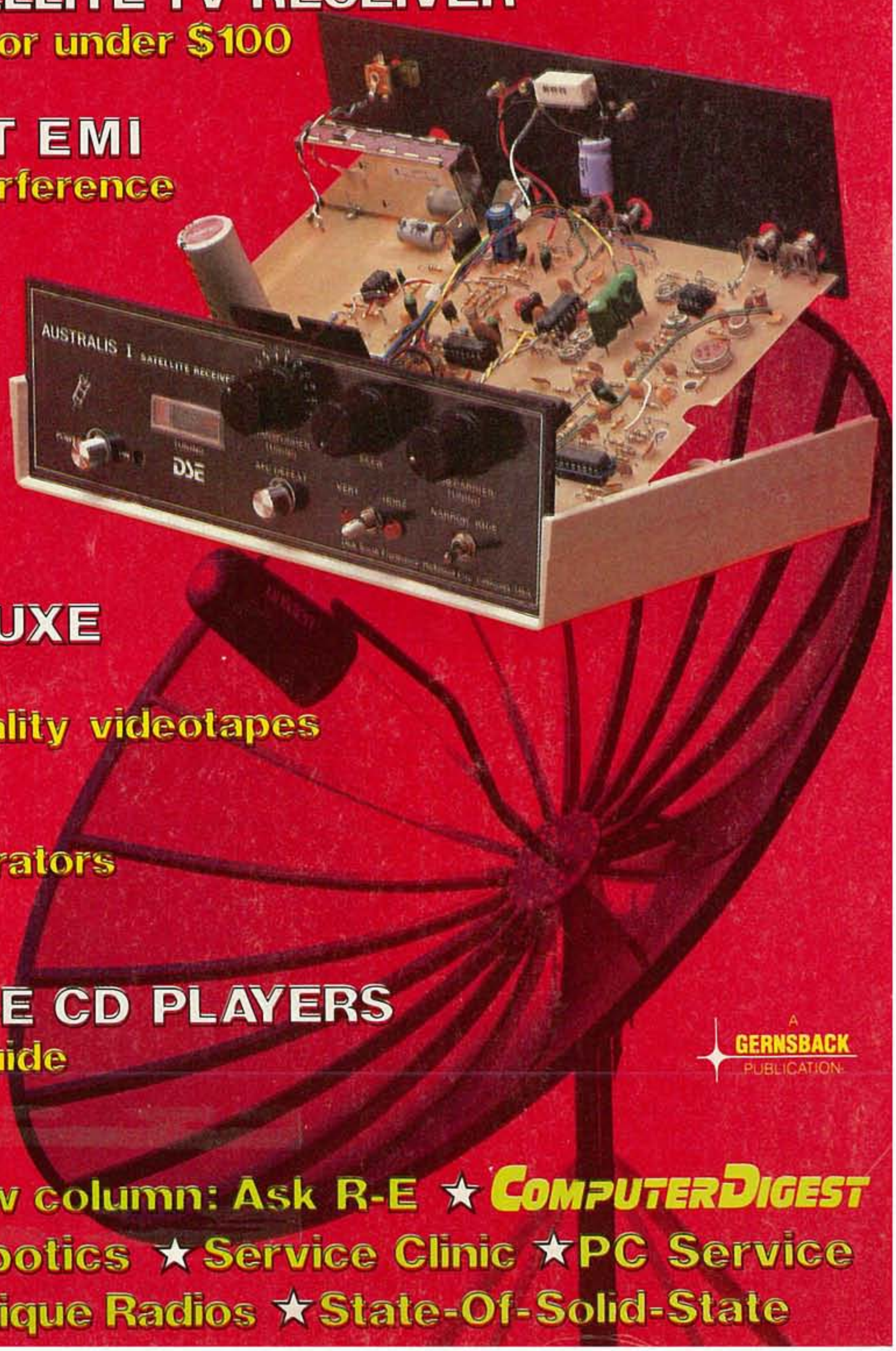
HOW TO COMBAT EMI
Electromagnetic interference can be stopped!

DON'T LET HEAT DESTROY YOUR PROJECTS
We'll show you how to keep things cool

BUILD R-E's DELUXE VIDEO TITLER
For professional-quality videotapes

DIGITAL IC's
How to use multivibrators in your designs

HOW TO SERVICE CD PLAYERS
A troubleshooting guide



A GERNSBACK PUBLICATION

PLUS:

★ New column: Ask R-E ★ COMPUTERDIGEST
★ Robotics ★ Service Clinic ★ PC Service
★ Antique Radios ★ State-Of-Solid-State

TEK 2236 100 MHZ OSCILLOSCOPE

THE ANSWER BY ANY MEASURE

100 MHz scope, counter, timer, multimeter: All one integrated system.

100 MHz dual time base scope. 3.5 ns risetime; sweeps from 0.5 s to 5 ns/div; alternate sweep; ±2% vertical/horizontal accuracy; vertical sensitivity to 2 mV/div @ 90 MHz.

9-digit fluorescent display. Digitally accurate readouts accompany the CRT waveform. Error messages and prompts also appear on the display.

Dc volts and ac coupled true RMS volts. Measured through the Ch 1 scope input.

Gated measurements. Use the scope's intensified marker to measure frequency, period, width and to count events within specified portions of the signal.

Auto-ranged, auto-averaged counter/timer. Frequency, period, width, delay time, Δ-time, plus totalize to more than 8 million events —with 7 digits plus exponent displayed.

Auto-ranged DMM. Use floating DMM side inputs with up to 5000-count resolution. Get precise readouts of average dc and true RMS voltage. Measure resistance from milliohms to gigohms.

Now make measurements faster, easier, with greater accuracy and user confidence. The Tek 2236 makes gated counter measurements, temperature, time, frequency, resistance and voltage measurements push-button easy. You see results concurrently on the 9-digit numeric readout and CRT display.

Its complete trigger system includes pushbutton trigger view, plus peak-to-peak auto, TV line, TV field, single sweep and normal modes.

At just $2650,* the 2236 includes the industry's first 3-year warranty on all parts and labor, including the CRT.

Integrated measurement system. 3-year warranty. 15-day return policy. And expert advice. One free call gets it all! You can order, or obtain literature, through the Tek National Marketing Center. Technical personnel, expert in scope applications, can answer your questions and expedite delivery. Direct orders include probes, operating manual, 15-day return policy, full warranty and worldwide service back-up.

Order toll-free: 1-800-426-2200 Extension 57

In Oregon call collect:
(503) 627-9000 Ext. 57
Or write Tektronix, Inc.
P.O. Box 1700
Beaverton, OR 97075

Tektronix®
COMMITTED TO EXCELLENCE

CIRCLE 261 ON FREE INFORMATION CARD

JANUARY '86

Radio-Electronics
Electronics publishers since 1908

Vol. 57 No. 1

Radio-Electronics, (ISSN 0033-7862) January 1986. Published monthly by Gernsback Publications, Inc., 200 Park Avenue South, New York, NY 10003. Second-Class Postage paid at New York, NY and additional mailing offices. Second-Class mail registration No. 9242 authorized at Toronto, Canada. One-year subscription rate U.S.A. and possessions $15.97, Canada $20.97, all other countries $23.47. Subscription orders payable in US funds only, international postal money order or check drawn on a U.S.A. bank. Single copies $1.95.
POSTMASTER: Please send address changes to RADIO-ELECTRONICS, Subscription Dept., Box 2520, Boulder, CO 80322.

COVER 1

What's new in satellite TV for 1986? A receiver for $100! What a way to kick off the new year! The receiver shown on the cover is a prototype of a satellite receiver that is available in kit form from Dick Smith Electronics. The receiver performs as well—or better than—many commercially available satellite receivers. Its low price makes it an ideal way to begin assembling your own TVRO system. Of course, for a complete system, you must add a downconverter, an LNA, and a dish, like the Uniden UST 110 shown in the background.

If you already have a system, can you think of a better way of adding a second receiver? The receiver we'll show you is easy to build. We even provide the foil pattern for the board! The hard-to-get parts are available separately, and a complete kit is also available. For more on this price/performance breakthrough, turn to page 45.

NEXT MONTH

THE FEBRUARY ISSUE IS ON SALE DECEMBER 31

BUILD A WIRELESS VIDEO-CAMERA LINK
Now you can record video images without being tied to your VCR.

BUILD A $99 SATELLITE RECEIVER
We continue with construction details.

BUILD A HUMIDITY MONITOR
With static-sensitive devices, humidity is not just a summertime concern!

TRANSISTOR SWITCHES
Design your transistor switching circuits for peak efficiency.

BUILD A SIMPLE SYNTHESIZER
It's fun to build and even more fun to play.

Radio-Electronics

Hugo Gernsback (1884-1967) founder
M. Harvey Gernsback, editor-in-chief
Larry Steckler, EHF, CET, publisher

EDITORIAL DEPARTMENT
Art Kleiman, editor
Brian C. Fenton, technical editor
Carl Laron, WB2SLR, associate editor
Jeffrey K. Holtzman, assistant technical editor
Robert A. Young, assistant editor
Julian S. Martin, editorial associate
Byron G. Wels, editorial associate
Jack Darr, CET, service editor
Robert F. Scott, semiconductor editor
Herb Friedman, communications editor
Bob Cooper, Jr. satellite-TV editor
Robert Grossblatt, circuits editor
David Lachenbruch, contributing editor
Richard D. Fitch, contributing editor
Mark J. Robillard, robotics editor
Bess Isaacson, editorial assistant

PRODUCTION DEPARTMENT
Ruby M. Yee, production manager
Robert A. W. Lowndes, editorial production
Andre Duzant, technical illustrator
Karen Tucker, advertising production
Geoffrey S. Weil, production traffic

CIRCULATION DEPARTMENT
Jacqueline P. Cheeseboro, circulation director
Rita Sabalis, assistant circulation director
Jacqueline Allen, circulation assistant

Cover photo by Robert Lewis

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

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

Advertising Sales Offices listed on page 136.

WHAT'S NEWS

New Still Video System prints from live scenes

A prototype of a still video system consisting of camera, player, and printer was demonstrated at the past Summer Consumer Electronics Show by Konica, Inc., of Englewood Cliffs, NJ. It can make still images of live scenes and play them back on the Konica still video player, or make hard-copy prints in black-and-white or color.

THE KONICA SV-C20 STILL VIDEO CAMERA.

The camera uses 2-inch floppy disks to store the still images of what is being displayed in the viewfinder. The still video player plays back what is recorded on the floppy disk and will display other information, such as the date and time the image was recorded. The printer, besides making hard-copy prints from the camera, can produce a hard-copy print (on color paper) from any video source, including a videocassette recorder. That will permit owners of home-video equipment to make still prints from their home-video movies.

It is hoped, Konica officials stated, that the first of the still video system's components will be on the market sometime within the next 15 months.

New stabilized laser device for fiber optics and space work

A laser device just announced by RCA is expected to have important applications in space communications and fiber optics.

The recent explosion in fiber optics has created a strong demand for lasers that operate at a single stabilized wavelength. Lasers with stable wavelengths will also be required in the future for space communications, optical computing, and data storage.

The wavelength of solid-state lasers changes because of changes in temperature, power level, and the strength of the pulsating driving currents required to put information on the light beam. Many companies are eagerly searching for a solution to that stability problem.

RCA's approach is a laser with an external waveguide structure; that waveguide contains a reflective grating and is made of a different material than the laser itself. The new device, called an External Bragg Reflecting Laser, provides greater reliability and improved performance over previous lasers of the same type.

The new approach avoids complicating the actual process of growing the crystal, thus simplifying manufacture. It has an additional advantage of allowing off-the-shelf diode lasers to be combined with off-the-shelf waveguide units to achieve stabilization at a desired wavelength. The external waveguides may also be used to shape the output light beam and to assist in coupling the light into optical fibers.

New software program ends cut-and-try mold making

General Electric has demonstrated what it calls a major advance in factory automation—computer software that can assist in analyzing complex parts and then automatically generate instructions for machining the molds in which they are made. Known as TRUCE (*T*ridimensional *R*ational *U*nified *C*ubic *E*ngine) it greatly amplifies the capabilities of solid modelling. With it, realistic images can be displayed on a computer terminal and manipulated just like objects held in the hand. They can be rotated to show all sides, cross-sectioned to reveal the interior, or peeled away a layer at a time.

The mold for a plastic backpack frame is the first production-oriented item projected by the G.E. researchers. The project started out with a conceptual sketch. The engineers then went directly to the computer to create a preliminary solid model embodying the features they wanted in a backpack frame, and to refine its various features. (In the structural performance tests alone, stress analysis made it possible to optimize the material's thickness to produce a backpack frame stronger than an existing metal one, but with only three-quarters of the weight.

Using a computer controlled milling machine, the researchers then cut a solid cavity block from high-density foam to verify the computer-generated tool paths. The GE researchers then machined the mold's actual core out of aluminum. No engineering drawings, blueprints, or physical models of either the part or the mold were required for any stage of the manufacturing process. **R-E**

ASSOCIATED RESEARCH, INC. | B+K PRECISION | FLUKE

RAG ELECTRONICS, INC.

New and Used Electronic Test Equipment
Sales • Service • Rental • Leasing

HITACHI (Hitachi Denshi, Ltd) 3.5 Digit DMM *Free* With Scope Purchase

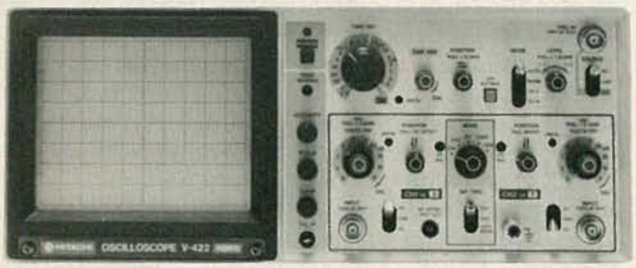
FEATURES:

- AC DC voltage
- AC DC current
- Resistance
- Diode test
- Audible Continuity check
- Temperature *(Type K, 3510 & 3525)*
- Data hold
- Manual or autoranging
- Overload protection
- LCD display
- Built-in stand
- Battery included
- Test leads included

Special!

MODEL	BASIC DC VOLTAGE ACCURACY	QTY 1 PRICE	QTY 3+ PRICE	One With Any Scope Purchased From RAG
3550	±.5% ±2 digits	$49.00	$42.00	*FREE*
3525	±.25% ±2 digits	$64.00	$54.00	$19.95
3510	±.1% ±2 digits	$79.00	$67.00	$29.95

2 year warranty plus carrying case included!



Model V-422 shown

MODEL V-212 **$461.00**
DC to 20 MHz, 1 mV/div, Dual Trace, Features 6" Rectangular CRT (w/two X10 probes).

MODEL V-222 **$536.00**
DC to 20 MHz, 1 mV/div, Dual Trace, D.C. offset for DMM Output, Verticle Mode Trigger, 6" CRT (w/two X1/X10 probes).

MODEL V-422 **$694.00**
DC to 40 MHz, other features same as V-222 (w/two X1/X10 probe).

MODEL V-1050F **$1,276.00**
DC to 100 MHz, 5 mV/div, Quad Trace, Delayed Sweep, Full T.V. Triggering, alternate time base (w/two X1/X10 probes).

MODEL V-650 **$956.00**
DC to 60 MHz, 1 mV/div, Triple Trace, Delayed Sweep, Full T.V. Triggering, variable trigger hold-off (w/two X1/X10 probes).

NEW! 3 year warranty parts and labor on above scopes!
RAG Electronics is a factory authorized Hitachi repair center.

CIRCLE 126 ON FREE INFORMATION CARD

CALL US TOLL FREE
1-800-732-3457
IN CALIFORNIA TOLL FREE
1-800-272-4225

- Master Charge
- VISA ■ COD
- Money Order
- Check

ADD FOR SHIPPING AND INSURANCE	
$0 to $250.00	$4.50
$251.00 to $600.00	$6.50
$501.00 to $750.00	$8.50
$751.00 to $1000.	$12.50
over $1000.00	$15.00

Prices subject to change without notice.

RAG ELECTRONICS, INC. / 21418 Parthenia Street / Canoga Park, CA 91304 / 1-818-998-6500

IWATSU | KEITHLEY | LEADER Instruments Corporation | Polaroid | POWER DESIGNS | Simpson

VIDEO NEWS

DAVID LACHENBRUCH
CONTRIBUTING EDITOR

• **Digital-effects VCR.** A VHS recorder using a computer memory to produce special effects is now being marketed in Japan by Toshiba; it is expected on the American market next spring. Unlike other video recorders with "clean" special effects, the new Toshiba uses only two heads, yet it provides the best slow-motion and freeze-frame we have seen on a consumer machine. The pictures were clear and sharp, with no trace of noise bars in the picture.

The VCR contains four 256K and two 64K dynamic RAM's, a memory-control IC, and analog-to-digital and digital-to-analog converters. For slow motion, the tape runs at a constant one-quarter speed, while the digital circuit sequentially selects and stores images in memory. In addition to freezing a frame of a videotape, the circuit can freeze any frame being displayed on the TV, provided the VCR's tuner is being used. The VCR sells for about $700 in Japan, but should cost somewhat more here.

• **More digital TV's.** To be introduced both here and in Japan early in 1986 is a new 26-inch digital-TV set by Sharp that can divide the screen into nine segments and show a series of still pictures of what is available on each of nine local channels. A similar system has been demonstrated by Mitsubishi, but it has no marketing date. The Sharp set can also convert any incoming signal to a sequence of still pictures—showing, for example, a sequence of still pictures of a baseball being hit by a bat. ITT Semiconductors, still the only source of IC's for a complete digital-TV set, says it has sold enough IC's to produce 200,000 digital sets. ITT's own TV-manufacturing facility in Germany has used about half of those. In addition to ITT and Sharp, digital sets are being produced by Panasonic, Sony, Toshiba, and Italy's Sinudyne. ITT says that 10 other brands will go into production within the next few months.

• **Camcorder news.** Camcorders, or combination camera-recorders, remain the hottest items in the portable-video field. Kodak is introducing a camcorder outfit consisting of an 8-mm tape deck and a separate camera, each weighing about 2 pounds. The camera and recorder can be used as separate items, connected by a cable, or they can be plugged together to form a camcorder. Kyocera, parent of the Contax and Yashica camera companies, will sell an 8-mm camcorder in the United States under its own name. Meanwhile, Sharp has joined those manufacturers offering camcorders that take full-size VHS cassettes.

• **TV station "sets" VCR.** It could never happen in this land of commercial TV, where TV stations don't encourage home videotaping, but in Germany, some stations actually are correcting programmable VCR's when their schedules slip. Unlike their American counterparts, German TV programs' listed starting times are often only approximate, and schedules frequently are upset when special programs are inserted unannounced. What happens when you set your VCR to tape a program scheduled for 8 p.m., but that actually doesn't start until 9:17? Your tape comes out fine if the station is using VPS.

VPS stands for Video Program System. It involves a special code-signal transmitted on line 16 of the vertical interval along with the program. A VCR equipped with VPS circuitry (or a VPS adaptor) starts to search for the VPS code 10 minutes before the scheduled starting time and continues to search for up to four hours afterwards. Recording starts only when the proper VPS code is found.

• **Star-spangled Sony.** Sony was the first Japanese manufacturer to set up an American TV-set plant (back in 1972), but it doesn't talk about it much, on the theory that Americans seem to prefer Japanese-made TV sets. Sony's U.S. plant in San Diego will produce 850,000 color sets this year, and in the next few months it is scheduled to increase its capacity to as many as 1,500,000 annually. Sony's newest color-TV model is a 27-inch set, and the company plans to produce 600,000 of them a year in San Diego. The company manufactures picture tubes as well as TV receivers at the plant. **R-E**

Superior performance by phone

The 8840A Digital Multimeter.

Now, with Fluke telemarketing, you can order the most affordable, most powerful DMM in its class, from any phone in the U.S.A.

Compare features, compare prices and you'll find that no other 5½-digit bench-top or system multimeter can match it.

As easy to use as your phone.

The simplified front panel of the 8840A is designed for ease of operation. Functions are clearly labeled. Even the vacuum fluorescent display is easy to read. And closed-case calibration and 50,000 hour MTBF make the 8840A easy to live with.

The 8840A is versatile: it answers your bench or system DMM needs. Standard capabilities include superior dc voltage accuracy (50 ppm at 1 year), 2- and 4-wire ohms, dc current, fast autoranging and user-selected reading rates.

Reach out and test the best.

Call toll-free and our sales engineer will tell you about the 8840A. Ask about our 15-day trial period and our one-year Fluke warranty.

Order now.
1-800-44-FLUKE

(1-800-443-5853) Ask for extension 111.

Fluke 8840A
Autoranging Volts, Ohms, and Amps
50 ppm basic dc accuracy (1 year)
0.16% basic ac accuracy (1 year)
2½, 20, and 100 readings/second

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

FLUKE®

Wouldn't you like to have a new skill you could call your own? Learn TV, audio, and video servicing with at-home training from NRI.

You can learn to service and
:pair TVs, stereos, electronic
usical instruments and ampli-
ers, car and portable radios,
:cord and tape decks, videocas-
:tte recorders and disc players,
most any kind of electronic
quipment on the market. And
ou can learn to do it at home,
n your spare time, without quit-
ng your job or wasting time
nd gasoline on night school.
RI will train you, as it has over
million and a quarter others,
vith effective methods proven
ver 69 successful years.

Hands-On Training

NRI training is practical train-
ng all the way. Throughout your
ourse, you'll perform hands-on
xperience projects that make
heory come to life and give you
eal understanding.

Includes Both 25" TV And VCR, Plus DMM And More

As part of your training, you'll
build your own 25" Heath/
Zenith color TV, a state-of-the-
rt unit with infrared remote
uning, programmable channel
selection, and the incredible
space phone for remote calling.
You also get a front-loading,
remote-controlled videocassette
recorder to play your video-
taped lessons and learn about
servicing this complex instru-
ment.

Practical training on a real state-of-the-art TV, VCR or stereo, using professional equipment

You'll learn troubleshooting techniques using a professional 3½-digit digital multimeter. You'll use it when assembling your TV to check demonstration circuits you build on the NRI Discovery Lab, and in your professional work. It's the equipment and training you need for success.

Exclusive NRI Training On Videotape

In addition to profusely illustrated lessons, you get NRI Action Videocassettes . . . videotaped lessons that show you graphic presentations of electronic systems, vivid closeups of servicing techniques and professional "shortcuts" to study and replay as often as you want.

Training For Success

NRI not only prepares you to become a top technician, we get you ready for independence. NRI Video/Audio servicing gives you a great new way to earn extra money doing part-time servicing for appliance and department stores—building a good-paying, new career with an electronics firm . . . or even starting your own business. You can start small, even part-time in your basement or garage, make the most of your opportunities to grow into a successful businessman.

Free Catalog . . . Mail Card Today

Send the postage-paid card for our free 104-page color catalog describing our courses in full, showing all equipment, lesson outlines, and career opportunities. It also shows other exciting courses like Microcomputers, Electronics Design, Industrial Electronics, Digital Electronics, and more. Mail the postage-paid card today for your copy. And see how you can make the most

of your talent. If card has been removed, please write to:

NRI Schools of Electronics
McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue
Washington, DC 20016

We'll give you tomorrow.

LETTERS

WRITE TO:

LETTERS
Radio-Electronics
200 Park Ave South
New York, NY 10003

TOUCHSCREEN TECHNOLOGY

My purpose in writing this critical letter is to alert you to the poor quality of Mr. Stern's article entitled, "Touchscreen Technology," in the September, 1985 issue.

It is hard to see how your writer could have spent much effort investigating this technology and market, and still have so grossly misunderstood how such an important product works, much less appreciate the advantages and limitations of the technology. You will note that the design does not involve three layers. The dots are inactive spacers that play no role in determining the resolution. Resolution of 4,000 $\times$ 4,000 has been standard with resistive touch screens for several years. Only one coordinate pair is generated each time the screen is touched. And sampling rates of up to 150 coordinate pairs per second are routine.

There are many other value statements in the article with which I would take exception. Elographics is the major supplier of touch screens and has a reputation for providing products that are highly reliable. One would hardly get that impression about resistive-membrane touch screens from the article.

While writers can be forgiven for making some misstatements when writing on areas of technology that are foreign to them, I do not recall reading an article as replete with error, and as poorly organized, as this one. Since the only supplier mentioned was Microtouch, I assume that someone from that company provided much of the information included in the article. That they may have given Mr. Stern incorrect information does not absolve him from the responsibility of double-checking his source prior to publication.

I might add that Microtouch has yet to deliver their product in quantity, or to prove that it will be a reliable product with long term use.

I hope that you will institute improved procedures to protect against such misinformation as that article presents.

ROBERT R. HIGHFILL
V.P. Marketing, Elographics, Inc.

While it's true that resistive-membrane touch screens are theoretically capable of 4,000 by 4,000 resolution, that is rarely ever achieved because of the nature of this touchscreen. Made of a plastic laminate, a relatively wide area of the membrane is, in fact, depressed when it is touched. Therefore, a resolution of 256 by 200 is far more realistic. Likewise, a 150 pair-per-second sampling rate is also claimed in product literature, but, since many coordinate pairs are actually depressed when the screen is touched, that sampling rate is effectively much lower, on the order of one-quarter or so of the claimed figure. Therefore, the figures quoted are typical of real-world findings, and that is why they were used in the article. As for clarity and long-term reliability, it can't be denied that a touchscreen, no matter how clear, will still impact the overall clarity of a CRT screen; and because the typical unit is a plastic laminate, it won't stand up to sharp instruments for long.—Marc Stern

CABLEREADY TV

There is an easier way to hook up a cable-ready TV and a cable-ready VCR to a cable converter/descrambler than using two split-

ters and two A/B switches, as detailed in, "Hooking Up Your VCR" (**Radio-Electronics**, August 1985, page 56, Fig. 12). Use a UHF block converter to move your pay channel up to a UHF channel. That setup has no switches, gives the VCR and TV access to everything, and gives the VCR full programmability.

SCOTT MALAN
Alpine, Ca.

ANTI-LOCK BRAKE SYSTEM

The description of our ABS antilock brake system in the September issue ("Electronics Under the Hood") was incorrect.

The system does not employ a brake-pedal pressure sensor, nor does it use an electronic module to engage the brakes, as was stated. Instead it reads wheel speeds from three sensors (one on each front wheel and one on the pinion gear of the rear axle differential). Those data are fed to an electronic control unit that establishes a vehicle reference speed and a basis of comparison for each wheel. When the brake pedal is pushed and, because of specific road-surface adhesion, at least one wheel approaches the point of locking, the system redirects the brake fluid from the involved wheel(s) back to the master cylinder. As wheel speed stabilizes and than begins to build again, braking is resumed. Effectively, the system precisely pumps the individual wheel brakes as needed, at a rate of up to 10 times per second.

It all happens automatically. The driver need only step on the brake pedal and steer.

A.B. SHUMAN
Manager, Public Relations,
Mercedes Benz of North America

PROPAGATION VELOCITY

In the August issue I was drawn to the "See-In-The-Dark Viewer"—and to the error in the box on page 51.

The propagation velocity of the electromagnetic radiation in space is equal to the product of the wavelength and frequency; in all other media it is less. One can't determine if the K employed here is intended to account for that. Of course, we may have a printing error, but I can't presume to deprive Mr. Grossblatt; he is such a deserving fellow! Keep up the good work!

L.D. SMITHEY

Pacific Palisades, CA.

You're absolutely right. The speed of light is, of course, $c = f\lambda K$, where K is the dielectric constant of the medium through which the light is travelling.

CHALLENGE TO THE VCR AND CABLE-TV INDUSTRY

I challenge the video and cable-TV industries to establish a standard logic interface for connecting a leased pay-TV decoder to a subscriber's VCR. The channel selection programmed into the VCR's memory timer would tune the decoder, which would then deliver the baseband video and audio signals to the VCR.

Think of the advantages: 1. Single-point control of channel selec-

PERFORMANCE
THAT IS OUT OF THIS WORLD...

$389.00
MODEL 2000 20MHz DUAL TRACE

$549.00
MODEL 3500 35MHz DUAL TRACE DELAYED SWEEP

...AT A DOWN TO EARTH PRICE

At last! Truly affordable test equipment with no compromise in design, and features you would expect to find only on oscilloscopes costing hundreds of dollars more! JDR Instruments presents two, new, high-performance models backed by a two year warranty and technical support which is only a phone call away. Perfect for the technician or advanced hobbyist, both models feature Dual Trace capability and a variety of operating and triggering modes, including CH-B Subtract and X-Y operation.

MODEL 2000 has a 20 MHz bandwidth and 20 calibrated sweeps ranging from .2s to .2μs. A convenient built-in component tester provides additional diagnostic power.

INCLUDES TWO HIGH QUALITY 1x, 10x TEST PROBES

MODEL 3500 features a 35 MHz bandwidth and exceptional 1mV/DIV sensitivity. Delayed sweep and variable holdoff allow stable viewing of complex waveforms.

CIRCLE 263 ON FREE INFORMATION CARD

ORDER TOLL FREE
800-538-5000
800-662-6279 (CA)

JDR INSTRUMENTS
1224 South Bascom Avenue
San Jose, California 95128 (408) 995-5430

tion. 2. Elimination of moving parts in the decoder. 3. No need for selector switches or splitters. 4. Better-quality signal, due to baseband connection. 5. Simple option to tape one channel and watch another. 6. VCR's with remote controls would have full control.

The technology already exists, since most VCR's and many cable decoders use digital channel selection. If a simple LSTTL logic interface could be agreed upon, one common cable subscribers' complaint would be satisfied.
ERIC G. LEMMON
Lompoc, CA

DIGITAL TV CIRCUITS

Recent articles have appeared discussing the various TV formats such as PAL, SECAM, NTSC, advances like HDTV, new PBS proposed formats such as MAC, and associated signal handling methods. It seems to me that the TV designers are spending a lot of energy in the wrong direction. I refer mainly to the domestic TV receiver designs using analog methods. Let me explain briefly, and perhaps spark some thought.

If the received broadcast signal were digitized right out of the first IF filter, then the format could be transparent to the display system used. Indeed, the display could be scanless, mapping the data extracted from the signal only as necessary to create the picture; and it would be void of the many interferences caused by relationships between various frequency components in the normal scan and signal elements.

The processor would discover the transmission format, the related (color, audio) signals, process the data and feed it to the output devices. Thus the TV receiver is easily updated (with ROM perhaps) to encounter any new formats and features.

The technology is here today. Why aren't such TV's on the market? Maybe they are, and just not described. How about an article on Digital TV circuits? I don't mean digital control, I mean real full-scope digital TV from the IF out.
GENE SIMMONS
Riyadh, Saudi Arabia

NEW IDEAS: APRIL FOOL?

I looked for an April Fool article, in the April 1985 issue of **R-E**, and finally decided that it had to be the "New Ideas" page, "Making Electronic Music—Automatically!" I can do the same thing it purports to do using only three IC's and one transistor, and I get nine notes instead of eight.

If I am wrong, my apologies to Mr. Artur Manhica.
SID BUCK
Key Largo, Fl.

I think you're missing the point of our "New Ideas" column. Its purpose is to bring new circuits designed by our readers to the attention of other readers. They're ideas, not finished products. If you can use a circuit that we present as a starting point for a more elegant design, then you're benefitting from it. If you're looking to "New Ideas" for tried-and-true solutions to problems, you've got the wrong idea.—Editor **R-E**

VIDEO ACCESSORIES

■ Highest quality ■ Highest performance ■ Lowest prices

bp VIDEO-CINE CONVERTER

The BP Video-Cine Converter is an optical device that allows the easy transfer of slides, 8mm or 16mm movie film to VCR tape. The Video-Cine Converter's precision optics put the image from your movie or slide projector on a high-contrast, rear projection screen. Your video camera shoots that image, can color-correct faded pictures, add narration to other sound. Can be used with any video camera or slide projector. If your video camera lacks close-up capability, you will need a macro lens attachment.

MODEL V-1701 ~~$36.95~~ $34.95

Macro Lens Attachment
Model V-14 ~~$14.95~~ $12.95

FOR ULTIMATE VIEWING

TEKNIKA

WIRELESS REMOTE CONTROL TV TUNER & CABLE CONVERTER WITH VOLUME CONTROL

Model 6510 **$169.95**

Wireless remote control with volume for cable TV, VHF-UHF antenna systems upgrades any TV to 140 channel capability.
• Works with any TV set • Quick, easy installation • Off-air and cable compatible • Quartz frequency synthesizer tuning • Direct access/memory scan selector • Ultra-compact, hand-held wireless remote control

bp 61 CHANNEL WIRELESS REMOTE CONTROL

Model V7661 ~~$79.95~~ $69.95

Wireless remote control on/off, channel selection and fine tuning.
• Works with any TV • 61 channel capability
• Microcomputer controlled PLL operation
• Converter panel controllable for channel up, down, on/off, fine tuning. • LED display
• Compatible with CATV systems.

bp STABILIZER/IMAGE ENHANCER/RF CONVERTER/VIDEO FADER/2-WAY DISTRIBUTION AMPLIFER

Model V1880 ~~$99.95~~ $79.95

Hook-up cable kit **$11.75**

The most versatile, all-in-one video processor. Can be used as a video guard remover for video tapes, enhancer, video to RF converter, professional video fade in and out and a dual output distribution amplifier.

bp VIDEO SWITCH

Model V4804 ~~$49.95~~ $39.95

Record a pay channel while viewing a standard channel. You can also connect an antenna/cable, VCR, video disc player, home computer and video game.

bp VIDEO TAPE REWINDER

Model V7777 VHS ~~$49.95~~
Model V7778 BETA ~~$49.95~~

Reduce wear and tear of your VCR heads with the AC powered circuit protected rewinders, LED power-on indicators.

$39.95 each

Charge it with VISA/MASTERCARD. Phone orders accepted.

Fordham

260 Motor Parkway, Hauppauge, NY 11788

Toll Free
800-645-9518
In NY State 800-832-1446

Service & Shipping Charge Schedule
Continental U.S.A.

FOR ORDERS	ADD
$25-100	$4.50
$101-250	$6.00
$251-500	$8.00
$501-750	$10.50
$751-1,000	$12.50
$1,001-1500	$16.50
$1,501-2000	$20.00
$2,001 and Up	$25.00

IF YOU WANT TO GET
YOU HAVE TO GET INTO

Learn PC Servicing By Building Your Own NTS/HEATH HS-15
Desk-Top Computer, Circuit-By-Circuit

NTS Intronic Home Training Takes You Below The Surface

NTS gets you right down into the heart of computer circuitry. You learn how microprocessors function, how they are designed, how they operate and are used to solve problems. Your program includes a wide variety of tests and projects, as you assemble your PC. You experience the excitement of seeing your own skills grow, the security of knowing you really understand what makes a computer tick.

A Career in PC Servicing

The world of computers is constantly expanding. Applications have spread from business to manufacturing, from industry to medical and scientific fields. Computer-aided design, engineering, and production have revolutionized drafting, graphics, and prototyping. Computer sales figures point to a continuing need for service technicians as well as installation and maintenance specialists. The type of training you receive will largely determine your ability to take advantage of these opportunities .... and nothing beats the practical, down-to-earth training you get from NTS.

The NTS/HEATH 16-Bit HS-151

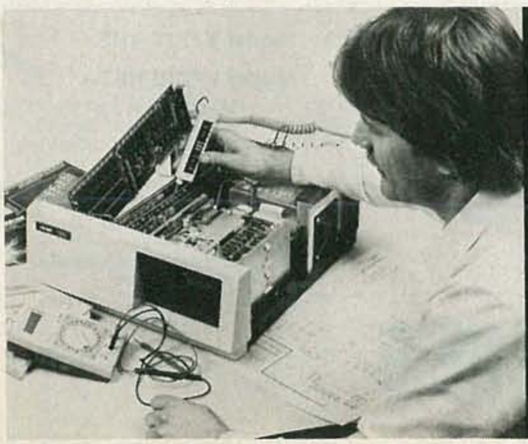
This desk-top PC is the most powerful and versatile ever offered in any home training program. Check the advanced features listed below:

1. 128 KB RAM user memory on board, expandable to 640 KB
2. 16-bit 8088 Microprocessor accepts advanced software, speeds word processing; also allows selection from the huge library of IBM software.
3. 5.25-inch floppy disk drive, double density, IBM formatted, stores up to 360 KB. (Expandable to dual disk drive, and optional 10.5 MB hard-disk drive.)
4. MS-DOS operating system, IBM compatibility, make a wide choice of software programs available.
5. Four open IBM-compatible slots provide for future expansion, printer, modem, etc. Will accept most peripheral boards designed for IBM-PC.
6. Two video outputs for color or monochrome display monitor. Your NTS course includes a high resolution monitor displaying 80 characters by 25 lines, or graphics.
7. Editing capabilities help you insert or delete characters and lines, erase, jump or smooth scroll, etc.

Your NTS training course will teach you to program on this outstanding PC, using lessons, texts, and diagrams to make full use of its capabilities. Catalog contains complete details.

IBM Compatible

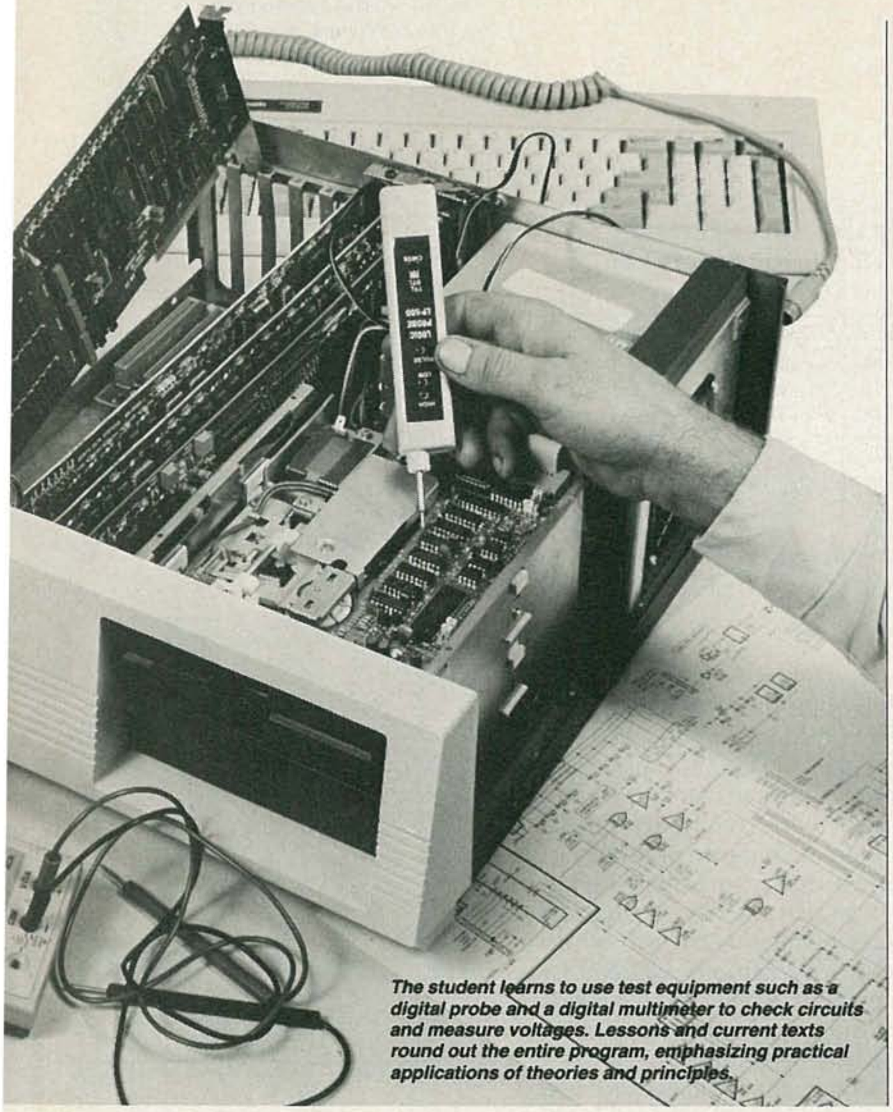
Learning circuitry through the construction of this equipment offers practical training for which there is no substitute. Test equipment is included.



Field servicing is interesting and rewarding. Technicians may work for a service company, manufacturer, or major users.

The NTS/HEATH HS-151 PC completed, inc monitor and full-function keyboard with ca style keypad, and typewriter format.

NTO PC SERVICING
A MICROCOMPUTER



The student learns to use test equipment such as a digital probe and a digital multimeter to check circuits and measure voltages. Lessons and current texts round out the entire program, emphasizing practical applications of theories and principles.

Installing the disk-drive in the PC is one of the final stages in the assembly of the microcomputer. Learning the use of test equipment to check circuits is an integral part of the training which, with field experience, develops invaluable career skills.

NTS COURSES COVER MANY AREAS OF SPECIALIZATION IN ELECTRONICS:

Robotics: Build the NTS/HEATH Hero 1 Robot as you learn robotic programming. Robot is complete with arm and gripper, voice synthesizer. Robotics is becoming increasingly important in industry as almost daily news features attest.

Video Technology: Build one of the most advanced Color TV sets in America as you learn circuit diagnostics, and the use of digital test instruments. Course covers color TV, video tape recorders, computer fundamentals, solid-state devices.

Industrial and Microprocessor Technology covers circuit analysis, microprocessors and automation applications, lasers, and basic industrial robotics.

TV & Radio Servicing is a specialized course offering an excellent foundation in the use and application of both analog and digital test equipment as applied to the TV servicing field. Learn circuits, adjustments, trouble- shooting, and servicing of Color and monochrome monitors.

Digital Electronics offers the student the opportunity to get involved with computer concepts, computer technology fundamentals, and digital equipment by training on the NTS Compu-Trainer.

Basic Electronics is a course designed for those wishing to have an over-view of electronics in many of its aspects including radio receivers, solid state devices, and electronic components.

NTS Intronic training programs include a variety of superb equipment, most of which is classified as field-type, making the training practical and career oriented. Texts and lessons have been tested in our Resident School in Los Angeles to assure home study students their courses of training are easy to understand NTS, now in its 80th. year, continues to be at the leading edge in Electronics home training.

** IBM is a trademark of International Business Machines Corp.*
** MS is a trademark of Microsoft Corp.*

If card is missing, simply write to the address shown below stating the course you are interested in. A FREE color catalog with all details will be sent to you by return mail.

NTS NATIONAL TECHNICAL SCHOOLS

TECHNICAL TRADE TRAINING SINCE 1905

Resident and Home-Study Schools

4000 So. Figueroa St., Los Angeles, CA 90037

ASK R-E

WRITE TO:

ASK R-E
Radio-Electronics
200 Park Ave South
New York, NY 10003

RESISTOR DECADE BOX

I want to build a resistance decade box that has six decades ranging from one ohm to one megohm. The problem is that using ten precision resistors per decade will be expensive. I understand that there are tricks for creating ten discrete values using only four resistors. Please show me how.—J. A., Cobleskill, NY.

Resistance decade boxes evolved from the British "Post Office Bridge," shown in its basic form in Fig. 1. (The British Post Office functions like both our FCC and our National Bureau of Standards.) The resistors are precision wire-wound types. The desired value, as shown in Table 1, is selected by opening and closing the correct combination of switches.

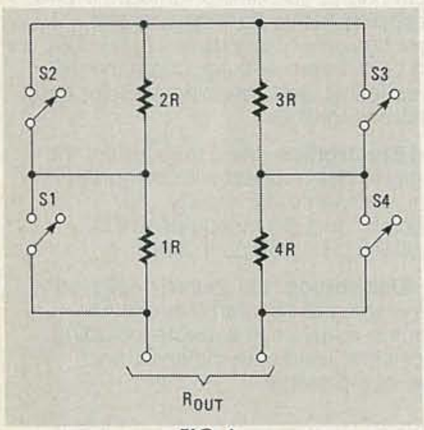


FIG. 1

TABLE 1—RESISTANCE VS. SWITCH POSITIONS

Value	Closed	Opened
1R	S2, S3, S4	S1
2R	S1, S3, S4	S2
3R	S1, S2,S4	S3
4R	S1, S2, S3	S4
5R	S2, S3	S1, S4
6R	S1, S3	S2, S4
7R	S1, S2	S3, S4
8R	S2	S1, S3, S4
9R	S1	S2, S3, S4
10R	—	S1, S2, S3, S4

Here, and in Figs. 2–4, note that the values of the resistors have not been specified exactly. To build a decade box using one of those circuits, just make sure that the resistors maintain the indicated proportions relative to each other. In Fig. 1, for example, values of 1 ohm, 2 ohms, 3 ohms, and 4 ohms will be suitable for a 1- to 10-ohm decade box. To build a 100- to 1000-ohm decade box you would use resistors of 100, 200, 300 and 400 ohms.

There are several ways to wire a 2-gang, 10-position rotary switch to obtain resistance values in discrete steps from 1 to 10. They use resistor combinations such as 1-2-2-5, 1-2-4-5, 1-2-3-5, 2-2-3-5, etc. Unfortunately, suitable switches can be hard to find, or expensive. In case you'd like to give it a try, however, Fig. 2 shows one example that is easy to hook up. The resistors should be wired directly between contacts on the switch wafer.

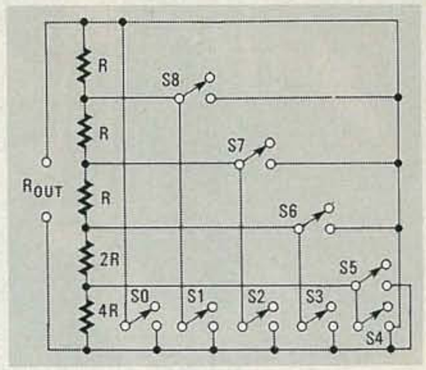


FIG. 3

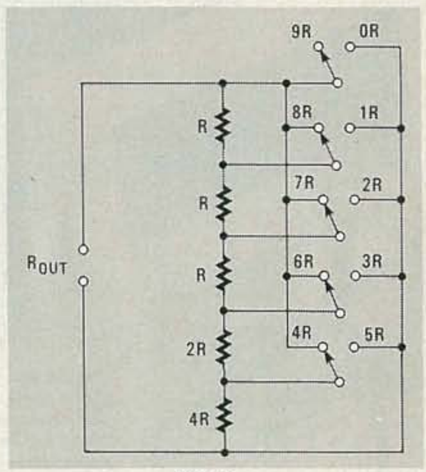


FIG. 4

Toggle and slide switches are less expensive and more readily available than rotary switches. Figure 3 shows how you can use nine single-pole, single-throw (SPST)

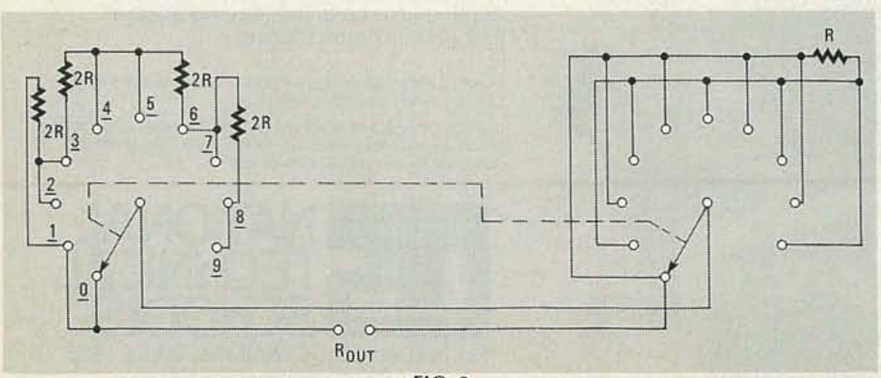


FIG. 2

As Featured In This Issue!

SATELLITE TV

Break Into a Whole New World of Electronics at an Unbelievable Price!

The Dick Smith SATELLITE RECEIVER KIT

Unit requires a 17-18V AC Supply

$99.95

Cat No K-6316

Unlock the world of television programming that you have never before experienced, the diversity of receptions is phenomenal. From sports to international politics, to movies, to the major news as it happens right before your very eyes. Months of research by top engineers has produced this state-of-the-art reputable design with a minimum of adjustments necessary for correct operation. Gone are the days of sweeping iron filters and borrowing expensive spectrum analyzers. All your need to align this kit is a multimeter.

Just Look At These Features:

★ **Easy to build Printed** Circuit Board. Our specially designed boards are silk screened with a component overlay and coated with a protective solder mask. This component overlay makes soldering the board a cinch. Just look at the list of components in the construction manual. Next to the component you'll see a number, e.g. R1 = 1k ¼w resistor. Find R1 on the board, plug the resistor in and solder. It's as simple as painting by numbers.

★ Easy to Tune - Our 17 years of experience has taught us to keep our kits simple. Extra time went into the research of our satellite receiver kit to make tuning the receiver easy. No broken ferrite plugs and coils, no Stanford test lab - we did away with those. All you'll need is a multimeter! - any multimeter with a 20v and 500ma scale!

★ Latest Technology - Uses state of the art high quality Siemens bandpass filter for IF filtering to provide low group delay distortion without the need for additional equalization networks. Provides greater selectivity, reproductability and stability than IC or helical filters as used in military communications.

★ Incredible Performqnce - Compare with receivers priced hundreds of dollars higher. Specifications like:

IF Input Frequency: 70mHz
IF Input Level: −35Bm to −5Bm
IF Input Impedance: 75 Ohms
IF Band Width: 26mHz standard 12mHz optional
Carrier to Noise Threshold: Less than 7dB
Video De-emphasis: CCIR 525 lines
Video Output Level: 1 volt (peak to peak)

It all adds up to a superb receiver!

Video Output Impedance: 75 Ohms
Video Polarity: Internally linked
Energy Dispersal Removal: 30dB or better
Audio Subcarrier Tuning Range: 5.4mHz to 8.0mHz
Audio De-emphasis: 75 micro seconds
Audio Output Impedance: 600 Ohms
Audio Output Level: −dB Nominal

Specifications may change without notice.

Look at the Features

Here's what Richard Maddox,Author of "Trouble Shooting and Repair of Satellite Systems" said when he saw the Dick Smith Australis I:
I couldn't believe the video quality... the overall performance rivals commercial receivers costing hundreds of dollars more. The ease of assembly and the way they have used field proven circuitry is fantastic. The quality of the board was better than expensive commercial units I'd worked with. . ."

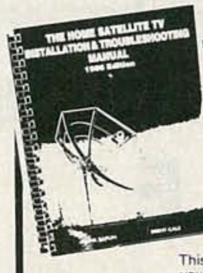
☆ *Kit comes complete to the last nut and bolt, screened board, front/rear panels, all mounting hardware – even solder and supplied with comprehensive instructions. The Australis I offers for the first time quality and achievable results to the first time builder for minimal outlay.*

☆ *Specially produced construction manual makes building the Australis I E-A-S-Y, even for the beginner. Explains every stage of construction from start to finish clearly, simply and concisely.*

☆ *Every kit contains a "Sorry Dick, It Doesn't Work" repair coupon. In the unlikely event that you can't get your Australis I to work. Just send it in to us together with the coupon and a service fee – and we'll fix it for you. A Dick Smith unique service.*

☆ *14 day nothing-to-lose trial offer. Purchase the Dick Smith Australis I Satellite Receiver kit K-6316, examine it for 7 days. If you feel it is beyond your capabilities, return the kit to us in the condition you received it and we'll refund your money in full. What could be fairer than that?*

☆ *SAVE $ – Compare the price of the Australis I with other receivers costing much, much more.*



HOME SATELLITE TV INSTALLATION & TROUBLESHOOTING MANUAL

1986 Edition

$29.95

This huge 311 page manual will explain everything you need to know to understand ,select equipment install, and troubleshoot satellite TV systems. Written in clear easily readable style, this is a must for every satellite TV dealer and people who want to install their own system. H.Taylor Howard said "This book . . . puts it all in one place and will make it possible to throw out that old collection".
Cat B-1846

The DICK SMITH Low-Cost Satellite System

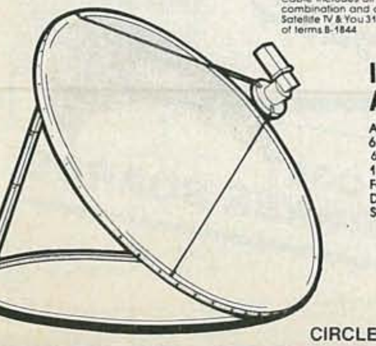
$799.00

Even in California where satellite signals are weaker we've been using this little beauty at Redwood City to demonstrate the Australis I - ask our staff, they put it up and down outside our showroom every day. No Holes and pouring concrete necessary - sturdy ring mount for easy installation and simple assembly. This Antenna is also ideal for sight surveys, and RV's Gain is 36DB F/D equals .375 Focal length 27". Manufactured in the USA of precision sturdy one piece formed aluminum.

SAVE OVER $135.00

Package Includes:

6' Antenna Dish - Complete with all Hardware and Instruction for assembly D-6326
65° Low Noise Amplifier D-6327
Feed Horn D-6328
Down Converter D-6329
Australis I Receiver Kit K-6316
125' RG6 Direct Burial Cable. (No conduit Required) 100% swept tested to 1450 MHz. Cable includes all other necessary cables- receiver, actuator, and polarity control combination and connectors W-2075
Satellite TV & You 31 pages of what you can watch, explains the basics, great glossary of terms B-1844



Items also Available Separately

Australis Receiver Kit K-6316.....$99.00
6' Dish Antenna D-6326.....$399.00
65° Low Noise Amplifier D-6327.....$189.00
125' Cables with Connectors W-2075 $99.00
Feed Horn D-6328.....$49.00
Down Convertor D-6329.....$99.00
Satellite TV & You B-1844.....$1.95

CALL FOR MORE INFO ON DELUXE SYSTEM WITH 9' DISH ANTENNA

CIRCLE 95 ON FREE INFORMATION CARD

The DICK SMITH Funway Mini-Synthesizer

FEATURED IN THIS ISSUE!

BUILD-IT-YOURSELF KIT

It's a real beauty this one: a real 'live' musical synthesiser - and it's live because it uses YOU as the note generator! You get an amazing range of control over the sound.
Cat K-2669

$19.95

See more Dick Smith Funway Kits on the next page.

WHERE THE ELECTRONIC ENTHUSIAST IS # 1 !

DICK SMITH ELECTRONICS

INCORPORATED IN THE STATE OF CALIFORNIA
BRINGING YOU MORE

switches and a 1-1-1-2-4 string of resistors to obtain a workable decade box. With that circuit, closing just one switch gives the desired resistance. A variation of that circuit is shown in Fig. 4, which uses five single-pole double-throw (SPDT) switches. The catch is that each switch must have a center-off position or the circuit won't function properly.

REPORTING SHORTWAVE RECEPTION

I've recently become an avid shortwave listener, and now I want to start collecting QSL cards. I understand that foreign stations want SINPO reports. What's SINPO?—R. N. H., Brentwood, NY.

A well-prepared reception report can be very helpful to a station's engineers and program managers. They'll send a QSL (verification) card if you send them enough information to prove that you actually heard their broadcast. List the station's call letters (if any) and frequency, the time (in GMT or Greenwich Mean Time) you heard the broadcast, and something about the contents of the program, such as "Announcements in English, then French, followed by a piano and flute duet." Follow this with the SINPO code, in a format something like this: S5–I5–N3–P3–O3. The complete SINPO code is shown in Table 2.

TABLE 2—SINPO CODE

	S	I	N	P	O
	Signal Strength	Interference	Noise, Static	Propagation Disturbance	Overall Merit
5	Excellent	None	None	None	Excellent
4	Good	Slight	Slight	Slight	Good
3	Fair	Moderate	Moderate	Moderate	Fair
2	Poor	Severe	Severe	Severe	Poor
1	Barely Audible	Extreme	Extreme	Extreme	Unusable

WIRING EXTENSION SPEAKERS

I stopped in a hi-fi store to purchase wire for extension speakers that I'm adding to my stereo. The young clerk really got on my case. He asked me all kinds of things about speaker size, how far away my speakers would be located, and lots of other fool questions. I walked out and purchased a spool of speaker wire at a supermarket. Later, I thought about that clerk's questions, and I wondered whether he was really trying to be helpful.—E. O. C., Port Chester, NY.

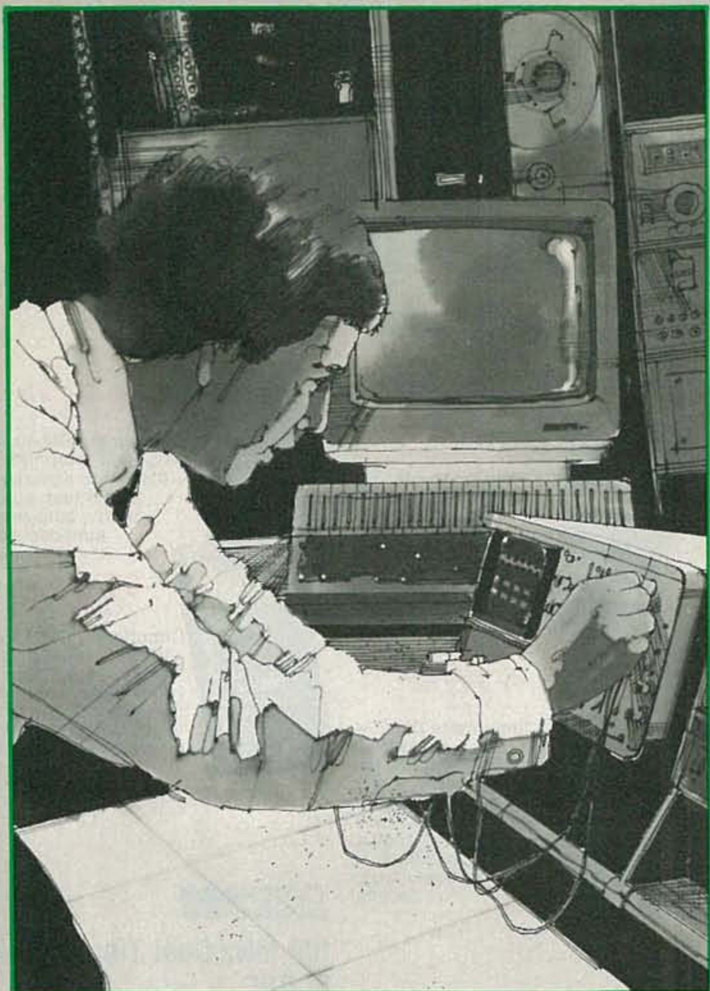
Oh, if we only had more clerks like the one that tried to help you! He wasn't being nosey; he really was trying to be helpful. When he asked about the "size" of your speakers, he most likely meant their *impedance*, not their diameter (6 inches, 12 inches, etc.) A loudspeaker is an AC-circuit device that has capacitance, inductance, and resistance, and all of those resist, or impede, the flow of electricity. The combination of all three is called impedance, which is specified in ohms.

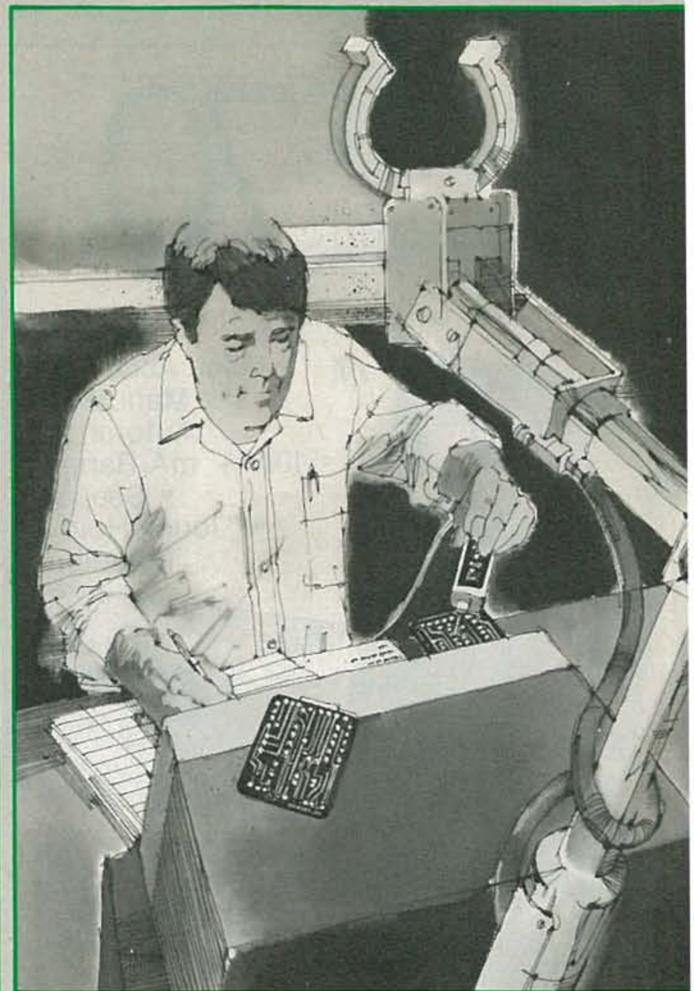
TABLE 3—WIRE SIZE VS. MAXIMUM LENGTH FOR 15% POWER LOSS

B&S Gauge	4 ohms	8 ohms	16 ohms
24	11	23	47
20	30	60	118
18	47	95	190
16	75	150	300
14	120	240	475

Whenever a speaker is connected to an amplifier, there will be some power loss in the speaker cable. The longer the cable, and the smaller its diameter, the greater will be the power loss.

When the cable size is too small, that is, when its impedance approaches that of the speaker itself, there can be a reduction in speaker volume, as well as a decrease in the speaker's low-frequency response. Table 3 shows the maximum wire length that can be used between the amp and the speakers so that line losses do not exceed 15% of the power being delivered by the amplifier. **R-E**





What can you do
Just about

CIE can show you how.

Computer technology. Satellite communications. Cable television. Cellular radio. Digital electronics. Robotics. Just a few of the hottest career areas in electronics. The ones everybody is talking about. The ones that are changing the way we live, the way we do business, the way we entertain ourselves. The best way to start a career in any of them? By learning the basic electronics theory and principles of how they work from CIE.

Join a leader.

Leading the world in specialized electronics training, CIE is the largest school of its kind with over 25,000 students at home and abroad. And with over 50 years of experience teaching electronics to thousands of men and women through proven methods of independent study **without** classroom sessions.

Learn as much as you want, when you want.

Whether you're interested in learning new skills or upgrading old ones, earning a diploma or an A.A.S. degree, CIE can match your needs with courses and programs that let you start where you want, go as far as you want from a basic beginner course all the way to CIE's Associate in Applied Science Degree in Electronics – a comprehensive program that prepares you for advanced electronics careers.

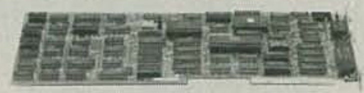
Custom training equipment helps you learn.

CIE believes in the importance of learning by

EQUIPMENT REPORTS

STB Systems Chauffeur Video Board

Now you can use color/ graphics software with your monochrome monitor.



CIRCLE 5 ON FREE INFORMATION CARD

IF YOU'RE SHOPPING FOR AN IBM PC OR a PC-compatible computer, somewhere along the line you'll be forced to choose a display option. You have the choice of getting a monochrome adapter and a monochrome monitor, or a color/ graphics adapter and color monitor. (And if you opt for color, then you have to decide between a composite and an RGB monitor.) How do you choose?

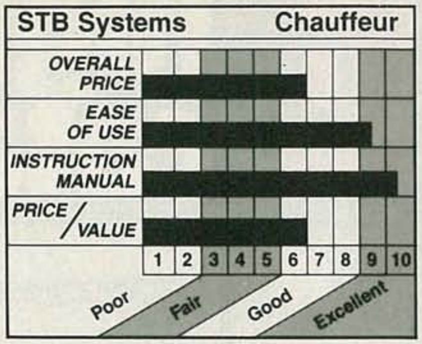
Color displays are nice, but if you work on text for very long, you'll soon grow tired because of the poor resolution. And you'll soon resent that you paid so much for an RGB monitor that can't display images as sharp as a less-expensive monochrome monitor can. But monochrome monitors have their drawbacks, too—especially if your software runs only with a color-display adapter. Ruling out buying one of each monitor type, it seems that making the right decision is rather difficult.

But now there's something to

make that decision easier: the *Chauffeur* video board from STB Systems, Inc. (601 North Glenville, Richardson, TX 75081). That add-on board takes the place of IBM's display adapter and acts as both a monochrome and a color adapter. Color displays are converted into a format that is compatible with a monochrome monitor. It's a good compromise.

The chauffeur is software-compatible with the IBM color/graphics adapter, and it is hardware-and-software-compatible with the IBM monochrome/printer adapter. In its text mode, it allows an 80-character × 25-line display, and provides underline, blink, reverse-video, hidden, and dual-intensity character attributes. Its video memory is 16K in text mode.

In its color mode, the *Chauffeur* converts a color display into a 16-level gray scale, and supports the IBM standard resolutions of 640 × 200 × 2 colors (shades) and 320 × 200 × 4 colors (shades). Its video memory in the graphics mode is 32K.



Setting up the *Chauffeur*

Installing the *Chauffeur* is similar to installing any other add-on card to a PC or compatible. The well-organized and well-written manual helps to make the process as easy as possible. Before the board is physically installed, all that's required is setting a few switches. First, a switch on the PC's motherboard must be set to indicate that a color/graphics display adapter is installed. Then, some jumpers and switches must be set on the *Chauffeur* itself. Two DIP switches are used to set the address of the parallel port, and the other two are set according to the type of monitor you have. (If your monitor isn't listed in the manual, you may have to adjust those switches after the board is installed.) A jumper lets you choose between displaying color screens as 16 shades of gray and displaying colors in only two shades (full intensity and black).

Can the *Chauffeur* and a monochrome monitor really replace a color/graphics card and color monitor? No. The *Chauffeur* has some disadvantages. For example, although colors are displayed in sixteen shades of gray, not all monitors can display all the shades. We found that much color software was hard to use because many of the colors ran together. We suggest that you see the *Chauffeur* in action—running the software you're interested in—*before* you buy.

The shading selection is chosen with a jumper on the *Chauffeur* board. Some color software looks better in 16 shades, some doesn't. Unfortunately, you have to open

ARM YOURSELF AGAINST STATIC WITH NTE'S NEW PATENTED FIELD SERVICE KIT.

Static electricity is a real hazard to sensitive electronic equipment. Now you can protect valuable components in the field and in the plant with NTE's new Field Service Kit.

Our Kit includes everything you need to keep your equipment free of static — a 24″ × 24″ table top work mat, wrist strap with 8′ coil cord, 15′ clip-on grounding line and anti-static component storage bags. Both the wrist strap cord and grounding cord contain integral current limiting resistors.

Unlike other kits currently on the market, NTE's patented* three-layer construction produces controlled static drain, eliminating the danger of sparking and the chance of additional component failure during the repair operation. The static-dissipative, vinyl work surface is durable and its bright green color enhances visibility. The entire Kit folds down into a compact unit and comes with its own zip-close bag.

Look for NTE's new Field Service Kit and our other static control products — including our anti-static foam, for shipping and storing equipment, and separately packaged wrist straps — at your local NTE distributor.

*Patent issued November 8, 1983.
U.S. Patent No. 4,414,260.

NTE®

NTE ELECTRONICS, INC.
44 FARRAND STREET • BLOOMFIELD, NEW JERSEY 07003

CIRCLE 274 ON FREE INFORMATION CARD

up the PC to get to the video board to change the jumper. We wish that STB Systems found some way to make the shading mode switch-selectable from the rear panel.

Many software packages are designed to run on both monochrome and color monitors. Such software checks the computer's configuration switches or jumpers to determine which monitor is attached. Of course, when you use the *Chauffeur*, the software thinks that you have a color-display adapter installed. That can be a disadvantage because the standard monochrome display often looks better than the *Chauffeur's* converted color display.

The *Chauffeur* package comes with *PC Accelerator* software that offers print-spooling, RAM-disk emulation, and some keyboard-enhancement features. We did not test that software.

So, you still haven't made up your mind—monochrome, color, or the *Chauffeur*? Well, at $395, the *Chauffeur* isn't cheap. But then neither are RGB monitors. We found the *Chauffeur* to work amazingly well with some software packages, but not so well with others. How do you really make up your mind? Have a dealer demonstrate the *Chauffeur* with the software that you will use the most; it's the only way to tell if the *Chauffeur* is right for you. **R-E**

Scope DVM-638 Multimeter

A full-featured meter at a budget price.

CIRCLE 6 ON FREE INFORMATION CARD

ASK A HOBBYIST OR TECHNICIAN about the features that they would like to see in a DMM, and you would get a "wish list" that's a yard long. Ask the same person what a meter with just a few of those desirable features would cost, and the response is likely to be just a wistful look, or a roll of the eyes.

But a decent meter, one with some of the "bells-and-whistles" that can help make a troubleshooting job, or any other kind of job, a lot easier need not cost an arm and a leg. Consider, for instance, the *DVM-638* from Scope, which is available through Fordham Electronics (260 Motor Parkway, Hauppauge, NY 11788); its impressive array of features, and its budget price, make for an exciting combination.

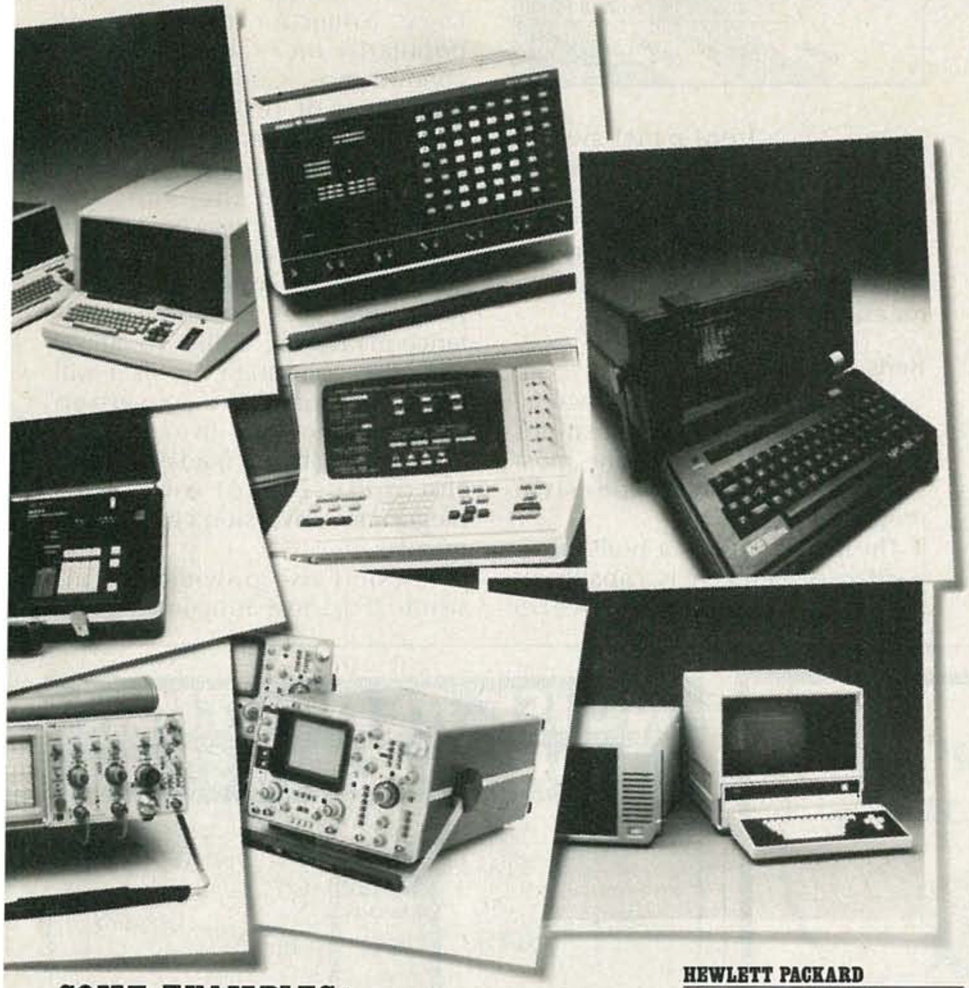
The *DVM-638*

Just in terms of the number of features, the *DVM-638*, offers far more than the typical DMM. But all the "bells-and-whistles" in the world can't turn a poor meter into a good one. They can, however, turn a good meter into a great one.

The *DVM-638* starts out as a good meter. It performs all of the basic functions one would expect of a digital multimeter, and does them well. DC voltage is measured over 5 ranges, from 200-mV to 1000-volts full scale; on the 200-mV range, levels as low as 100 μV can be measured. DC accuracy on all ranges is specified as ±5% of reading + 1 digit. The unit is overload-protected to 1000-volts DC or peak AC on all ranges.

AC voltage (rms) is also measured over 5 ranges, with the top range being 750 volts. Basic accuracy is specified as ±1% of reading + 4 digits, except for the top range (750 volts), where it is ±2% of reading + 4 digits. The unit is overload-protected to 750-volts rms on all ranges except the lowest (200 mV), where the overload protection is specified as 300-mV rms for a maximum of 15 seconds.

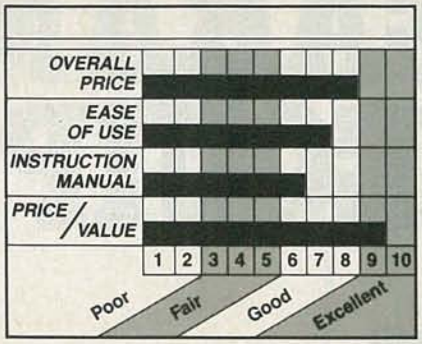
The unit can measure AC and DC current. AC current is measured over 4 ranges, from 2 mA to 10 amps full-scale; on the 2-mA range, currents as low as 1 μA can be measured. Accuracy is ±1% of reading + 4 digits on all ranges except the 10-amp range, where it



is specified as ±1.5% of reading + 4 digits. The 10-amp range is not fused; all other ranges are protected by a 250-volt, 0.8-amp fast-blow fuse.

DC current is also measured over 4 ranges, from 2 mA to 10 amps full-scale. Accuracy is specified as ±0.8% of reading + 1 digit, except for the 10-amp range where it is specified as ±1.5% of reading + 1 digit. Overload protection for the DC-current function is similar to that of the AC-current function.

Resistance is measured over 6 ranges, from 200 kilohms to 20 megohms full-scale; on the 200-kilohm range, resistances as low as 0.1 ohm can be measured. On the 200-kilohm range, the specified accuracy is ±0.8% of reading + 3 digits; on the 20-megohm range, the accuracy is specified as ±1.5% of reading + 1 digit. On all other ranges, the accuracy is specified as ±0.5% of reading + 1 digit. The unit is protected against overloads to 250 volts DC or rms. In addition, there is a low-voltage resistance function. When that function is selected, via a front-panel switch, the unit will output less than 0.25 volts when making resistance measurements. That voltage level will not turn on silicon junctions, thus allowing in-circuit resistance measurements to be made.



Bells and whistles

Now we get to the "good stuff." Those are functions and features normally found only on the most sophisticated (and expensive) meters.

The *DVM-638* has a built-in capacitance meter. It is capable of measuring capacitance over 5 ranges, from 2 nF to 20 μF full-scale. On the 2-nF range, capacitance as small as 1 pF can be measured. Accuracy is affected somewhat by the dissipation characteristics of the capacitor itself; overall, it is specified as ±1% of reading + 4 digits.

While all meters measure resistance, a function that is gaining popularity on high-end units is conductance. (Conductance is the reciprocal of resistance and is measured in Siemans; the Sieman was formerly known as the mho.) That's because that function provides an easy way to test for leakage. The *DVM-638* offers a 200-nS conductance range. That effectively increases the unit's resistance-measuring ability to 10,000 megohms, although the user will have to perform the conversion from conductance to resistance himself; that task is made easier by the inclusion of an nS-to-megohms conversion chart in the manual.

The unit also provides a transistor- (H_{FE}) test function. When

testing a transistor, the device is plugged into the appropriate socket (NPN or PNP) on the meter. The transistor's gain (H_{FE}) is then displayed on the readout.

You can, of course, test continuity with any meter, but the job becomes easier if an audible indicator is provided. Such tones are becoming standard on most better DMM's, and this unit is no exception. The tone is switch-selectable. In addition, up-arrow and down-arrow annunciators on the display are used to give a quick visual indication of continuity.

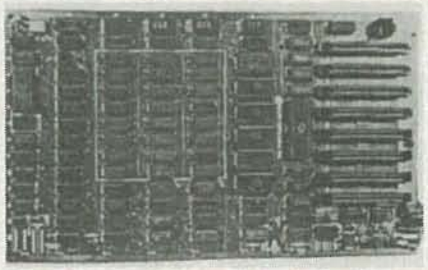
Finally, the unit has a level-detector function that can be used to sense high and low logic levels. In that function, the input is compared to an internal 0.8-volt reference. The result of that comparison is displayed on the read out via the up-arrow (logic low) annunciators. The audio tone, if selected, sounds on inputs that are below the reference.

The unit is supplied with manual, vinyl carrying case, set of test leads, battery, and spare fuse. The manual is small, but fairly complete. It includes just about everything you might expect, except perhaps for some information on the unit's theory of operation. Also, while the location of the calibration adjustments in the unit are indicated, further details on calibration were not provided. A detailed schematic is included, as well as a parts-placement diagram.

Our only real complaint with the *DVM-638* is in the area of mechanical construction. We subjected the unit to "field conditions;" in other words, we dropped it to see how it would hold up. The result was that the range and function selector switches, located down the side of the unit, ceased to work properly. Evidently, the impact (the unit was dropped onto the floor from bench level) caused the case to bind the switches. The problem was fixed by opening the case to relieve the situation; once everything was buttoned up, the unit worked perfectly. The unit's high-impact plastic case was unmarred by the test.

The bottom line on the *DVM-638* is value. At its price of $79.95, you will have a tough time finding a unit that is its equal. **R-E**

Radio-Electronics mini-ADS



APPLE II+ COMPUTER. 48K Apple II+ Motherboard, fully populated, with Applesoft in ROM **$250.00.** Complete computer with Apple compatible keyboard, case, power supply, and motherboard **$455.00.** Starter system with single disk drive **$645.00.** Professional system with dual disk drive and monitor **$895.00.** C.O.D. orders accepted. **V.I.P. ELECTRONICS, P.O. Box 628, Forestdale, R.I. 02824, (617) 755-9778.**

CIRCLE 281 ON FREE INFORMATION CARD

MODEL 350 MULTI-PURPOSE WORK CENTER. This Multi-Purpose Work Center can be used to work on objects up to 9 inches in size plus tiny hard to hold objects. The Standard base tilts, turns and rotates to any work position. The tray base mount keeps small parts and tools at hand. (Combination of 376, 300 and 312) **$47.95. PANAVISE PRODUCTS, INC. 2850 East 29th Street, Long Beach, CA 90806-2399. Telephone (213) 595-7621 Telex 18-2135.**

CIRCLE 259 ON FREE INFORMATION CARD

FREE TOOL & INSTRUMENT CATALOG. New catalog is packed with thousands of hard-to-find tools, test equipment, and technical supplies for testing, repairing, installing, experimenting, and building electronic equipment. Products are shown in full color and described in detail with pricing. Easy ordering by phone or mail. 24-hour shipment. In a hurry to receive your catalog? Call **(800-225-5370.) CONTACT EAST, INC., PO BOX 786, No. Andover, MA 01845 (617) 682-2000.**

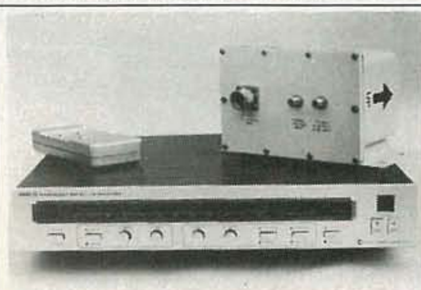
CIRCLE 55 ON FREE INFORMATION CARD

CALL NOW AND

RESERVE YOUR SPACE

- 6 × rate $745.00 per each insertion.
- Reaches 225,379 readers.
- Fast reader service cycle.
- Short lead time for the placement of ads.
- We typeset and layout the ad at no additional charge.

Call 212-777-6400 to reserve space. Ask for Arline Fishman. Limited number of pages available. Mail materials to: mini-ADS, RADIO-ELECTRONICS, 200 Park Ave. South, New York, NY 10003.

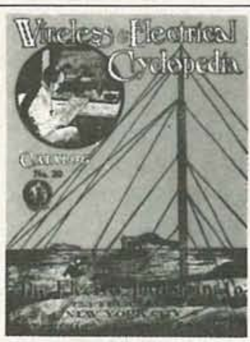


SATELLITE TELEVISION RECEIVER SEMIKIT with dual conversion downconverter. Features infrared remote control tuning, AFC, SAW filter, RF or video output, stereo output. Polorator controls, LED channel & tuning indicators. Install six factory assembled circuit boards to complete. **Semikit $250.00.** Completed downconverter add **$75.** Completed receiver and downconverter add **$100. JAMES WALTER SATELLITE RECEIVER, 2697 Nickel, San Pablo, CA 94806. Tel. 415-724-0587.**

CIRCLE 124 ON FREE INFORMATION CARD

TEST COMPONENTS IN CIRCUIT, POWER OFF WITH THE NEW HUNTRON® TRACKER®2000. Revolutionary Huntron Trackers find shorts, opens, leakage and bonding problems in analog, digital and hybrid components. Test capacitors, logic circuits, op amps, transistors and more. An excellent troubleshooting tool that finds the faults scopes, DMM's and logic analyzers miss. Tracker prices starts at **$995.00.** For nearest distributor, **call 1-800-426-9265 Dept. 120. HUNTRON INSTRUMENTS, INC. 15123 Highway 99 North, Dept. 120 Lynnwood, WA 98037.**

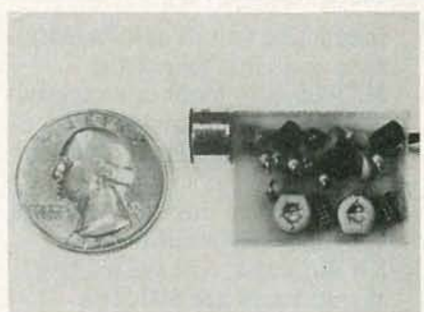
CIRCLE 265 ON FREE INFORMATION CARD



ELECTRO IMPORTING CO. CATALOG. This reprint of the historic 176-page catalog No. 20 gives you an accurate look at the state of electronics in 1918. Contains everything from a Zinc Spark Gap to a 1000-Mile Receiving Outfit. You can get your own copy of this modern antique, profusely illustrated, for only **$4.95** plus $1.00 P&H. Order yours from **R-E BOOKSTORE, Radio-Electronics, 200 Park Avenue South, New York, NY 10003.**

APPLIANCE REPAIR HANDBOOKS—13 volumes by service experts; easy-to-understand diagrams, illustrations. For major appliances (air conditioners, refrigerators, washers, dryers, microwaves, etc.), elec. housewares, personal-care appliances. Basics of solid state, setting up shop, test instruments. **$2.65 to $5.90 each.** Free brochure. **APPLIANCE SERVICE, PO Box 789, Lombard, IL 60148. 1-(312) 932-9550.**

CIRCLE 84 ON FREE INFORMATION CARD



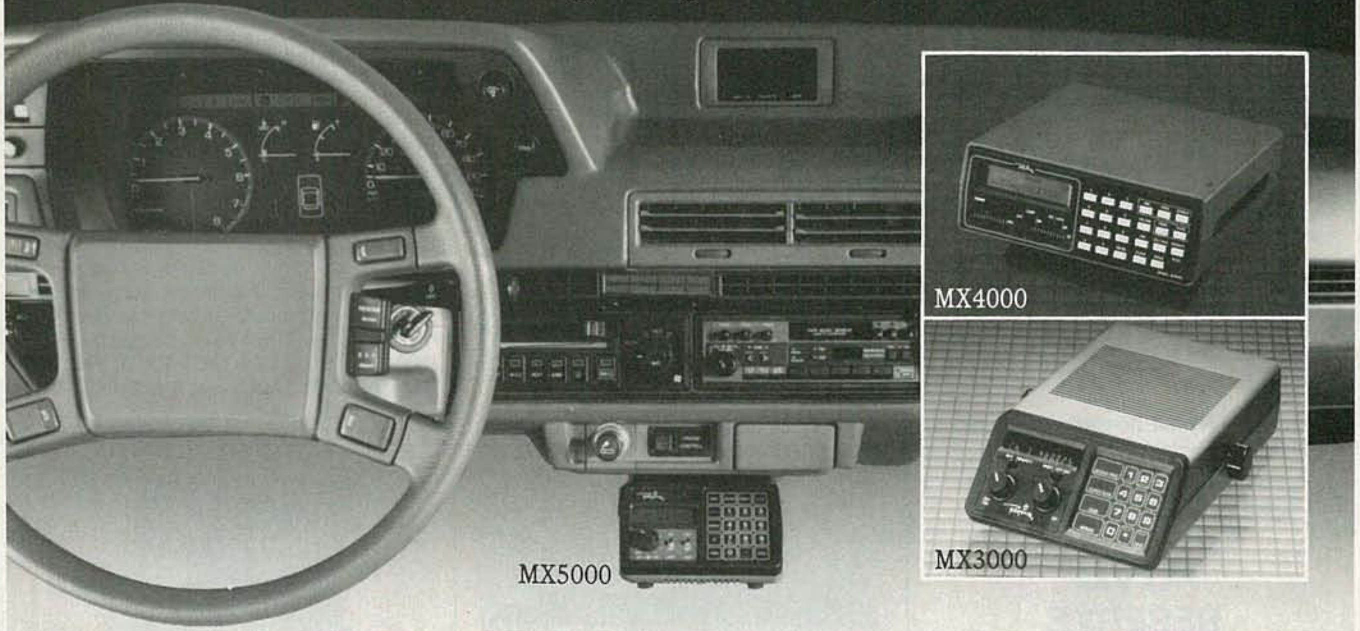
THE MOST EXCITING KIT YOU WILL EVER BUILD The model WAT-50 miniature FM transmitter uses a 4-stage circuit NOT to be confused with a simple wireless microphone. Up to 1 mile range. So sensitive, it will pick-up a whisper 50 feet away! Use with any FM radio. Complete kit only **$29.95** tax incl. VISA and MasterCard accepted. FREE SHIPPING. **DECO INDUSTRIES, Box 607, Bedford Hills, NY 10507. (914) 241-2827.**

CIRCLE 127 ON FREE INFORMATION CARD

New 800 MHz models

Regency Scanners

Bring you the Excitement of Police, Fire, Emergency Radio, and more.



Our radios deliver the local news. From bank hold-ups to three alarm fires. It's on-the-scene action. While it's happening from where it's happening . . . in your neighborhood.

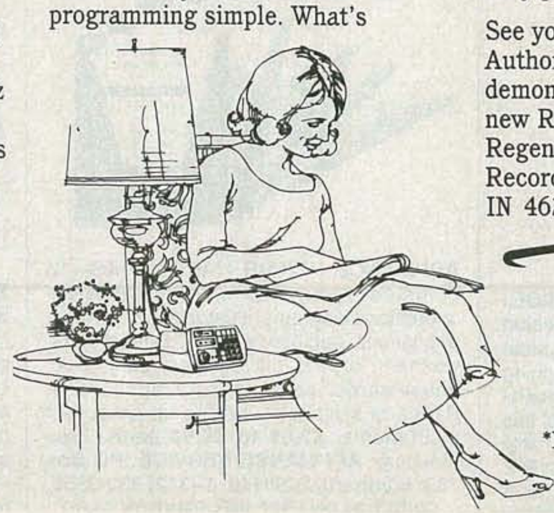
You can also listen to weather, business and marine radio calls. Plus radio telephone conversations that offer more real life intrigue than most soap operas. And with our new models, there's even more.

Unique Capabilities

Introducing two all new Regency scanners. First, there's the MX7000, a 20 channel, no-crystal unit that receives continuously from 25 to 550 MHz and 800 MHz to 1.2 GHz. That's right! Continuous coverage that includes VHF and UHF television audio, FM Broadcast, civil and military aircraft bands and 800 MHz communications. Next in line is the new MX4000. It's eight band coverage includes standard VHF and UHF ranges with the important addition of 800 MHz and aircraft bands. Both units feature keyboard entry, a multifunction liquid crystal display and selectable search frequency increments.

Practical Performance

If you don't need the 800 MHz range coverage, Regency offers two exciting new units. The MX5000 is a 20 channel, no-crystal scanner that receives continuously from 25 to 550 MHz with all the same features as the MX7000. Then there's the 30 channel MX3000. It's digitally synthesized so no crystals are necessary, and the pressure sensitive keyboard makes programming simple. What's more, it has a full function digital readout, priority, search and scan delay, dual scan speed, and a brightness switch for day or night operation.



At Home Or On The Road

With compact design, easy access front panel and mounting bracket these Regency scanners are ideal for mobile* use. But we also supply each radio with a plug-in transformer and a telescoping antenna so you can stay in touch at home. The MX4000 even has a rechargeable battery pack so it's fully portable.

See your Regency Scanner Authorized Dealer for a free demonstration on these and other new Regency Scanners. Or, write Regency Electronics, 7707 Records Street, Indianapolis, IN 46226.

Regency®
ELECTRONICS, INC.
7707 Records Street
Indianapolis, IN 46226-9989

*Mobile use subject to restriction in certain localities.

CIRCLE 262 ON FREE INFORMATION CARD

BUILD THIS

$99 Satellite-TV Receiver

RICHARD MADDOX

OK, TVRO fans, here's your chance to build a high-performance satellite receiver—for peanuts!

THE IDEA OF RECEIVING TV SIGNALS FROM satellites became popular almost instantaneously when the first home TVRO was built in 1979. However, due to the tremendous costs involved, the *practice* of receiving TV signals from satellites was nowhere near as popular. Only recently have prices dropped to the point where satellite-TV can be enjoyed by a large number of people.

Receiver kits helped make satellite TV affordable to electronics hobbyists (to whom TVRO was esecially appealing.) But the kits that were available were difficult to build, and they required a lab's worth of expensive test gear to align. But now—thanks to advances in electronics and state-of-the-art circuit design—we can show you how to build a satellite receiver for less than one hundred dollars! It's very easy to build, and requires only your eyes, a TV set, and a voltmeter to align. And that's not all: The receiver performs as well as—if not better than—commercial units costing several times as much.

If you already own a satellite-TV system, this is an ideal opportunity for you to add a second receiver to your system at a very low cost. All that is required is an isolated two-way power divider, a downconverter, and the associated cabling. If you have an older satellite system, and your picture, sound, or both aren't up-to-snuff, then this receiver may be just what you need to improve reception. It accepts a standard 70-MHz input, and features continuous transponder-tuning, tunable audio subcarrier with switchable bandwidth, a polarization control circuit, defeatable AFC, and an integral crystal-controlled RF modulator for output on TV Channel 3 or 4.

Of course, the receiver can't pick up satellite-TV signals all by itself—several other components are necessary. We'll briefly describe what's needed for a complete system. But if you're very unfamiliar with satellite TV, we suggest you check the special sections that appeared on the subject in the June 1984, October 1984, June 1985 and July 1985 issues of **Radio-Electronics**.

Main system components

There are several components, in addition to the receiver, that are needed to complete a TVRO system: the dish, the feedhorn, the LNA (low-noise amplifier), the downconverter, and the cable. We'll examine each of those in turn.

The dish is parabolic in shape, and it is built from metal. The strength of the signal received by the antenna probe in the feedhorn is proportional to the diameter of the dish. Luckily, satellite power levels have increased the past few years to the point that a small dish (four to six feet in diameter) provides adequate reception throughout much of the midwest and south. Throughout the rest of the country, an eight- to ten-foot dish will probably be necessary for good reception, although newer satellites may allow the use of a four- to six-foot dish. Whatever sized dish you use, though, it must be aimed precisely at the desired satellite. Signals from the satellite then hit the dish and are reflected to a point, the focal point of the dish, where the *feedhorn* is located.

The feedhorn has several purposes. It collects the microwaves that have been reflected by the dish, directs them to the LNA, and selects the desired polarity.

To understand why polarity is important, you must understand that TV satellites can broadcast on 24 different channels, numbered 1 through 24. The trick is that the odd-numbered channels are broadcast in a different spatial orientation than the even-numbered channels. That is done because the frequencies of the odd and even signals actually overlap one another. But because they're polarized differently, we can receive one set without interference from the opposite set. We'll discuss more about how that works in the "theory-of-operation" section below.

The *LNA* (low-noise amplifier) is similar to the antenna pre-amp found on fringe-area TV antennas. Its purpose is to boost the satellite signals to a level that can drive the downconverter. The LNA is mounted behind the feedhorn.

The two most important specifications of an LNA are the noise temperature and the gain. Noise temperature is rated in degrees Kelvin; the lower the number, the less noise the amplifier adds to the signal as it is amplified. Gain is measured in dB, and typically ranges between 30 and 55 dB. An average LNA today might have 100°K noise temperature and 50 dB gain, although some high-performance models are rated at 85°K.

Roughly speaking, the noise temperature of the LNA can be correlated to the size of the dish. For example, a ten-foot dish and a 100-degree LNA will give results similar to an eight-foot dish and an 80-degree LNA, or to a six-foot dish and a 60-degree LNA.

The *downconverter* is what actually tunes in the desired channel. It is mounted directly to the LNA or behind the dish on the mount. Downconverters usually have three electrical connections: the input, which comes from the LNA, the 70-MHz output, which goes to the receiver, and an additional voltage that is used to tune in the desired transponder channel. That voltage is set by the user at the receiver. Most common downconverters use a tuning voltage that ranges from two to sixteen volts. Receivers usually supply that tuning voltage to the LNA through the same cable and connector that the 70-MHz signal travels through.

Some downconverters are designed to be mounted directly to an LNA, and must be used with a 30- to 35-dB gain LNA. If a 50-dB LNA is used, it is recommended that the downconverter be mounted behind the dish and connected to the LNA via RG213 cable, unless the dish is smaller than about seven feet, or unless the downconverter is specifically designed to be used with a high-gain LNA.

There are two types of coaxial cable used in typical satellite systems: RG213 and RG59. The standard 75-ohm cable used to hook up TV antennas is RG59, and RG213 is special 50-ohm cable designed for high-frequency use. The LNA is connected to the downconverter with RG213 cable, and two RG59 cables connect the receiver and the downconverter. An additional RG59 cable connects the receiver to the TV set. Finally, the feedhorn is connected to the receiver via a two-conductor shielded cable. One conductor carries the supply voltage from the receiver, and the other provides the polarizing pulses that we'll discuss in a moment. But let's begin at the beginning. Refer to the block diagram in Fig. 1 and the complete schematic diagram in Fig. 2 while following this discussion.

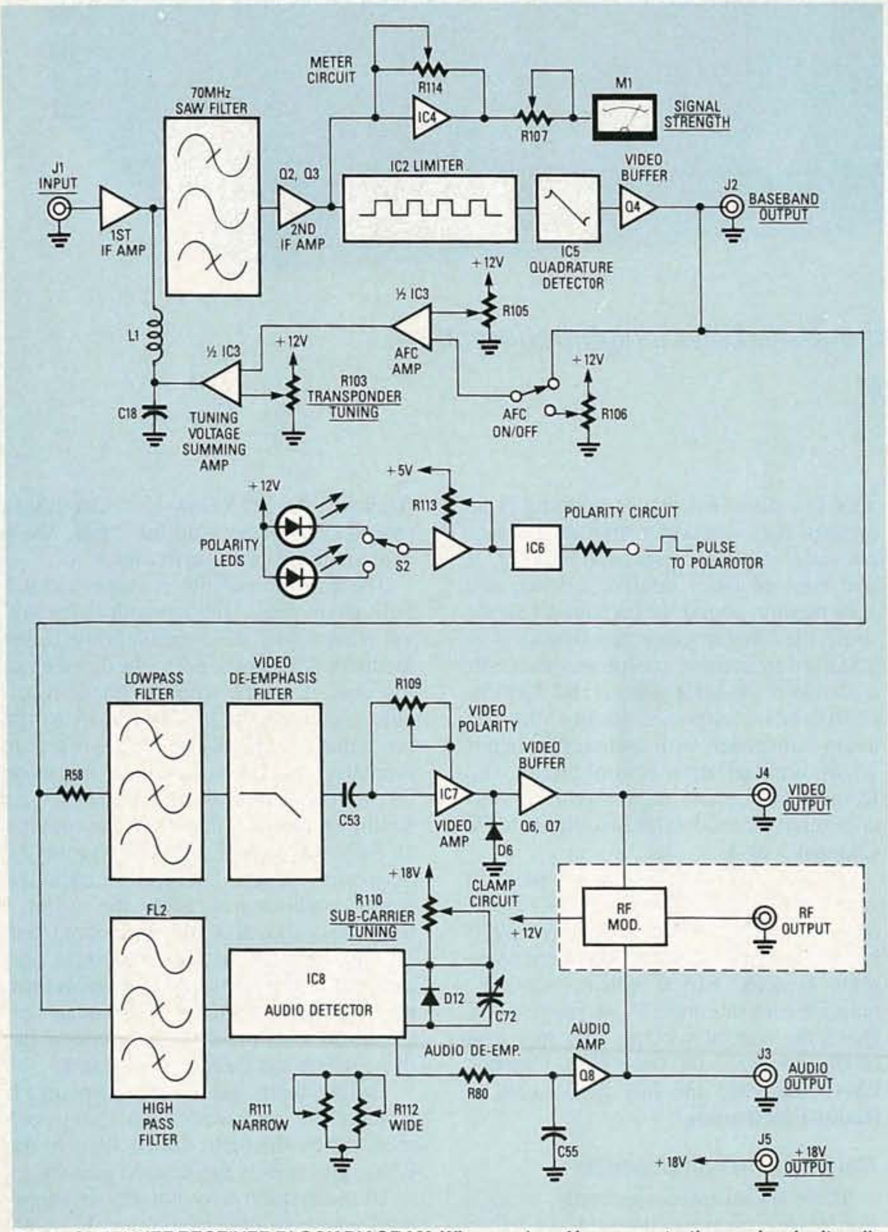


FIG. 1—SATELLITE RECEIVER BLOCK DIAGRAM. When analyzed in segments, the receiver isn't really as complicated as it looks.

Theory of operation

The receiver accepts a 70-MHz signal from the downconverter at jack J1; that jack also supplies the variable tuning voltage to the downconverter. The input signal is isolated from the tuning voltage by inductor L1 and capacitor C18. Front panel potentiometer R103 (TRANSPONDER TUNING) is used to tune in the desired transponder. Trimmer potentiometers R102 and R104 set the maximum and minimum voltages, respectively, presented to the downconverter.

An AFC (Automatic Frequency Control) voltage is derived from the received signal and summed with the tuning voltage by IC3. AFC can be defeated by front-panel switch S1 if terrestrial interference is encountered (or if a synthesized downconverter is used). When AFC is defeated, R106 supplies a compensation voltage for proper tuning.

The 70-MHz input signal is capacitively coupled to IC1, which provides a gain of about 25 dB. Filter FL1 is a SAW (*S*urface *A*coustic *W*ave) filter with a bandwidth of 27 MHz. Its purpose is to strip off noise and interference occurring on either side of the selected channel.

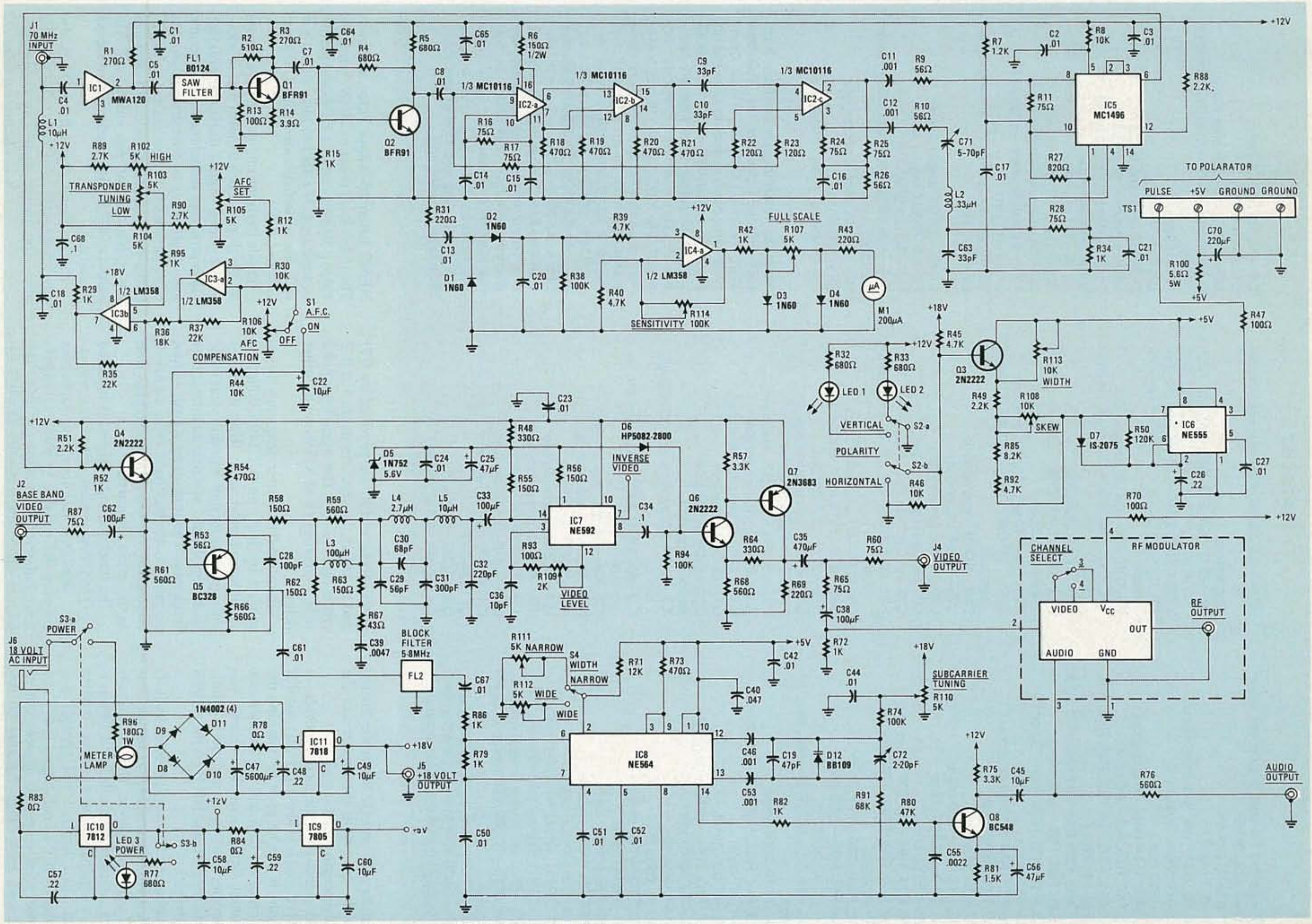


FIG. 2—THE COMPLETE SCHEMATIC of the receiver shows the tuning circuit, the IF section, the video and audio circuits, polarization-control curcuit, RF modulator, and power supply. A complete kit is available, and hard-to-find components, including the PC board, are available separately.

PARTS LIST

All resistors 1/4-watt, 5% unless otherwise specified.
R1, R3—270 ohms
R2—510 ohms
R4, R5, R32, R33, R77—680 ohms
R6—150 ohms, ½-watt
R7—1200 ohms
R8, R30, R44, R46—10,000 ohms
R9, R10, R26, R53—56 ohms
R11, R16, R17, R24, R25, R28, R60, R65, R87—75 ohms
R12, R15, R29, R34, R42, R52, R72, R79, R82, R86, R95—1000 ohms
R13, R47, R70, R93, R96—100 ohms
R14—3.9 ohms
R18–R21, R54, R73—470 ohms
R22, R23—120 ohms
R27—820 ohms
R31, R43, R69—220 ohms
R35, R37—22,000 ohms
R36—18,000 ohms
R38, R74, R94—100,000 ohms
R39, R40, R45, R92—4700 ohms
R41—unused
R48, R64—330 ohms
R49, R51, R88—2200 ohms
R50—120,000 ohms
R55, R56, R58, R62, R63—150 ohms, ½-watt
R57, R75—3300 ohms
R59, R61, R66, R68, R76—560 ohms
R67—43 ohms
R71—12,000 ohms
R78, R83, R84—0 ohms (jumper)
R80—47,000 ohms
R81—1500 ohms
R85—8200 ohms
R89, R90—2700 ohms
R91—68,000 ohms
R96—180 ohms, 1 watt
R97–R99, R101—unused
R100—5.6 ohms, 5 watts
R102, R104, R105, R107, R111, R112—5000 ohm trimmer potentiometer
R103—5000 ohm linear potentiometer
R106, R113—10,000 ohm trimmer potentiometer
R108—10,000 ohm linear potentiometer
R109—2000 ohm trimmer potentiometer
R110—5000 ohm linear potentiometer
R114—100,000 ohm trimmer potentiometer

Capacitors
C1–C5, C7, C8, C13–C18, C20, C21, C23, C24, C27, C42, C44, C50–C52, C61, C64, C65, C67—0.01 µF, ceramic disk
C6, C37, C41, C43, C54, C59, C66—unused
C9, C10, C63—33 pF, ceramic disk
C11, C12, C46, C53—0.001 µF, ceramic disk
C19—47 pF, silver mica
C22, C45, C49, C58, C60—10 µF, 25 volts, tantalum
C25, C56—47 µF, 16 volts, tantalum
C26, C48, C57, C59—0.22 µF, 30 volts, tantalum
C28—100 pF, ceramic disk
C29—56 pF, ceramic disk
C30—68 pF, ceramic disk
C31—300 pF, ceramic disk
C32—220 pF, ceramic disk
C33, C38, C62—100 µF, 16 volts, electrolytic
C34, C68—0.1 µF, ceramic disk
C35—470 µF, 16 volts, electrolytic
C36—10 pF, ceramic disk
C39—0.0047 µF, ceramic disk
C40—0.047 µF, ceramic disk
C47—5600 µF, 40 volts, electrolytic
C55—0.0022 µF, ceramic disk
C70—220 µF, 25 volts, electrolytic
C71—5–70 pF, variable
C72—2–20 pF, variable

Semiconductors
IC1—MWA120, hybrid small-signal amplifier
IC2—MC10116, triple differential line receiver
IC3, IC4—LM358, dual op-amp
IC5—MC1496, video detector
IC6—NE555, timer
IC7—NE592, video amplifier
IC8—NE564, phase-lock loop
IC9—7805, 5-volt regulator
IC10—7812, 12-volt regulator
IC11—7818, 18-volt regulator
Q1, Q2—BFR91
Q3, Q4, Q6—2N2222
Q5, Q7—BC328 or 2N3683
Q8—BC548 or ECG548
D1–D4—1N60
D5—1N752, 5.6-volt zener diode
D6—HP 5082-2800 or 1N6263 Schottky diode
D7—1S2075
D8–D11—1N4002
D12—BB119 tuning diode
LED1—standard green LED
LED2, LED3—standard red LED's

Other components
J1, J5—"F" connector
J2, J3, J4—RCA phono jack
J6—coaxial power input jack
TS1—4-position screw-terminal strip
L1, L5—10 µH
L2—0.33 µH, six turns on a ¼-inch form.
L3—100 µH
L4—2.7 µH
S1, S4—SPDT, toggle switch
S2, S3—DPDT, toggle switch
FL1—BO124 SAW filter
FL2—5–8 MHz block filter (Dick Smith L-1600)
M1—200 µA edge-reading meter
RF modulator
T1—18-volt AC power transformer

Note: the following are available from Dick Smith Electronics, Inc., P.O. Box 8021, Redwood City, CA, 94063: Complete kit of parts including case but no power transformer, #K-6316, $99.95 plus $4 shipping; SAW filter, #L-1620, $29.95; Case, #H-2507, $12.95; PC board, #H-7000, $29.95; 18-volt transformer, #M6672, $7.95;BFR91 transistor, #Z-1691, $1.19; BB119 diode, #Z-3070, $0.20; MWA120 RF amplifier, #Z-6095, $12.50; MC10116 ECL IC, #Z-6000, $0.79; HP5082-2800 Schottky Diode, #Z-3230, $2.00; 5–8—MHz filter, #L-1600, $3.95. Other individual parts, and complete satellite systems, are also available from Dick Smith. California residents please add 6.5% sales tax. Orders outside U.S. must include U.S. funds and add 15% of merchandise total for shipping.

Transistors Q1 and Q2 boost the filtered signal to drive both the limiter and the signal-strength meter circuit.

The signal-strength meter provides a relative indication of transponder strength. It can be used to fine-tune the position of the dish and the feedhorn for maximum signal strength. Trimmer potentiometer R107 sets the meter's full-scale deflection, and R114 sets the meter's sensitivity.

Amplitude limiting is provided by IC2, an MC10116 balanced ECL (*E*mitter *C*oupled *L*ogic) transceiver. That limiting removes amplitude-modulated components—impulse noise—from the 70-MHz signal. Two limited FM signals are provided by IC2's final stage at pins 2 and 3; those signals are 180 degrees out of phase with each other. Another 90 degrees of phase shift are provided by C71 and L2 before the signal from pin 3 of IC2 enters pin 4 of IC5. The signal from pin 2 of IC2 enters pin 8 of IC5 without further delay.

The 70-MHz carrier frequency is removed by IC5, an MC1496 balanced modulator-demodulator. That IC mixes the signals from pins 8 and 10 with those from pins 4 and 1 and removes the carrier frequency. The remaining signal, output on pin 6, is the baseband video signal. It contains all the video information as well as the audio sub-carrier.

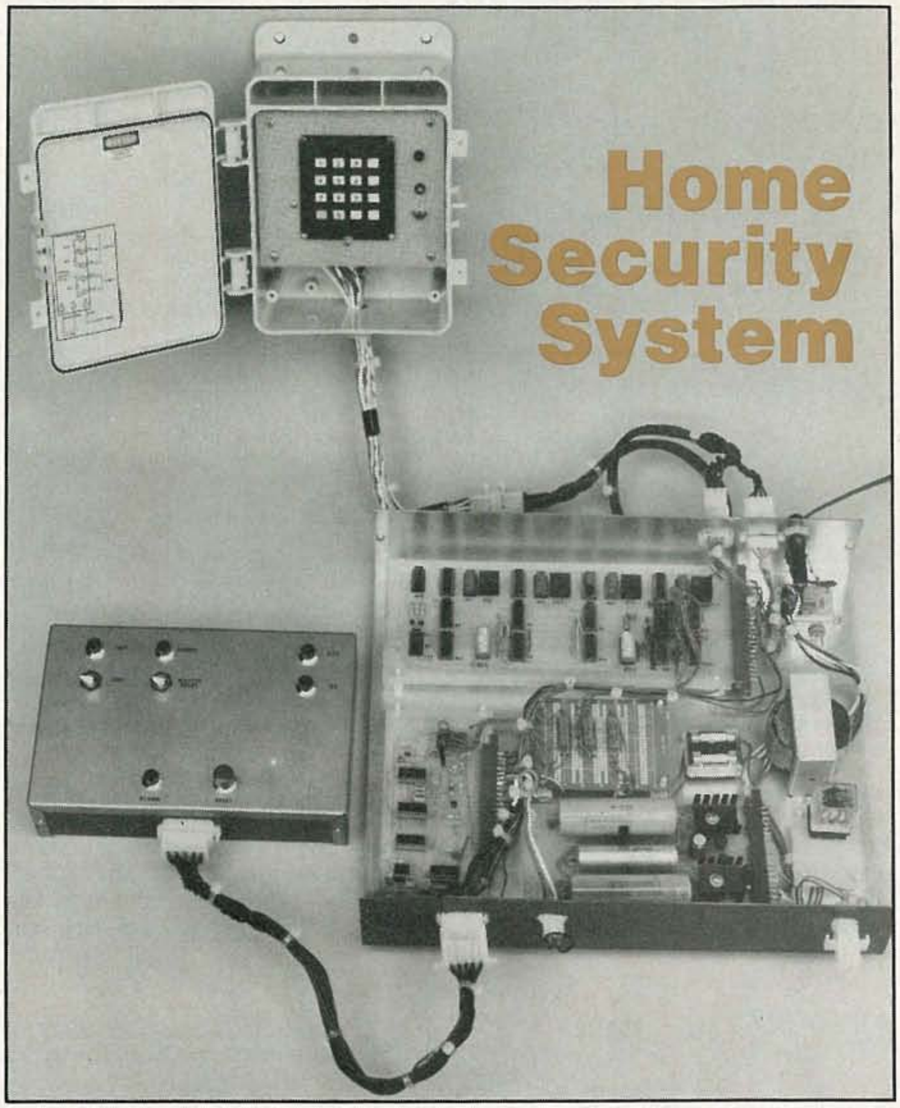
The baseband video signal is buffered by Q4 to provide a low-impedance output. The inductors, resistors, and capacitors between R58 and C33 form a lowpass filter and a video de-emphasis filter. The filtered video is then amplified by IC7, an NE592 balanced-output video amplifier. The video level is set by R109, while the video polarity is set by a PC-board jumper connecting C34 either to pin 7 or pin 8 of IC7. For a normal video signal, connect C34 to pin 8.

Diode D6 is the clamp that traps out the 30-Hz dispersion waveform that is added to the video signal during uplinking. (That *dithering* technique helps to eliminate interference to terrestrial microwave communications.) Transistors Q6 and Q7 buffer the signal to provide a 75-ohm output with a one-volt p-p video level. The output of Q7 is also used to drive the RF modulator.

The baseband signal from Q4 is also amplified by Q5, and feeds a 5- to 8-MHz filter. The filtered signals are then routed

continued on page 112

Home Security System



This low-cost home alarm system features a digital combination lock, optional display circuitry, simple installation; and it's not limited to home use.

ANTHONY J. LaMARTINA

Part 2

LAST TIME, WE BEGAN to look at the display board. Let's finish that discussion now. (See Fig. 4 in last month's **Radio-Electronics**.)

After a key has been pressed, its binary code, according to its position in the matrix, appears on IC15's output pins 16–19, and the DAV (DATA AVAILABLE) output is sent high at pin 13. That pin goes high whenever a key is pressed, and it goes low whenever the key is released. After a suitable debounce period, DAV will go high again if it senses that another key has been pressed. The 74C923's four-bit outputs are connected to the inputs of IC14, whose outputs are connected to the inputs of IC13, whose outputs are connected to the inputs of IC12. Each time the DAV line goes high, the outputs of each stage are shifted into the following stage.

We should mention that the row (X) and column (Y) inputs of the keyboard encoder IC are not wired to the corresponding rows and columns of the keyboard matrix. That was done to confuse anyone trying to defeat the alarm. For example, pressing the "1" key causes a value of "2" to be output. Similarly, pressing the "9" key causes a "C" to be output.

Anyway, the output of each stage feeds a 74LS85 4-bit comparator and a 9368 seven-segment display decoder/driver/latch. Each of the latter drives a FND500 seven-segment display; any common-cathode display may be used, however. There are seven resistors connected between the outputs of the 9368 and the displays; we used 14-pin resistor networks, rather than discrete resistors, in our prototype.

The 9368 IC's, current-limiting resistors and displays may be omitted from the design without affecting the function of the circuit. They were included to help debug the initial prototype; they also provide visual indication that the keyboard scanning circuitry is working properly.

Each 74LS85 compares four bits of information from DIP switch S1 or S2 to four bits of information from IC12, IC13, IC14 or IC15. The DIP switches are connected to the "A" inputs of the comparator, and the latches are connected to the "B" inputs. Looking at S1, switch *a* is the MSB (*M*ost *S*ignificant *B*it) of the left-most digit. Switches *b*, *c* and *d* are the remaining bits of digit 1. Switch *e* is the MSB of the second digit, and switches *f*, *g* and *h* are the remaining bits of that digit. The individual switches in S2 similarly correspond to the third and fourth digits.

Counting in this circuit is done in binary. For example, in order to use "5" as the first digit of our four-digit code, switches S1-a–S1-d would be set up as Ø1 Ø1. A "1" or high logic level represents an open switch and a "Ø" or low logic level represents a closed switch.

Sixteen distinct values can be represented by each digit: the digits zero through nine and the letters A through F. Unlike some IC's, the workhorse 7447 for example, the 9368 seven-segment display decoder/driver/latch we have specified will accept binary inputs above the value of nine and display the correct hexadecimal digit. For example, a binary input of 1111 equals hex "F," and will be so displayed.

We use a 16-key keyboard to punch in the digital combination code. Ten of those keys could be labeled with the numerals 0–9. The six additional keys might be labeled CLEAR, ENTER, FUNC A, and so on, to help confuse someone trying to break in the protected area.

Each 74LS85 has three outputs, indicating whether the "A" inputs are greater than, equal to or less than the "B" inputs. Those outputs are cascaded from IC11 to IC10, from IC10 to IC9, and from IC9 to IC8. The outputs of the latter indicate the overall relationship between the values programmed in S1 and S2, and the last four keyboard entries. When the values programmed in the DIP switches are less than the (last four) values punched in at

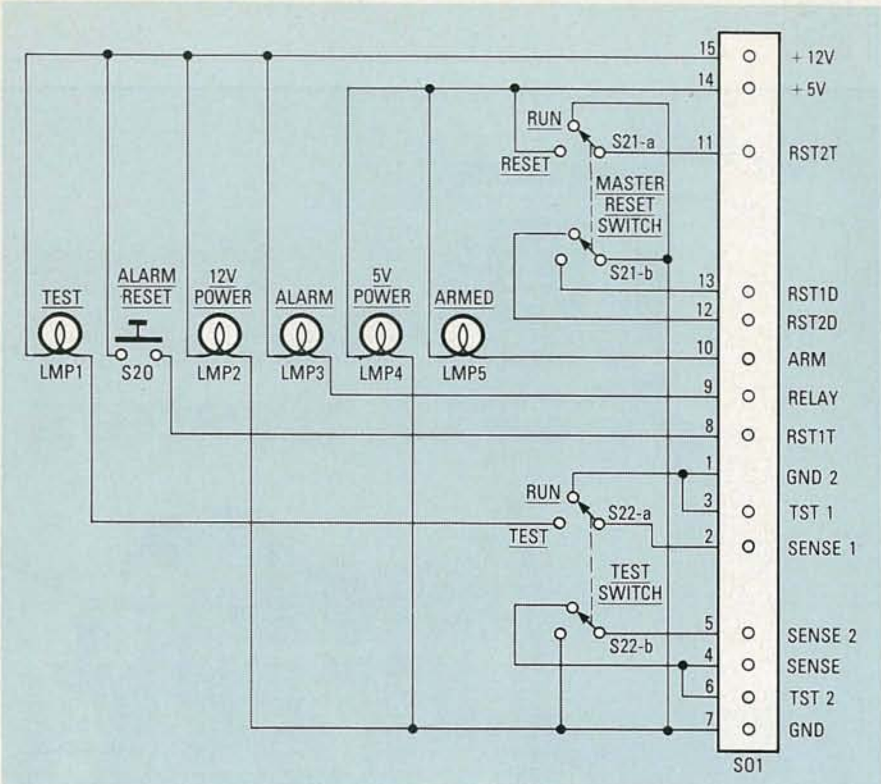


FIG. 6—SCHEMATIC DIAGRAM OF THE CONTROL PANEL. All five lamps should be low-current devices to conserve power.

the keyboard, LED6 illuminates. Likewise, LED8 lights up to indicate the greater than condition, and LED7 indicates the equality condition. On the keyboard panel, OK LED10 also lights up to indicate the equality condition.

The A=B signal from IC8 is also fed to one input of AND gate IC6-a. The other input comes from ENTER switch S19 on the keyboard panel (Fig. 5). After the code sequence has been punched in at the keyboard, the A=B output goes high, and LED10 lights up, indicating that ENTER switch S19 should be pressed. After that is done, pin 6 of IC6 goes high and clocks a "1" into "D" flip-flop IC7-a, whose Q output goes high and energizes relay RY4. Then the relay's contacts close and short out the sense loop terminals, and that allows the actual sense loop to be broken.

In addition, once the flip-flop has been set, additional keyboard entries, which might cause A=B to go low, will not re-enable the alarm circuit; MASTER RESET SWITCH S21 must be toggled for that to occur. In fact, both the timer board and the display board are reset by that switch. When it is pressed, several things happen. Four-bit latches IC12–IC14 are reset, so "Ø's" appear at their outputs, on the displays, and at the inputs to the comparators.

At the same time, one side of RY3's coil is grounded, which energizes the relay, and causes its contacts to close across the XI and YI inputs of the keyboard encoder IC. The relay's closing simulates pressing the 0 key, and is done because IC15 has no RESET pin. In that way, all four digits are reset to values of zero. For that reason, "ØØØØ" should not be used as the entry code, as system reset would disarm the alarm. In addition, "D" flip-flop IC7 is reset when MASTER RESET SWITCH S21 is toggled; that de-energizes RY4 and allows the sense loop to function properly.

Control panel

As shown in Fig. 6, housed in the control panel are the TEST, ALARM RESET and

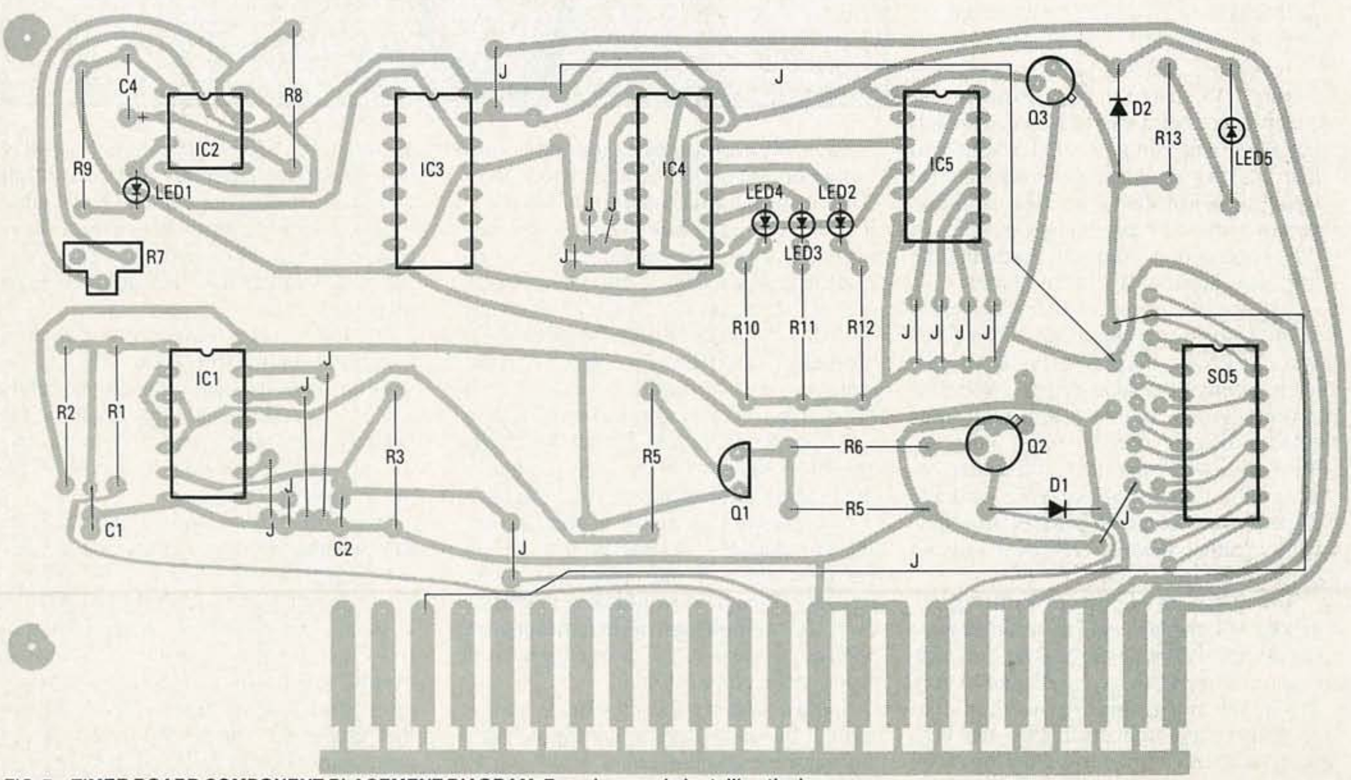


FIG. 7—TIMER BOARD COMPONENT-PLACEMENT DIAGRAM. Exercise care in installing the jumpers.

PARTS LIST

All resistors are ¼-watt, 5%, unless otherwise noted.
R1, R3—100,000 ohms
R2—4.7 megohm
R4, R5—10,000 ohms
R6—100 ohms
R7—100,000 ohm potentiometer
R8—3,300 ohms
R9, R10, R11, R12, R13—150 ohms
R14, R15, R16—220 ohms
R17–R46—330 ohms
R47—25 ohms, 1 watt
R48—10,000 ohms, 1/2-watt

Capacitors
C1, C5, C9, C12—0.1 µF, 35 volts, tantalum
C2—100 pF
C3—0.47 µF
4—10 µF, 10 volts, electrolytic
C6, C8, C11—1 µF, 10 volts, electrolytic
C7—4000 µF, 25 volts, electrolytic
C10—2000 µF, 25 volts, electrolytic

Semiconductors
IC1—4001 quad NOR gate
IC2—555 timer
IC3—4017 decade counter
IC4—4518 dual BCD up counter
IC5, IC7—4013 dual "D" flip-flop
IC6—4081 quad AND gate
IC8–IC11—74LS85 4-bit comparator
IC12–IC14—74C173 4-bit latch
IC15—73C923 20-key encoder
IC16–IC19—9368 hexadecimal display decoder/driver
IC20—LM340T-5 5 volt regulator
IC21—LM340T-12 12 volt regulator
IC22—H11C5 or MOC3001 opto-isolator
BR1, BR2—BR31 1-amp bridge rectifier
D1, D2—1N4001
DSP1–DSP4—FND500 common cathode, 7-segment display
LED1–LED10—standard LED's
Q1—2N4403
Q2, Q3—2N4401
Q4—2N2222
TR1—BT136-600 or similar triac

Other Components
F1—6/10 Amp, 250 volts
F2, F3—1 Amp, 250 volts
LMP1–LMP3—12 volt lamp
LMP4, LMP5—5 volt lamp
RY1—12 volts DC, DPDT relay
RY2–RY4—SPST 5-volt reed relay
S1, S2—8-position DIP switch
S2–S18—16-position keyboard matrix
S19—SPST momentary
S20—SPST momentary
S21, S22—DPDT momentary
S23—SPST key-operated switch (optional)
T1—117-volt AC Primary, 8 and 13 volt secondaries (Northlake F3-214)

Connectors
EC1, EC2—22-position edge connector
P1, P2—15 position Molex
P3–P5—16 position DIP header
P6—9 position Molex
P7—4 position Molex
P8—12 position Molex
P9—2 position Molex
SO1, SO2—15 position Molex
SO3—2 position Molex
SO4—6 position Molex
SO5–SO7—16 position DIP socket
SO8—8 position Molex
SO9—4 position Molex
SO10—12 position Molex

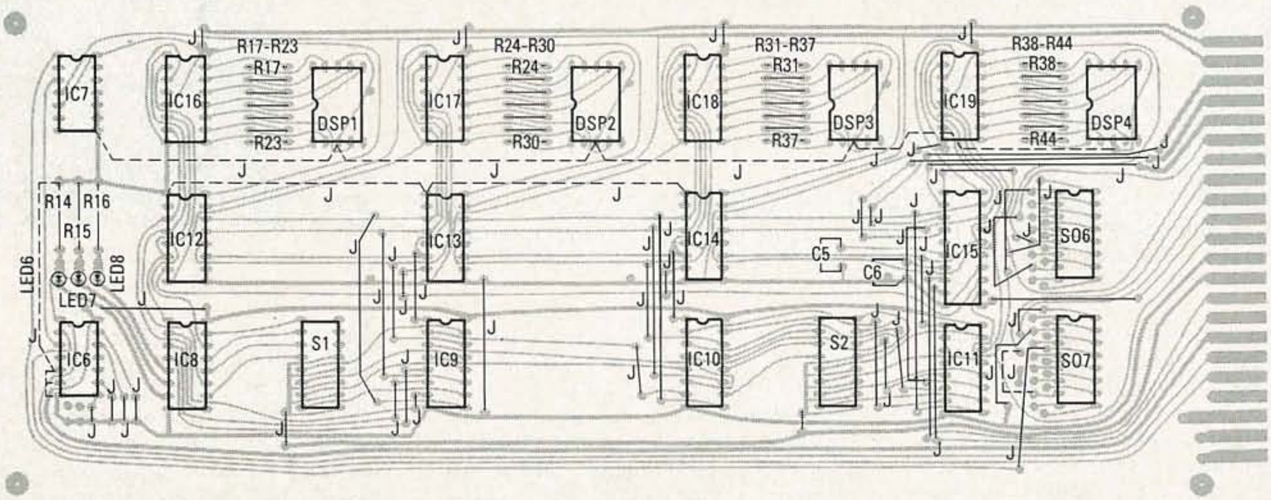


FIG. 8—DISPLAY BOARD COMPONENT-PLACEMENT DIAGRAM. Jumpers must be wired on both sides of this board. The solid lines represent jumpers mounted on the component side of the board; the dashed lines represent jumpers mounted on the foil side.

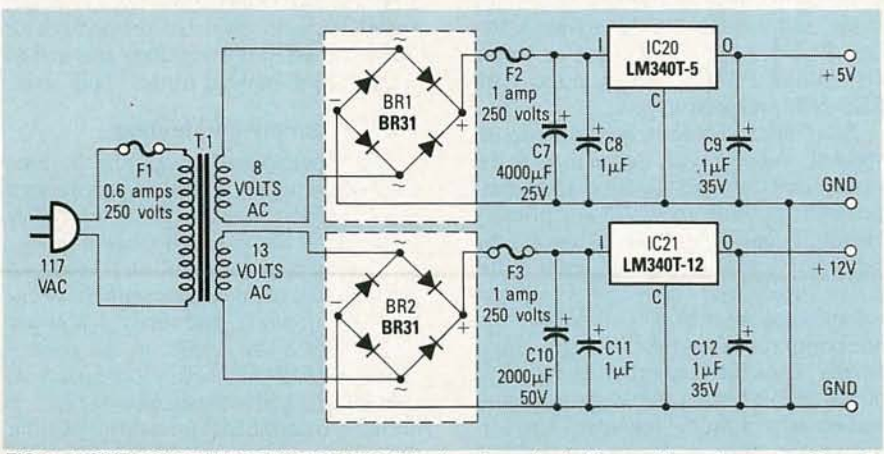


FIG. 9—POWER SUPPLY FOR THE ALARM. This circuit may be built on a piece of spare perf-board.

MASTER RESET switches. In addition, lamps LMP2 and LMP4 indicate the presence of twelve and five-volt power, respectively. LMP5 illuminates when the alarm is armed, and LMP1 illuminates when the TEST switch is toggled, but only if the sense loop is intact. Finally, LMP3 illuminates when the alarm is armed and the sense loop is broken.

Construction

A project like this is best built sub-assembly by sub-assembly. Build each board and panel as if it were a separate project. If you'll be using PC boards, make the boards first using the patterns shown in the "PC Service" section of this magazine. After etching, carefully inspect each board for un-etched copper between adjacent pads and traces.

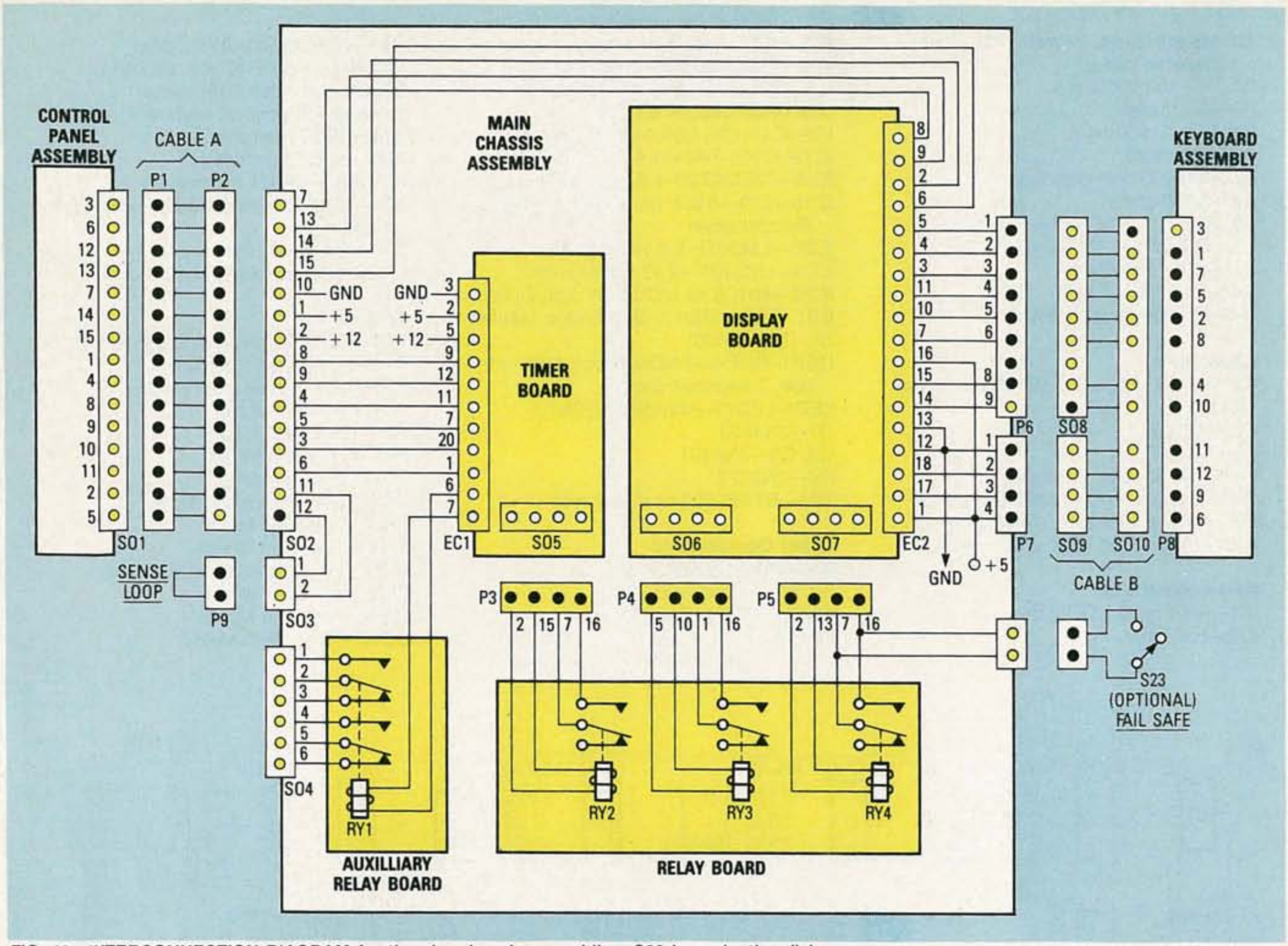


FIG. 10—INTERCONNECTION DIAGRAM for the alarm's sub-assemblies. S23 is an (optional) key-operated SPST switch that will allow entry in case power to the display board is interrupted. Be sure to use reliable connectors, especially for Cable A and Cable B.

After the boards have been cleaned up, stuff them. Use the component-placement diagram provided in Fig. 7 for the timer board and in Fig. 8 for the display board. First insert the lowest profile components, the diodes and resistors. Hold a piece of stiff cardboard against them so they won't fall out. Now turn the board over so the copper side faces up. Solder all leads, and then clip them. Next do the IC sockets, then the transistors and LED's, and finally the capacitors, trimmer resistors, and all other components.

Our PC artwork has a number of extra pads near IC4–IC7. They are used to ground the inputs of unused gates and flip-flops that might pick up stray signals and cause other gates in the same package to act erratically. Providing separate pads on the PC board allows for future expansion or modification of the circuit. To use those gates you would simply remove the jumpers grounding them and hook up the circuit you need. In any case, wire all the jumpers in accordance with the component-placement diagrams in Fig. 7 and Fig. 8. Note that the timer board has jumpers on *both* sides of the board.

After the boards have been completely stuffed, carefully inspect them again and make sure there are no solder bridges between adjacent pads or traces. It's also a good idea to verify that the five- and twelve-volt power lines are not shorted to ground. The power supply used in our prototype is a surplus unit, but an equivalent circuit is shown in Fig. 9.

The relays in our prototype are mounted on pieces of perf-board. Relay RY1 is socketed because it switches fairly heavy loads, and may need to be replaced. Relays RY2–RY4 are hard-wired to 16-pin DIP plugs P3–P5, which mate with SO5–SO7, respectively.

After all the boards are stuffed, inspected, and approved, mount them to the main chassis assembly using snap-in plastic standoffs. Wire up the 115-volt primary circuit, T1 and fuses F1–F3. Connect the secondary leads of T1 to the inputs of the power supply, and verify that the correct voltages appear at its outputs before connecting those outputs to the other boards. To facilitate insertion and removal of the circuit boards, the edge-card connectors are not rigidly mounted. The wiring that connects all sub-assemblies together is shown in Fig. 10; all wiring is point-to-point and bundled.

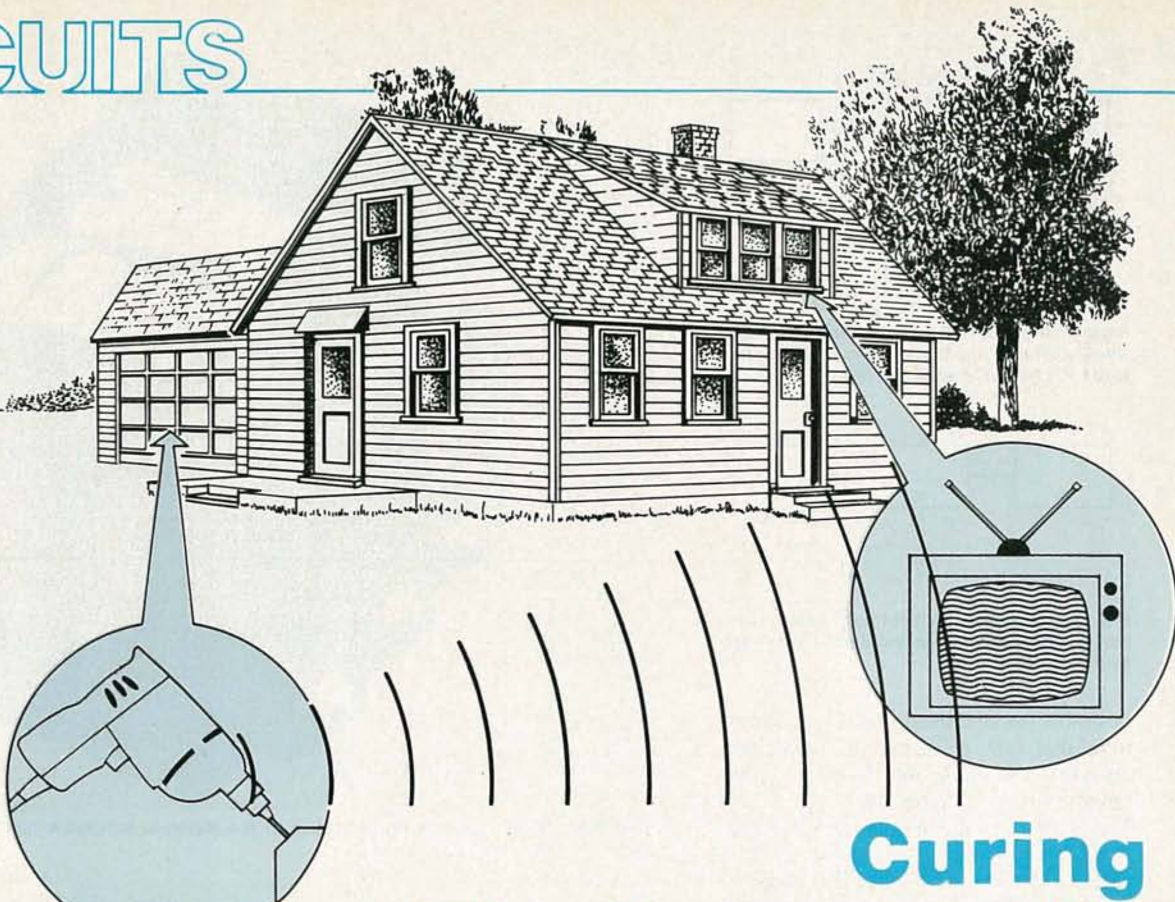
The control panel components are mounted in an aluminum chassis about 6 × 8 × 2 inches. Internal wiring is point-to-point. Molex connectors were used to connect the control panel to the main chassis; again you may wish to use "D" connectors.

The keyboard panel components were mounted in a waterproof "bell" box. The keyboard itself, the LED's, and the ENTER switch were all mounted on perf-board; the entire assembly was then attached to standoffs pre-molded in the "bell" box.

Final assembly and testing

Before permanently mounting the three chassis assemblies and wiring up the area to be protected, make two short test cables for Cable A and Cable B (shown in Fig. 10). Connect the control and keyboard panels to the main chassis with those cables. Apply power, and verify that power lamps LMP2 and LMP4 in the control panel, and LED9 in the keyboard panel all light up. The LED connected to the 555 on the timer board (LED1) should be flashing about once per second. That rate should

continued on page 112



Curing Electromagnetic Interference

MICHAEL F. VIOLETTE

Shields and grounds play an important role in minimizing the effects of EMI. In this article we learn how they work, and how to design an effective shield or ground system.

Part 2 LAST TIME, WE TALKED about the general nature of *E*lectro*M*agnetic *I*nterference (EMI). Among other things, we looked at its sources, what it affects (its victims), and how the interference gets from the source to the victim (the coupling path). We also looked at the two different types of EMI; common-mode and differential-mode interference.

This month we will delve more deeply into the ways EMI can be eliminated and *E*lectro*M*agnetic *C*ompatability (EMC) can be achieved. Specifically, we will be looking at grounds and shields, and how they can be used to eliminate the effects of EMI.

Grounds

Consider the grounding scheme shown in Fig. 1. In it, a long ground wire connects circuits 1 and 2, and circuit 3 is tied to the ground wire of circuit 2. The system ground or ground reference is shown at the left. Ideally, conductors have no impedance; if that were actually the case, the grounding scheme shown would work fine. However, real wires do have an impedance associated with them. Consider, for instance, Fig. 2. That figure is the equivalent circuit for the grounding system shown in Fig. 1. As shown in Fig. 2, ground currents I_{G1}, I_{G2}, I_{G3}, flow in the ground leads. Because of the impedances in the leads, noise voltages are generated, and they can be large enough to cause problems for the circuits connected to them.

Also, as is shown in Fig. 2, the design of the ground system is such that ground loops exist. A ground loop can be created when a circuit is physically connected to a ground lead or bus at more than one place. Because the nature of the connections between circuits 1 and 2, and circuits 2 and 3 is, at this point, unknown, it is entirely possible that the circuit shown could have two ground loops. Ground loops are un-

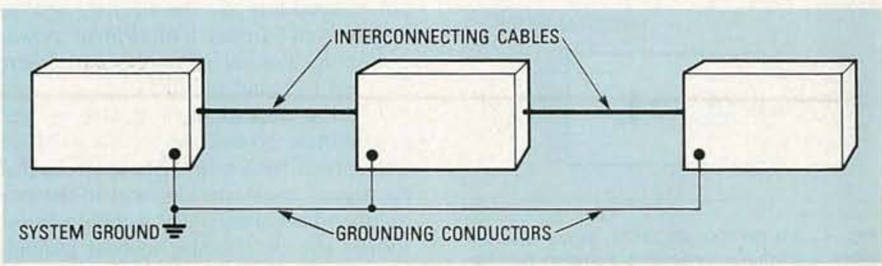


FIG. 1—A POOR GROUNDING SYSTEM. Because of the impedances associated with the ground leads, this system is susceptible to EMI.

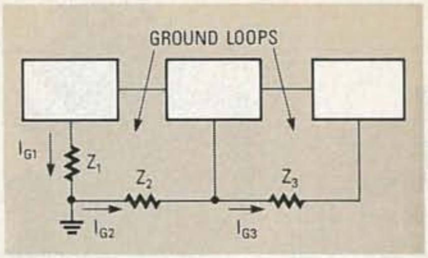


FIG. 2—EQUIVALENT CIRCUIT for the grounding system shown in Fig. 1. The ground currents flowing through the impedances of the ground leads will generate noise voltages.

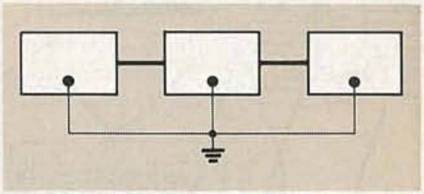


FIG. 3—A STAR GROUND. In this grounding system, all of the circuits are tied directly to a single system ground.

desirable because the common-mode currents that flow in them can couple into circuitry and cause interference (called common-mode interference).

A better arrangement is shown in Fig. 3. The grounding system shown there is called a star ground. Notice that each circuit is connected to a common ground point or system ground (sometimes called the star point) through a dedicated connection. To keep impedances as low as possible, those connections should be kept as short as possible. Star-ground systems are used in many electronic devices, including computers and TV's.

Breaking ground loops

There still may be ground loops in the system of Fig. 3 and they still must be eliminated. Several techniques are used to break ground loops. One technique is to "float" one or more of the interconnected circuits (disconnect the circuit from the system ground). That is not always possible, and it is unsafe in high-voltage circuits.

A better approach is to physically isolate the various circuits. That can be done with a opto-isolator. As shown in Fig. 4, that device consists of an LED and a phototransistor. Such devices are readily

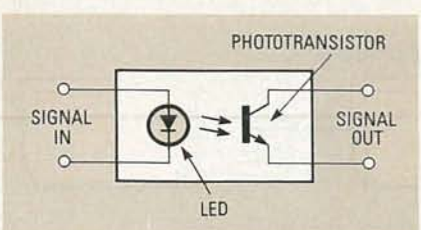
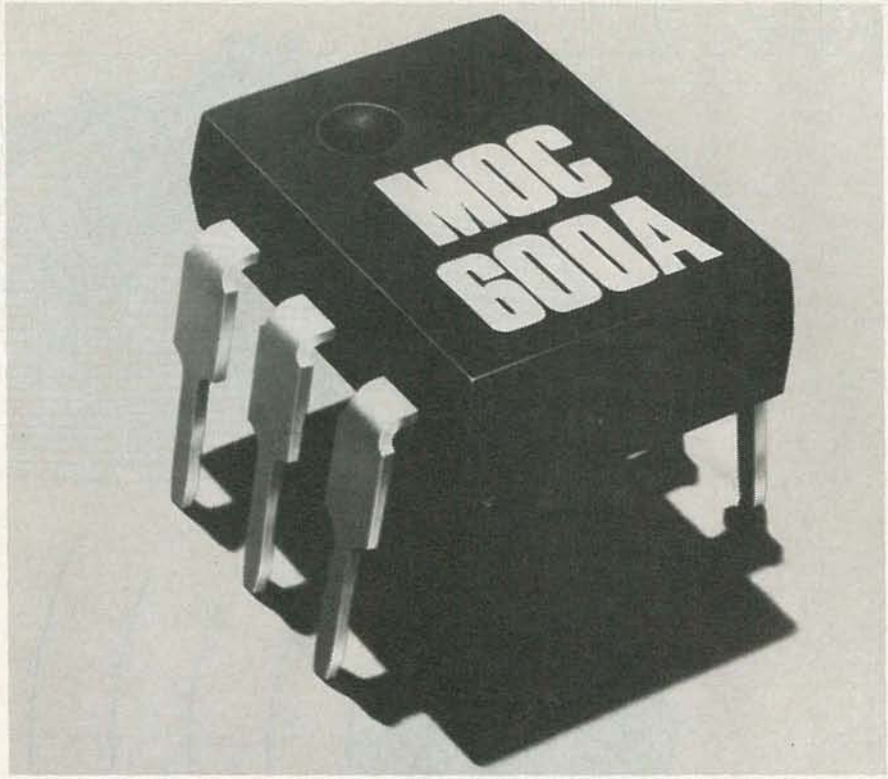


FIG. 4—AN OPTO-ISOLATOR. Since it eliminates electrical connections between two circuits, this device can be used to break up ground loops.



OPTO-ISOLATORS, such as the members of the Motorola MOC600A family, are inexpensive and readily available.

available in IC form and are fairly inexpensive.

The operation of an opto-isolator is as follows: With no input signal the LED is off; but when an input signal is present, the LED turns on, and the light from the LED turns the phototransistor on. Current flows through the phototransistor, which results in a signal at the output of the opto-isolator. There is no hard-wire connection between the input and output of the opto-isolator, and therefore, no ground-loop currents flow.

The opto-isolator is also effective against common-mode currents. By definition, common-mode currents flow on both input lines of the device, but they are unable to flow across the opto-isolator because of the absence of connection between the input and the output of the device. One limitation of the opto-isolator is a parasitic (unintentional) capacitance that exists between the input and output of the device. At higher frequencies, that capacitance results in a degradation of the isolation between the input and the output. Depending on the device, and its application (signal isolation or power switching), that capacitance is somewhere between 1 pF and 180 pF.

Isolation transformers can also be used to eliminate ground loops. An isolation transformer has a turns ratio of 1:1, so that the signal levels are identical in the primary and secondary. An isolation transformer can be effective against ground-loop currents and common-mode signals because there is no hard-wire connection between the primary and the secondary of the isolation transformer. Again, the limitation to the isolation transformer is the primary to secondary parasitic capacitance, which can be significant (up to 1000 nF).

That parasitic capacitance can be reduced or eliminated by inserting an electrostatic (foil) shield between the primary and the secondary. That metal shield is made of a nonmagnetic material (nonferrous) and does not interrupt the normal flow of magnetic flux around the transformer; thus the magnetic circuit of the transformer is affected very little. At high frequencies, more than one shield may be required.

Figure 5-*a* shows an unshielded isolation transformer and the primary-to-secondary (input-to-output) capacitance, C_{IO}. Figure 5-*b* shows a single-shielded isolation transformer; such a transformer is usually effective at frequencies up to 100 kHz. The shield effectively reduces the primary-to-secondary capacitance by dividing C_{IO} into a primary-to-shield (input-to-shield) capacitance, C_{IS}, and a shield-to-secondary (shield-to-output) capacitance C_{SO}. The series combination of C_{IO} and C_{SO} is less than C_{IO}. Note that the shield in Figure 5-*b* is connected to the common-mode reference (ground) by a low impedance connection. As shown, a portion of the common-mode currents flow from the transformer primary through C_{IS} and return to ground, reducing the common-mode current on the secondary side of the transformer. Thus, the

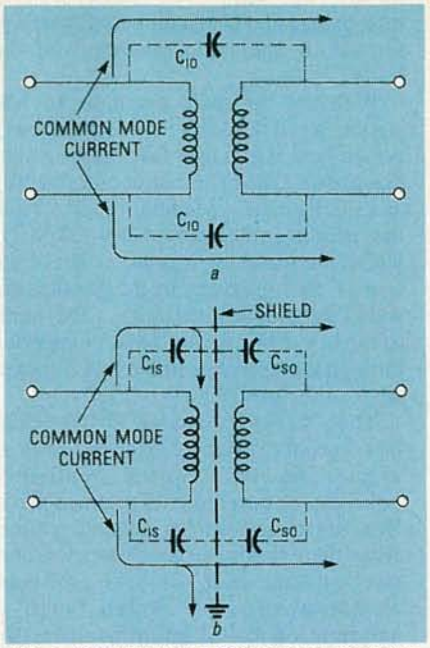


FIG. 5—ONE DRAWBACK in using an isolation transformer to break up ground loops is the high parasitic capacitance between the windings (*a*). One solution to that problem is to place a shield between the windings (*b*).

action here is that of a current divider, and the net effect is a decrease in common-mode currents on the secondary side.

Ground planes

Examine the PC board used for a high-speed digital circuit and you will likely see that the majority of the copper is un-etched; the only copper removed is that needed to avoid shorting traces. The remainder of the copper, surrounding the circuit, is used as a ground plane. A ground plane is a flat metal plate or surface to which ground connections are made.

Ground planes offer several advantages. For one, their use helps eliminate the possibility of ground loops on the PC board. Also, at high frequencies, their large surface area (when compared with a PC trace) results in a low impedance.

Safety considerations

It is possible that a design intended to minimize EMI may be unsafe. For example, floating a circuit to break a ground loop may not be advisable because of the impact on the safety design of the system. If the circuit is a high-voltage one, a connection to the system ground must be provided in the event of a short. When dealing with AC-powered equipment, especially equipment housed in a metal cabinet or case, a safety ground (usually via a 3-line power cord) should be provided. Otherwise, should a breakdown occur and the "hot" side of the AC supply be applied directly to the case, there will be no path to ground. That is, until someone touches the case, perhaps with disastrous results.

Shielding against EMI

Shielding is used to reduce unwanted radiated energy from coupling to and from a system. Radiated energy is generated by many sources. In some cases, that is indeed the intended function of the source; those include RF transmitters of all types. Other times, the radiated energy is an unintended side effect. Many different types of equipment can be unintentional sources of radiated energy. Among the most common of those are computers and power lines. Radiated energy can also be generated by natural sources, such as lightning.

Electromagnetic radiation

An antenna is used to transmit and/or receive electromagnetic radiation energy. That energy is in the form of n electromagnetic wave that travels through space at the speed of light. Associated with that wave is a wavelength, λ, and a frequency, f, which are related through the equation $\lambda = C/f$, where C is the speed of light (3×10^8 meters/second), λ is measured in meters, and f is measured in hertz. Note that wavelength and frequency are inversely proportional; that is, as the frequency of radiation increases, the wavelength decreases. When the length of a wire is equal to about a quarter wavelength at some frequency (or some integral multiple of a quarter wavelength), the wire becomes an efficient antenna at that frequency. That means that it is capable of easily receiving or transmitting electromagnetic radiation.

While an efficient antenna is desirable when you are dealing with radio communications, if one of the conductors in your project becomes an "efficient antenna," it is a nuisance. That conductor becomes a means for electromagnetic energy to couple into the circuit. If the coupled energy is higher than the sensitivity (for analog circuits) or noise margin (for digital circuits) of the circuit, that energy can cause the circuit to malfunction. In addition, if the circuit is a high-frequency one, it is possible for it to become a source of electromagnetic radiation itself, affecting the operation of nearby equipment.

In either case, the way to cure the problem is to place a shield around the project. A shield is designed either to keep the EMI out or to keep it from escaping.

How does a shield work? A good EMI shield absorbs part of the electromagnetic wave and reflects part of the wave away. The theory behind shielding is quite complex. It is based upon aspects of Maxwell's electromagnetic radiation equations and it is beyond the scope of this article. But we can describe what goes on qualitatively, so that you can gain some understanding of how the process works.

The shielding mechanism

First, there are three different types of electromagnetic fields. All electromagnetic fields are composed of an electric field and a magnetic field. The relationship between the electric and the magnetic field is similar to the relationship between voltage and current. That relationship is given by Ohm's law, which states $V = IR$.

In electromagnetic field theory, there is a similar equation that relates the electric and magnetic fields. That equation is $Z = E/H$, where E is the intensity of the electric field and H is the intensity of the magnetic field. The variable Z is the impedance of the field; the three different types of electromagnetic fields are defined in terms of that impedance. Those are high-impedance, low-impedance, and free-space fields.

A high-impedance field is created by a source (antenna) that has a high impedance. For instance, a dipole antenna has a very high impedance because the antenna elements are not connected together (except through the capacitance in the air between the elements). It is difficult to shove current into the dipole because of that high impedance. The radiated wave that comes off of the antenna is also high impedance; it is called an electric field because E is large relative to H, which creates a large value of Z.

A low-impedance field is created by a source that has a low impedance. One type of low-impedance source is a loop antenna. A loop antenna has its ends shorted together and therefore has a low impedance at its terminals so current can easily flow through the loop. That creates a low impedance, or magnetic, field. An example of a source of magnetic fields is a power line in which relatively large current flows; such lines are the cause of many EMI problems.

High and low impedance fields exist when you are close to the source or the antenna; that region is called the *near field*. As you move away from the antenna, you approach what is called the *plane-wave* or *free-space* region. In the free-space region, the impedance of an electromagnetic wave is very simply equal to 120π (or approximately 377 ohms).

For proper design of the shield, it is important to know the impedance of the electromagnetic field. For that reason, it is also important to know where the near-field region ends and the free-space region begins. That distance, known as the transition distance (R), is defined as $R = \lambda/(2\pi)$.

Shield design

As stated, the purpose of a shield is either to reflect or to absorb electromagnetic radiation. A shield around a circuit acts as a barrier to electromagnetic energy by reducing the field strength on the other side of the barrier. The *shielding effectiveness* (SE) of a shield is a comparison between the amplitude of the field on one side of the shield (incident field) compared to the amplitude on the other side (the resultant field). If the SE of a shield is high, then the "problem" wave is reduced in amplitude.

A simplified model of how a shield works is shown in Fig. 6. An electromagnetic wave is incident from the left of the shield (although the wave can be generated from the inside of equipment). Part of the wave is reflected away and part of the wave penetrates into the shield material. When the wave penetrates to the other side of the shield, another reflection takes place at the interface between air and metal. The energy that is reflected travels back through the material and exits on the left side. Much of the energy that is not reflected is absorbed by the shield material.

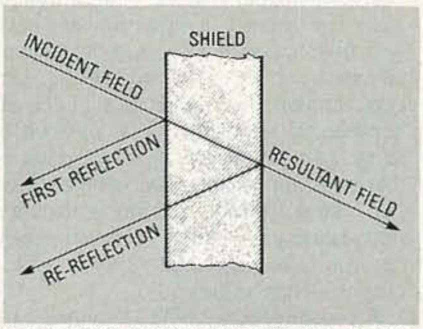


FIG. 6—HOW A SHIELD WORKS. Note that the electromagnetic energy is reflected at both shield/air interfaces. In addition, some of the energy is absorbed by the shield material.

rial. The remainder of the energy exits the right side of the shield as the resultant field.

Most shields are designed to attain an SE between 20 and 80 dB (10 to 10,000-fold reduction) and some "super shields" are designed for SE's between 100 and 120 dB (100,000- to 1,000,000-fold reduction). In general, any shield with an SE of less than 20 dB is not very effective.

Let's look at an example. Consider an incident electric field, E_I, with a strength of 1 volt per meter (V/m) that is causing an electronic system to malfunction. If a shield with an SE of 60 dB is installed, what is the resultant field on the inside of the shield? First, convert the electric field to dB: $E_{IdB} = 20\log_{10}(1) = 0$ dB

To find the resultant field strength, E_R, subtract the shielding effectiveness from the incident field strength. Thus, the resultant field is 0 dB – 60 dB = –60 dB. Or, in volts-per-meter:

$$E_R = 10^{(E_RdB/20)} = 10^{(-60/20)} = 10^{-3} = .001 \text{ volts-per-meter}$$

That is a reduction of 1000.

To design a good shield, it is important to consider the type of field you are dealing with. The following "rules of thumb" should be followed to select the correct shield material:

To shield against electric waves, reflection is important. Use a high conductivity metal (such as copper or aluminum) for the shield. The high conductivity (which results in a low impedance) of the material essentially short circuits the electric field just as a piece of wire short circuits a voltage source in a hard-wired circuit. The field is reflected away by the short circuit. Reflection of the wave results in a reduction of the field on the opposite side of the barrier.

Likewise, copper and aluminum are suitable shielding materials when dealing with free-space electromagnetic waves. The shielding mechanism is a combination of reflection and absorption.

To effectively reduce magnetic fields, however, the shield material must have magnetic properties. For instance, the operation of a transformer depends on the material in the transformer core. Transformer cores are constructed of magnetic (ferrous) materials, such as silicon steel. The current in the primary of a transformer creates a magnetic field that pushes a magnetic flux around the core of the transformer. Very little flux exists in the air around the transformer because air is non-magnetic. The concentrated flux in the core is said to "link" the primary and secondary windings in a transformer. The result is that a time-changing signal in the primary will induce a similar signal in the secondary.

To reduce magnetic fields, then, the shield must be able to concentrate the magnetic flux from the source of the magnetic field. That creates a shield against the magnetic field. Magnetic field shielding is relatively difficult because of the weight and expense of the materials involved (such as steel).

Shielded-box design

An important aspect of shielding design is how the shield material is assembled. A perfect shield is a totally enclosed box, made of the proper shield materials, in which the circuit is placed. However, switches, knobs, power cords, signal cables, and ventilation holes are necessary if the circuit is to be useful. Pretty soon, there are a lot of holes in our perfect shield; those allow radiated energy to "leak" into the box. A compromise between the perfect and the practical must be made. There are methods available to accommodate the holes and still have a pretty good shielded box design. Let's look at some of those methods.

An important consideration in shielded-box design is the size of the hole in the shield. At low frequencies, the wavelength of the EMI is large compared to the size of the hole. As the frequency increases, the wavelength decreases and the energy can leak through the hole and pass through the shielded box. That phenomenon can be observed the next time you ride in a car and pass under a metal truss bridge that has a number of openings formed by the metal members of the bridge.

With the car radio tuned to an AM station, around 1 MHz (λ = 300 meters), notice how the signal fades out or even disappears. The bridge structure is acting as a shield to the AM radio signal. Switch the radio to an FM station (88–108 MHz) where the wavelength is a fraction of the size of the openings in the bridge; the signal should be unaffected. The high-frequency FM signals pass unimpeded through the openings in the metal framework of the bridge.

Thus, to design a good EMI shielded box, keep the openings in the box as small as possible. For instance, ventilation holes can be covered with a screen mesh. Box seams should be soldered closed. Also, there should be good electrical contact across the seam, so remove the paint or non-conductive finish (such as anodization on aluminum) from the edges. The idea is to have, as much as possible, a continuously conductive surface.

In addition, there are numerous products available that can be used to maintain the integrity of the shielding. Those include conductive gaskets, which are fitted to seams and covers of shielded boxes to provide electrical continuity across the seam; shielded windows, which are made of glass or plastic panels in which tiny screen mesh is placed; conductive paints, which are sprayed on plastic enclosures for shielding purposes (many popular computers use conductive paints and coatings on their cabinets), and special shielded switches.

Thus far we have seen how proper grounding and shielding can greatly reduce the affects of electromagnetic interference. While those techniques are useful in eliminating problems that might appear, they are most useful if considered in the design stages of a project. By EMI-"proofing" your design in the first place, you will greatly reduce the chance that any unforseen problems will crop up later on.

Now that we have some idea of how to eliminate or reduce the affects of radiated electromagnetic interference, how do we do the same for conducted EMI? Obviously the methods and products mentioned thus far in this article are effective in fighting radiated EMI, but they will do nothing to eliminate the affects of conducted EMI (interference that enters the circuits via a power line or signal cable). To eliminate the problems caused by conducted EMI, other techniques are required. Among those is the use of filters designed to trap out the interfering signal. In the next part of this article we will look at those filters and how they work. We will also look at still more techniques for reducing the effects of EMI. **R-E**

BUILD THIS

VIDEO TITLER

Now that we know how the circuit works, it's time to build and align the unit.

JACK FLACK

Part 3 THIS MONTH, WE'LL finish up our description of the video titler's circuit; we'll see how to build the titler; and then we'll take a look at its operation. As we'll be referring to illustrations that have appeared in the previous two installments (November and December 1985), you might want to have those on hand as we continue.

The microcomputer

The microcomputer section is the most important for human interaction with the titler. Its schematic is shown in Fig. 14. Most of the techniques used are straightforward. The 6809 microprocessor (IC23) was chosen because it offers a number of advanced software features such as 16-bit operations and long-branch instructions for relocatable code.

It is important to recognize the timing requirements of the VDP data and control signals as well as the timing of other devices attached to the 6809 address and data bus. Several timing problems were overcome by using the positive cycle of the E clock (IC23, pin 34) which, along with IC15-c, enables the main system memory decoder, IC18-a, a 74LS139 2- to 4-line decoder/multiplexer.

The titler's interface bus was designed to allow a home computer to access the VDP and ROM. The 6809 three-states its data, address and R/$\overline{\text{W}}$ lines when its $\overline{\text{HALT}}$ line (pin 40) is pulled low. On the titler, pulling that line low also disables the main system memory decoder (IC18-a) by forcing a continuous high output on IC15-c. I/O-select capability is accomplished by R42 and D6, which allow either the main system memory decoder (IC18-a) or an external home computer to select the I/O decoder (IC18-b). ROM SELECT is also provided by R41 and D5.

A full-travel keyboard was included in the design to provide fast and easy creation of titles. Almost any unencoded keyboard—including many available on the surplus market—can be substituted. Of course, you'll need to change the surplus keyboard's wiring by cutting traces and adding jumpers. You could also design a new PC board for the keyswitches.

Figure 15 shows the memory mapping used by the titler. Note how the I/O is mapped. Address line AØ is used by the VDP internally to determine what type of data is on the bus: VDP address/register setup or video memory/register data. Address line A1 is used by the I/O decoder (IC18-b) to choose between the VDP and I/O ports.

That I/O decoder selects the input or output port based on whether a read or write operation is occurring. Therefore, reading from or writing to the port address (8002H) automatically chooses the proper port.

An 8K low-power CMOS static RAM was chosen to provide 30 pages of titles and battery-backup capability. The 8K RAM's have 2 select lines ($\overline{\text{CS1}}$ and CS2). The active-high select can be tied to the 5-volt supply. If V_{CC} on the CMOS RAM remains above 2 volts at the same time that the 5-volt supply drops below 0.8 volts (as when the titler is turned off), the RAM will go into standby mode, and data will be retained.

Building the video titler

You don't have to be a pro to build the video titler; but you shouldn't be a rank beginner, either. Testing and adjustments can be performed without an oscilloscope, but they may be more difficult and time-consuming.

While you can build the titler using wire-wrapping techniques, using a PC-board is preferable. You can either make

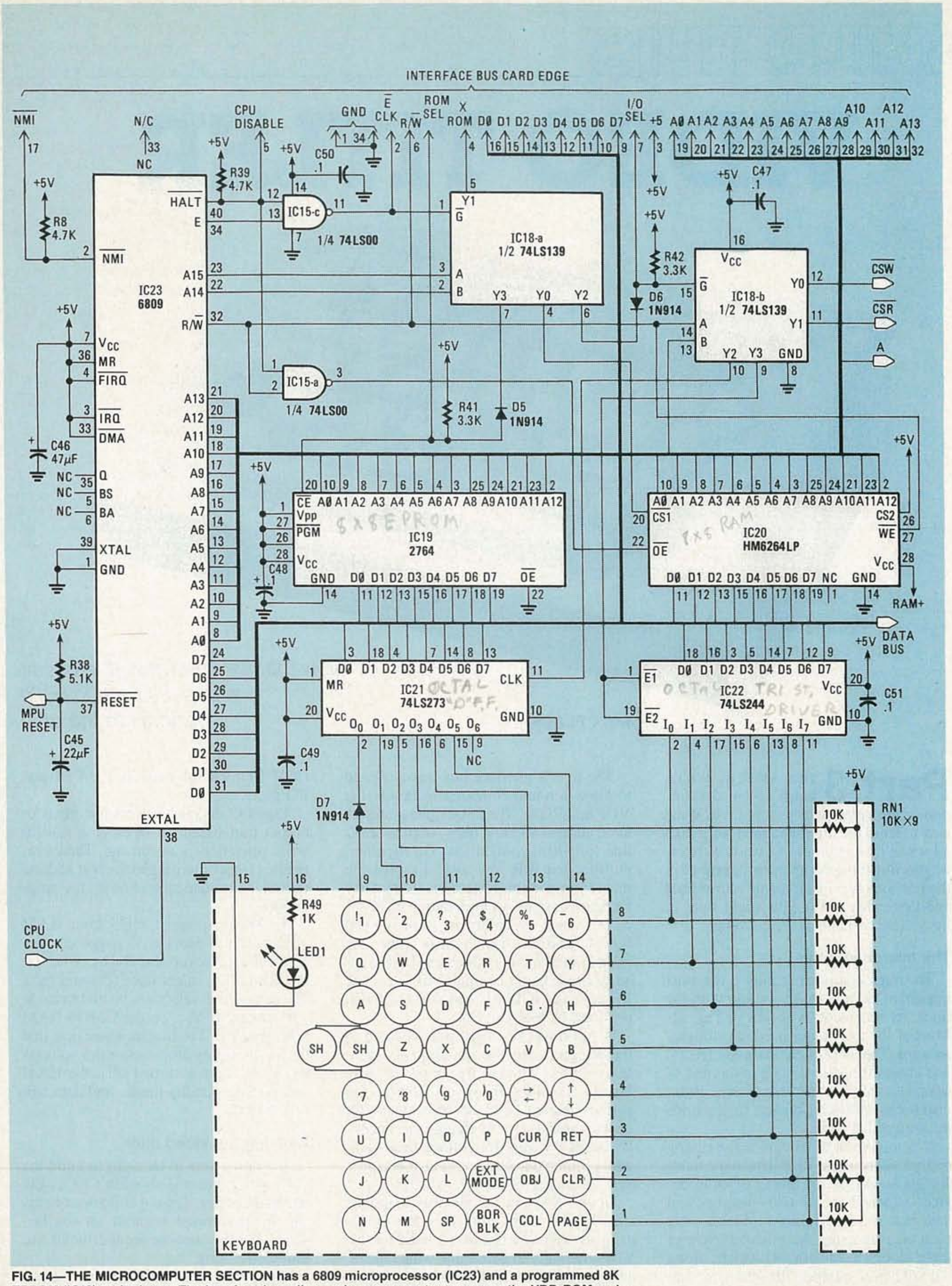


FIG. 14—THE MICROCOMPUTER SECTION has a 6809 microprocessor (IC23) and a programmed 8K EPROM (IC19) as its heart. The interface bus allows a home computer to access the VDP, ROM and external-mode select. We'll get to the details on that in a future issue.

your own (see the "PC Service" section of this magazine), or you can buy one from the source mentioned in the Parts List. A parts-placement diagram is shown in Fig. 16, and Fig. 17 is a photo of the author's prototype.

Regardless whether you use a PC board, be certain to use sockets for the IC's. If you choose to wirewrap, you'll need to use DIP headers or some other technique for mounting the discrete components.

As you wrap or solder the wires, check off each connection on the schematic. Be sure to use the decoupling capacitors specified in the schematic, and mount them as close to the IC's as possible. For easier troubleshooting, use different-colored wire for power, ground, and other (data-, address-, and control-line) connections.

Remember that several of the IC's are CMOS types and require special handling. Also, use a twisted pair of wires for the video inputs and outputs to minimize RF interference.

If you're not using a PC board, special care should be taken in locating the two oscillator circuits. The PLL (IC4 and IC5) should be as far as possible from the 3.58-MHz chroma clock circuit (IC14 and IC15) and the video inputs and output. The chroma processor (IC14) calls for separation of the oscillator portion (components associated with IC14 pins 6 and 7) and the input (pin 1).

Mount the +5- and +12-volt regulators directly on the enclosure to help dissipate heat. Also, be extremely careful when hooking up the 10-pin video jack

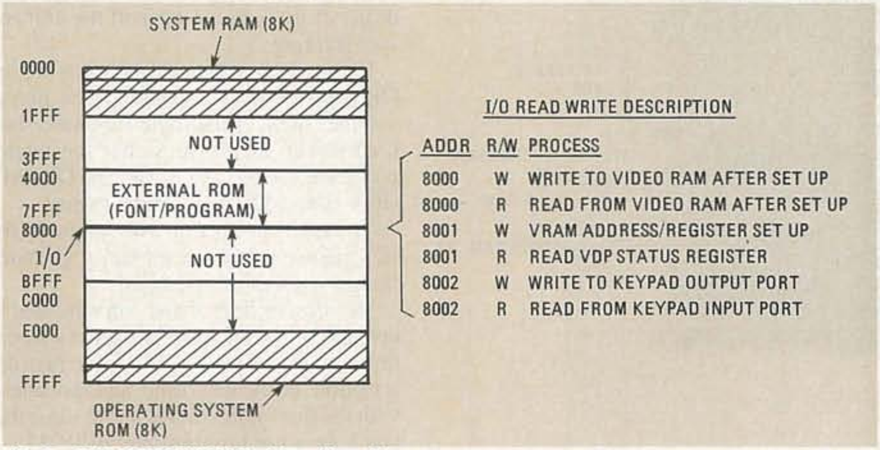


FIG. 15—THE MEMORY MAP of the video titler.

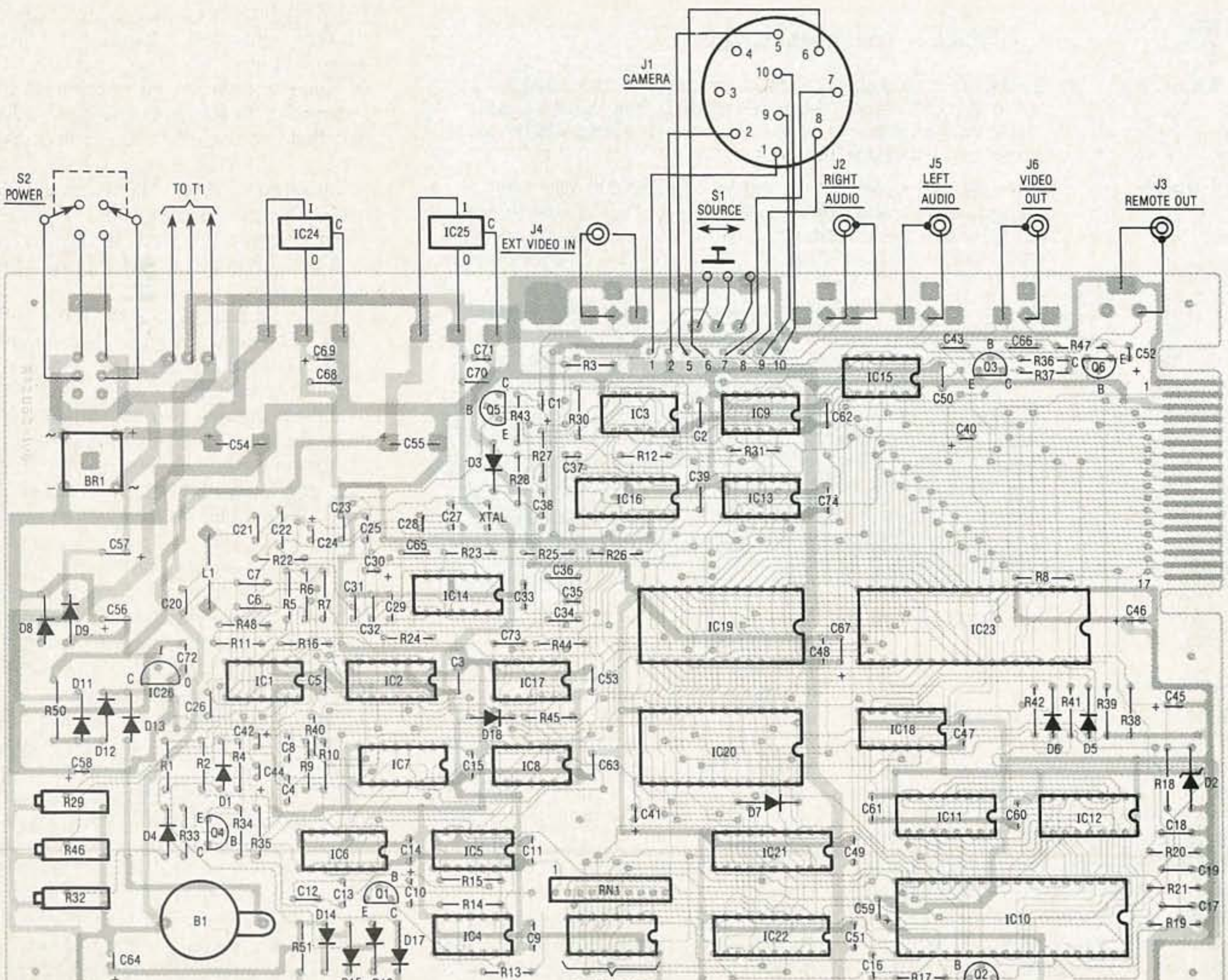


FIG. 16—THE PARTS PLACEMENT DIAGRAM FOR THE VIDEO TITLER. Foil patterns for the titler are shown on pages 77 and 79.

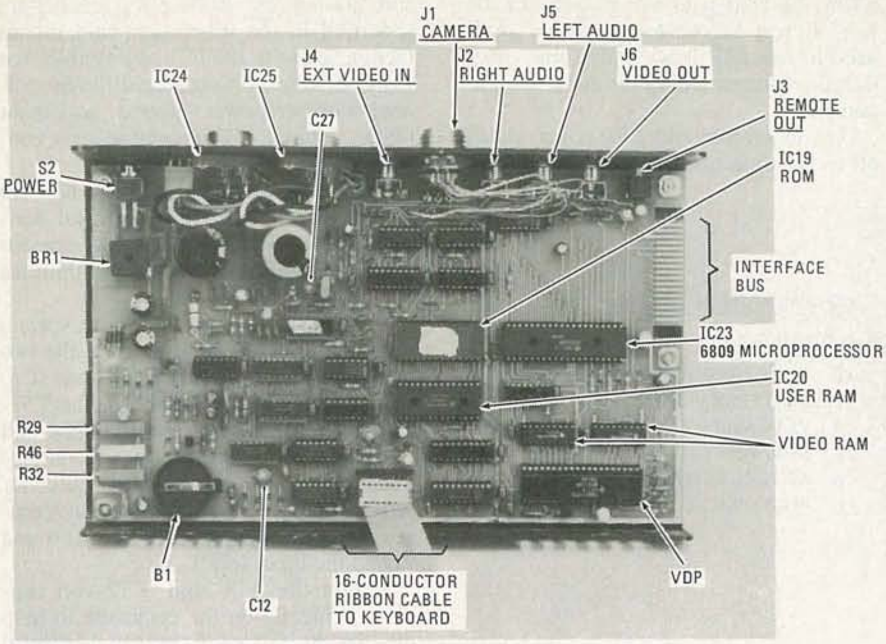


FIG. 17—THE AUTHOR'S PROTOTYPE and some of the main components and adjustments.

TABLE 1—TITLER ADJUSTMENTS

• C12	Changes clock frequency and locking range. When in internal mode, adjust C12 until a black screen with cursor is seen. Fine tuning will be required in the external mode. If a picture still is not present, try the next adjustment.
• R46	Changes level where external video is selected over VDP video. Initially, set voltage at pins 1 and 11 of IC17 (also the wiper of R46) to zero or near zero. Then, in the internal mode, adjust so that the VDP image is clean. In external mode, find the point where the VDP and external video are the cleanest.
• R32	Changes the bias on the VDP video signal. The effect is seen as a VDP image that is darker or lighter relative to the external image. Use black characters for this adjustment, and adjust so that the characters are as black as possible without the picture tearing.
• C27	Adjusts the VDP colors and the locking range of the chroma processor. Color may not be present until this adjustment is made. Adjust in external mode. Try small adjustments and remove screwdriver to check effect.
• R29	Changes the color of the VDP only in the external mode. Display black characters, and adjust so that the least amount of color is visible.

(J1). One mistake could damage your camera.

Initial testing

Before you insert IC's into their sockets, and before turning on the power, use an ohmmeter on a low-resistance setting (1 ohm) to check for shorts in the power-supply connections. You will likely read some resistance (50 to 80 ohms) due to the discrete components, but you should not read zero. That's a short (probably caused by bent wirewrap pins or solder bridges). Examine your board closely. Don't assume that you'll catch your mistakes when you power up—it may be too late.

Once you've determined that the power connections are OK, power up the titler. Look, listen, feel, and *smell!* Transistors and resistors can get hot quickly when something is wrong. Some transformers sound funny when they are beginning to melt. Smoke does not necessarily mean fire, but we're not building a cigarette lighter. If you see something unusual, turn off the unit quickly! (But wait a few seconds before you start touching components. You'll still be able to find the culprit, but waiting could spare you a burn.)

If all is well, leave the unit on and check the main power supply outputs with a voltmeter. The power supply is shown in Fig. 6.) They should be very close to the desired voltages. However, the +3-, +1.5-, and +0.7-volt supplies may vary 10 to 15 percent. And with no IC's installed, the output of the +5-volt supply may be closer to 6 volts because of R50. If any readings are zero or especially low, you probably have a short somewhere. Three-terminal voltage regulators (78XX and 79XX) have protection against short circuits which usually result in voltage drops. If that occurs, turn off the unit and start hunting.

If the main power-supply outputs are OK, check each IC socket for the proper voltage. Most of the logic IC's have standard power supply pins, but the microprocessor (IC23), VDP (IC10), DRAM's (IC's 11 and 12), and others *do not!*

When all checks out, you can insert the IC's. However, you can't really go much farther without the EPROM.

The description of the software that is contained in the EPROM requires an entire article in itself. We'll defer that description until next time and go ahead with the final adjustments and assume that you have a pre-programmed EPROM.

Final adjustments and testing

Once you have all the IC's (including the EPROM) inserted, you're ready for the final adjustments. Connect the titler's video output to the video input of a VCR or video monitor. If you're using a VCR, be sure that the RF connections are correct and that any switches are appropriately set.

Power up the titler. There are a number of possible pictures that could be present. What you want to see is a black screen with a medium green cursor in the upper left corner.

If only garbage is present, don't worry. The clock frequency can vary enough to allow the sync pulses to be outside the specifications of the TV set. Follow Table 1, and try the first two adjustments. Because those two adjustments tamper with the master clock, you'll want to reset the microprocessor and VDP by turning the titler off and then back on before further testing.

The adjustments can be performed without an oscilloscope if you're patient. Remember that at any point in the adjusting process you may have to readjust a previous step. You may also have to power down to reset the microprocessor.

When you complete the initial adjustments and a medium green cursor is present, congratulations! If you're still having problems, an oscilloscope may be necessary. But before you go hunting for one, use an ohmmeter and recheck the power-connections on the VDP (Fig. 7) and other IC's. Also check the RESET/SYNC input on the VDP (IC10, pin 34). It should be at a 4- to 5-volt level. If you get a reading of less than 2 volts or greater than 7 volts, check the connections on pin 34, Q2, R18, and D3. You may need to verify that the correct components were installed at

PARTS LIST

All resistors 1/4-watt, 5% unless otherwise noted.
RN1—10,000 ohms × 9 resistor network
R1—10,000 ohms
R2—6800 ohms
R3—75 ohms
R4,R48—51,000 ohms
R5, R11, R12, R15, R25–R27, R35, R43, R49—1000 ohms
R6, R8, R30, R31, R39—4700 ohms
R7—3900 ohms
R9, R38—5100 ohms
R10—4300 ohms,
R13, R16, R18, R22, R24, R28, R40—2200 ohms
R14, R23—680 ohms
R17, R36—120,000 ohms
R19, R20, R21—470 ohms
R29, R32—1000 ohms, PC-mount trimmer potentiometer
R33, R37—1500 ohms
R34, R47—220 ohms
R41, R42—3300 ohms
R44, R45—820 ohms
R46—10,000 ohms, PC-mount trimmer potentiometer
R50—33 ohms
R51—68 ohms

Capacitors
C1, C40–C42, C44, C64—10 μF, 25 volts, electrolytic
C2, C3, C5, C9, C11, C14, C15, C16, C26, C33, C38, C39, C43, C47, C48, C49, C50, C51, C53, C60, C61, C62, C63, C68, C70, C72–C74—0.1 μF ceramic disc
C4, C22, C23, C25, C29, C31, C32, C34, C36—0.01 ceramic disc
C6—0.0022 μF mylar
C7—.0047 μF mylar
C8—0.001 μF mylar
C10—0.47 μF, 25 volts, electrolytic
C12, C27—5–30 pF PC-mount trimmer
C13, C28—12 pF, ceramic disc
C17–C19, C66—220 pF, ceramic disc
C20—150pF ceramic disc
C21—390 pF ceramic disc
C24, C30, C58—1 μF, 25 volts, electrolytic
C35, C37—47 pF ceramic disc
C45—22 μF, 10 volts, electrolytic
C46, C52, C59, C67, C69, C71—47μF, 16 volts, electrolytic
C54—2200 μF, 25 volts, electrolytic
C55—4700 μF, 16 volts, electrolytic
C56, C57—100 μF, 25 volts, electrolytic
C65—33 pF, ceramic disc

Semiconductors
IC1—LM339 quad comparator
IC2—74LS221 dual non-retriggerable one-shot
IC3—74LS05 hex inverter
IC4—MC4044 phase-frequency detector
IC5—MC4024 dual voltage-controlled multivibrator
IC6, IC7—74LS191 up/down binary counter
IC8, IC9, IC13—4066 quad analog switch
IC10—TMS9128 video display processor (Texas Instruments)
IC11, IC12—4416 16K × 4 dynamic RAM, 200 ns
IC14—CA3126 chroma processor (RCA)
IC15—74LS00 quad nand gate
IC16—LM1889 TV video modulator (National)
IC17—SN75108 Dual in-line receiver
IC18—74LS139 dual 1-of-4 decoder
IC19—2764 8K × 8 EPROM
IC20—HM6264 LP 8K × 8 static RAM
IC21—74LS273 octal D-type flip-flop
IC22—74LS244 octal 3-state driver
IC23—MC6809 microprocessor
IC24—7812K regulator, +12-volts
IC25—7805K regulator, +5-volts
IC26—79L05 regulator, −5-volts
D1, D3, D4, D5–D7, D11–D18—1N914
D2—1N751 Zener, 5.1 volts
D8, D9—1N4001 rectifier, 50 PIV
D10–not used
BR1—full-wave bridge rectifier, 6 amps
LED1—standard red LED
Q1, Q6—2N2222
Q2, Q3—2N3906
Q4, Q5—2N3904

Other components
XTAL1—3.579545 MHz
L1—56 μH
T1—14-volt secondary, center-tapped
J1—10-pin video camera jack
J2, J4–J6—PC-mount phono jack
J3—3/32 inch phone jack
S1—SPST PC-mount slide switch
S2—DPDT rocker switch, vertical PC mount

Miscellaneous: Lithium-battery holder and battery, 49-key keyboard, 16-conductor ribbon cable, enclosure, etc.

The following are available from Micro-Video-Technology, P.O. Box 76, Chattanooga, TN 37343: main PC board (silk screened, with gold fingers), $40; Programmed EPROM, $25; Custom keyboard, $80; Custom enclosure, $40; All switches, jacks, and connectors, $30; 14 VCT wall transformer, $30; TMS9128 VDP, $30; partial kit (includes all the above), $250. All orders add $5 ($13 outside U.S.) for shipping and handling.
The following are available from JDR Microdevices, 1224 South Bascom Ave., San Jose, CA 95128 (800) 538-5000: All components—*except those available from Micro-Video-Technology*—$69.95 + $2.50 for shipping.
The following is available from MFJ Enterprises, Inc., 921 Louisville Road, Starkville, MS 39759: Complete titler, assembled and tested with 1 year unconditional guarantee, $599.95 plus $6 shipping. (Return if not satisfied within 30 days for refund, less shipping.) Orders only (outside Mississippi) 1-800-647-1800. Information and Mississippi orders 601-323-5869. MasterCard and Visa accepted.

those locations. Remember that if you see, feel, smell or hear something unusual, you probably have a problem. Power down immediately and check it out.

If all else fails, then an oscilloscope will be required. First make sure that the titler is generating a stable composite-video signal. If it's not, the VDP (IC10) is probably not operating properly. Check the master clock (pin 6) for a 10.7-MHz signal. You should also have a 3.58-MHz clock at pin 37. There should be a black-and-white composite-video signal at pin 36. If no signals are coming from IC10, check the power-supply connections again. If the video signal is present, use the schematic and check the signal at all points until you reach Q6 (in Fig. 13).

Once the hardware is working, the next step is to make sure that your software is functioning properly. Type in several characters and try out all the functions (except external mode).

Once the software is running, you're ready to test the external mode. Before plugging in a camera, make sure that you have 12 volts on pin 10 of the camera connector (J1 in Fig. 7), and that 12 volts is not present on any other pins. Always turn off the titler before plugging in the camera.

Set switch S1 to the camera input or the external input, whichever is appropriate, and turn on the titler. If you're using a camera, you should see all the various camera LED's come on. Since the titler powers up in the internal mode, you should see the same black picture on the screen with a green cursor.

Press the EXT MODE key. That will likely cause more garbage on the screen. Go back to internal mode just to make sure that nothing has happened. If all is well in internal mode, go back to Table 1 and perform the remaining adjustments starting with number 2.

If you are unable to get a clean picture with the adjustments, you have a hardware problem. Disconnect the power, camera, etc. and check for bad solder joints, shorts, bent IC pins, and other possible problems. Don't get too discouraged. Many problems can exist without permanently damaging the components.

Operating features

We've gone through a lot of theory and construction details, but we haven't talked much about what the titler can do and how you can use it. Now that we've finished the testing, it's time to see what we can expect the titler to do.

When the titler is first powered up, it is in its internal mode—the background and

TABLE 2—KEYBOARD MODES AND KEY RESPONSES

Key	Unshifted	Shifted	Blanked	Unblanked	Cursor on	Cursor off	Object on	Object off
26 Alphabetic	lower case	upper case	NR	—	—	NR	NR	—
10 Numeric Punctuation	Numeric Character	Punctuation Character	NR	—	—	NR	NR	—
Left right arrow	Left	Right	NR	—	If object is off, cursor moves	Checks object	Objects moves	—
Down up arrow	Down	Up	NR	—				
Cursor	—	—	NR	—	Turns off cursor	Turns on cursor	—	—
Return	—	—	NR	—	—	NR	NR	—
Clear	—	—	NR	—	—	NR	—	—
External mode	—	—	—	—	—	—	—	—
Object	Turns on off object	Changes object (in object mode)	NR	—	—	—	Turns off object	Turns on object
Blank border color	Blanks/ unblanks screen	Changes border color	Unblanks screen	Blanks screen	—	—	—	—
Color	Changes character color	Changes background color	NR	—	If object is off, character color changes	Checks object	Changes object color	—
Page forward/back	Pages forward	Pages back	—	—	—	—	—	—

NR = No response
— = Status of mode does not effect key function

border are black. and an external video signal is ignored. The cursor is at the top left corner of the screen and is medium green.

The titler has a character set that is made up of 25 alphabetic characters (capital only), 10 numeric characters, 10 punctuation characters and a "space" character for a total of 47 characters in all. You'll notice 11 other keys on the keyboard; those are used for a variety of functions, such as moving the cursor and changing mode.

The titler can hold 30 pages of characters. Each page can contain eight 16-character lines, and each character can have a different color (background and character color). Sixteen different colors are available, including a transparent color that allows the external video picture to show through (when the titler is in its external video mode).

Once you have your titles or subtitles ready, the cursor can be removed from the screen by pressing the CURSOR key. Then, you might go back to your first page of titles, blank the screen by pressing the BLANK key, and go into the external mode. Blanking the screen does not clear memory or otherwise destroy anything you've entered. It merely causes only the border to appear on the screen. If the border is transparent (as it is after the unit is first powered-up), the external video image appears on the screen.

If no external video signal is present when you enter the external mode, the picture will tear apart and be completely useless. That doesn't affect the data you've entered. You can recover a stable image by going back to the internal mode or by connecting an external video signal to the unit's input.

The action of most of the keys on the titler's keyboard is straightforward. However, there are several aspects that need more explanation. Some keys perform differently when certain modes have been evoked. Table 2 is a summary of the titler's responses to various keys in various modes. For example, as shown in Table 1, in order to place characters in the current page of memory, you need the cursor on, the screen UNBLANKED, and the object mode off.

An *object* (such as an arrow) can be displayed on the screen when the screen is UNBLANKED (with or without the cursor on). Just remember that as long as you see a cursor on the screen and not an object, you can write characters on the current page. You can display, change, and move an object on the screen as long as the screen has not been BLANKED.

Hitting the CLEAR key clears the current page.

The COLOR key initiates three functions. When an object is present, it changes the object color. When the cursor is on and no object is present, it changes the cursor color. (The cursor color designates the color of future characters; existing character colors don't change until they've been retyped using a new cursor color.) Unshifted, the COLOR key changes the character color. When the key is shifted, the background color of the character is changed.

The OBJECT key, when unshifted, alternatively displays and removes the object. While in the object mode (that is, when an object is present on the screen), character inputs are ignored. The two arrow keys move the object instead of the cursor and the COLOR key changes the object color.

When the titler is in its object mode, the shifted OBJECT key changes the *type* of object that can be displayed. Four objects are available: an oval frame, an "X," a rectangular frame, and an arrow. After you leave the object mode, the specific object, pattern, color, and location is retained and used when the object is subsequently displayed.

Unfortunately, that's all we have room for this month. When we continue next time, we'll take an in-depth look at the titler's software and then we'll see how the interface bus can be used. **R-E**

"Heat-Proofing" your Projects

Do your projects suffer from overheating? We'll show you how to keep them cool.

VAUGHN D. MARTIN and BILLY W. DAVIS

HEAT CAN DEVASTATE SEMICONDUCTOR components and can make your projects unreliable or short-lived. Fortunately, there are ways to protect your projects from excess heat. We'll show you how it's done. In this article (the first of two parts), we will discuss how electronics designers deal with the flow of heat on a quantitative basis, and how heat may be controlled by using heatsinks and forced-air cooling systems. We will also discuss how thermoelectric devices are used to control heat, and some modern methods of sensing temperature.

In the second part of this article we will examine optical means of sensing and measuring temperature, thermo probes, and Vortex tubes (devices that can produce very low temperatures almost instantaneously without complex drive machinery).

Heat flow

Physicists often talk about three different kinds of heat transfer or heat flow: conduction, radiation and convection. Molecular motion is the cause of *conduction*. Molecules at a higher temperature have higher kinetic energy than do their nearby neighbors, and some of that energy is transferred by those molecules' impinging on one another. Even at the junction of a heatsink's surface and air, energy is transferred via conduction from molecules in the heatsink to molecules in the air.

Heat flow due to *radiation* is caused, not by particle motion, but by the emanation of electromagnetic waves that encompass the spectrum all the way from ultraviolet to infrared light.

In radiation, energy itself is transferred, and in conduction the particles possessing that energy remain in one place. In *convection*, by contrast, the particles themselves move, either of their own accord, or by being forced to move. Convection is related to conduction, in that energy is transferred by means of molecular motion.

Electronics designers must concern themselves with all three types of heat transfer. Conduction is the primary means by which heat is transferred from the internal junction of a semiconductor device to an external surface such as a heatsink, where the effects of both radiation and convection then become noticeable. The size and type of material used for heatsinking has a direct effect on the amount of heat radiated. If a device generates more heat than its heatsink can effectively radiate, forced (or natural) convection must be used to maintain the device at a safe operating temperature.

TABLE 1—ELECTRICAL AND THERMAL UNITS

Electrical			Thermal		
Quantity	**Unit**	**Symbol**	**Quantity**	**Unit**	**Symbol**
Voltage	Volts	V	Temperature	°C	T
Current	Amps	I	Heat Flow	W	P_D
Resistance	Ohms	R	Thermal Resistance	°C/W	θ

Heat and electricity

In order to quantify discussions of heat flow, an analogy is often drawn between the units used to describe the flow of electricity, and those used to describe the flow of heat. As shown in Table 1, voltage corresponds to temperature; current corresponds to heat flow; and electrical resistance corresponds to thermal resistance. The circuit diagrams in Fig. 1 illustrate how heat-flow problems may be treated in a manner similar to electrical-flow problems.

The basic thermal relationship may be stated as follows: the change in temperature is the product of dissipated power and thermal resistance, or, in short, $\Delta T = P_D\theta$. The equation reveals that if a device must dissipate a certain amount of power, its thermal resistance must be minimized in order to keep its temperature rise to a minimum. A dual subscript on a thermal resistance is used to indicate the resistance at the junction of two materials. For example, θ_{SA} refers to the resistance at the junction of the heatsink (S) and ambient air (A).

Various kinds of semiconductors can withstand different maximum temperatures. Germanium, for example, can tolerate temperatures from 85°C to 100°C, whereas silicon can tolerate from 150°C to 200°C. Generally, however, we try to avoid operating semiconductor devices at such elevated temperatures, because performance decreases drastically when that is done.

For example, the input leakage current of some op-amps doubles each time junction temperatures increase 10°C. For another example, the graph in Fig. 2 shows the effect that temperature has on the maximum power that a typical power transistor can handle. Below about 25°C, the transistor can handle 90 watts of power. But above that temperature, the maximum power that the transistor can dissipate decreases linearly, until, at 100°C, the transistor becomes inoperable. Clearly, then, the more power we need the transistor to dissipate, the lower we must keep its temperature.

Why does the transistor get so hot? We must remember that both the emitter-base and the collector-base junctions generate heat. However, since the collector-base junction is reverse-biased, it has higher resistance, and it thereby produces more heat. In fact, the collector-base junction produces so much more heat than the forward-biased emitter-base junction that the

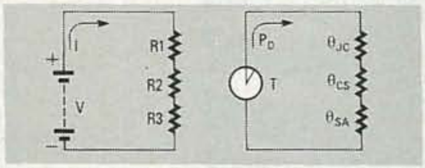


FIG. 1—THERMAL AND ELECTRICAL FLOW are similar conceptually and mathematically.

heat generated by the latter may usually be ignored. Doing so allows us to simplify the power-dissipation equation considerably:

$$P_D = I_C \times V_{CE}$$

Here P_D refers to the power dissipated by the transistor; I_C refers to its collector current, and V_{CE} refers to the voltage across the transistor's collector and emitter. As you might suspect, P_D in this electrical equation may be related mathe-

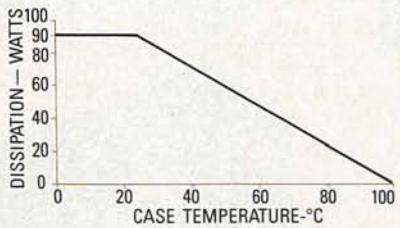


FIG. 2—A TYPICAL POWER TRANSISTOR'S ability to dissipate power decreases rapidly above a case temperature of about 25 °C.

matically to P_D in the thermal equation cited above.

As you know, placing resistors in parallel makes it easier for current to flow. Heatsinks work on the same principle; paralleling thermal resistances makes it easier for heat to flow. So by paralleling the heat-radiating mass and surface area of a semiconductor's case with a heatsink, thermal resistance is lowered, and that allows a more effective path by which heat may flow. Theoretically, in fact, an infinitely large heatsink should reduce thermal resistance to zero. Fortunately, we should never need an infinitely large heatsink—we couldn't manufacture one even if we did need it. What size do we need for a given application? As we'll see, it's rather simple to calculate.

Heatsink calculations

We may rewrite our previous thermal equation in terms of power dissipation as:

$$P_{D(max)} = (T_{J(max)} - T_{A(max)}) / \theta_{JA}$$

Here T_J is the maximum junction temperature (in degrees Celsius) that we wish our transistor to tolerate, T_A is the maximum ambient air temperature (in degrees Celsius) in which we expect our circuit to operate, and θ_{JA} represents the total thermal resistance encountered by the heat trying to escape our device.

That thermal resistance may be broken down into several series resistances that are merely added together:

$$\theta_{JA} = \theta_{JC} + \theta_{CS} + \theta_{SA}$$

We may state that relationship in words by saying that the total thermal resistance from junction to air (θ_{JA}) equals the sum of the resistances from junction-to-case (θ_{JC}), case-to-heatsink (θ_{CS}), and heatsink-to-air (θ_{SA}). We obtain θ_{JC} from a data book describing the device used; the other two values must be calculated or assumed. Let's see how, given the following:

- $T_{A(max)} = 60°C$
- $T_{J(max)} = 125°C$
- $I_{C(max)} = 0.8$ amps
- $V_{CE(max)} = 10$ volts

We can see immediately that eight watts (10 volts × 0.8 amps) of power must be dissipated. Typically, a TO-3 case can safely withstand about 2.8 watts; a TO-220 case, about 1.8 watts; a TO-202 case, about 1.5 watts; and small TO-39 and TO-92 packages can handle only about two-thirds of a watt.

If we're using a 78XX-series voltage regulator in a TO-220 case, we must, therefore, provide heatsinking to dissipate an additional $8 - 1.8 = 6.2$ watts. Checking the data sheets, we see that the 7800 series has a $\theta_{JC} = 5°C/W$. Rearranging our previous thermal equation, we find that:

$$\theta_{JA} = (T_J - T_A)/P_D$$

Plugging our assumed values in, we find that $\theta_{JA} = (125 - 60)/(0.8 \times 10) = 8.13$ °C/W. The sum of the thermal resistances must equal 8.13, and, since $\theta_{JC} = 5$ °C/W:

$$\theta_{CS} + \theta_{SA} = 3.13$$

Now if we use silicone thermal grease between the heatsink and the case of the transistor, we can approximate that $\theta_{CS} = 0.13°C/W$ (we'll show you why in a minute), so that leaves θ_{SA} to provide the additional 3°C/W of thermal resistance. The nomograph in Fig. 3 may be used to determine the size of an appropriate heatsink. Note that, to achieve a thermal resistance of 3°C/W, a vertically-mounted piece of aluminum 3/16-inch thick must have an overall surface area of 22 square inches.

However, surface area is not the only thing to consider when designing heat-

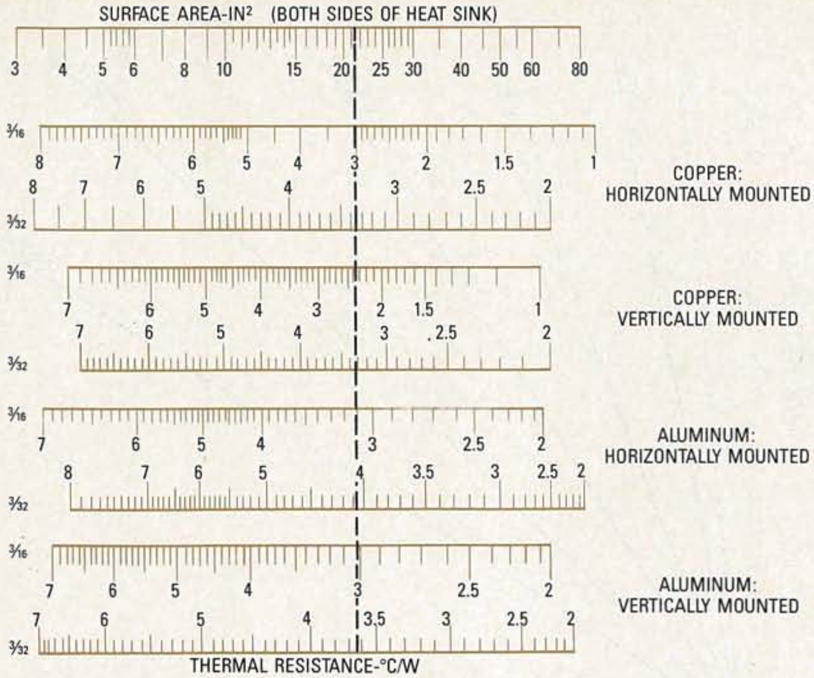


FIG. 3—DETERMINING SURFACE AREA of a heatsink is easy with this nomograph.

sinks. We must also take account of the material the heatsink is made of, the heatsink's surface finish, and the manner in which the heat-generating device is coupled to the heatsink.

The two most popular materials for heatsinks are copper and aluminum. Copper has a thermal conductivity four times that of aluminum, but it also costs much more. Aluminum is, therefore, used more often. Other materials are used to combat special problems. For example, magnesium is very light, and beryllium oxide (BeO) is an excellent insulator.

Emissivity is the term describing the effectiveness with which a given surface radiates energy; in Table 2 we show emissivities of several typical heatsink surfaces. In general, a larger value of emissivity means a better ability to radiate heat. Note that black oil-painted heatsinks radiate most effectively. Commercially available heatsinks are therefore usually painted (or anodized) black.

The third heatsink design consideration is that of device coupling. Often we cannot simply bolt a heat-generating device directly to a heatsink because doing so would cause the device's electrical output to be shorted to ground. To avoid that sort of problem, we usually use a washer that has both low thermal and high electrical resistance. There are three materials commonly used for such washers: mica, anodized aluminum, and beryllium oxide.

Mica is the most commonly used, and anodized aluminum is also fairly widely used, although if the surface of the latter is scratched, an electrical short may result. Beryllium oxide performs better than mica or anodized aluminum, but, unfortunately, it is toxic in powdered form and when vaporized. In Table 3 we compare the thermal resistance of those three insulators to that of an insulator-less junction, both with and without silicone grease. As you can see, the lowest resistance is provided using no insulator and silicone grease; that is what allowed us to assume the value of 0.13°C/W in the discussion above.

TABLE 2—EMISSIVITY OF COMMON HEATSINK SURFACES

Surface	Emissivity (E)
Polished Aluminum	0.05
Polished Copper	0.07
Rolled Sheet Steel	0.66
Oxidized Copper	0.70
Black Anodized Aluminum	0.7—0.9
Black Air Drying Enamel	0.85—0.91
Dark Varnish	0.89—0.9
Black Oil Paint	0.92—0.96

TABLE 3—THERMAL RESISTANCE (°C/W) WITH AND WITHOUT SILICONE GREASE

Insulator	Without	With
None	0.20	0.10
Teflon	1.45	0.80
Mica	0.80	0.40
Anodized aluminum	0.40	0.35

Guide to heatsink use

After all surface-area and thermal-resistance calculations are done, there are a number of practical steps one can take to help increase the effectiveness with which a heatsink dissipates heat:

- Avoid mounting voltage-sensitive devices (power transistors, regulators, etc.) next to other heat-generating components, like power resistors.
- When using heat-sensitive devices in smaller packages (TO-5, TO-39, TO-92), keep lead lengths to a minimum, and maximize copper runs on the PC board.
- Make sure that the heatsink-to-device interface is very flat. With larger heatsinks, that becomes difficult; so, for good thermal conduction, use a thin layer of silicone grease, such as Dow Corning 340, General Electric 662, or Thermalloy's *Thermacote*. Such "grease" is actually a metallic-oxide-filled silicone compound; it effectively increases the surface contact of the two mating devices by filling in air gaps and scratches.
- When a device must be electrically insulated from its heatsink, use an insulating washer 0.003- to 0.005-inch thick. Doing so increases thermal resistance, but that can be partially offset by applying silicone grease to both sides of the washer.
- When using a finned heatsink, maximum heat dissipation will occur when the fins are vertically oriented.
- Be very careful bending the leads of power-sensitive components. Hairline cracks can drastically reduce their heat-dissipating ability.

New heatsinking products

Several manufacturers have introduced products recently in an effort to simplify assembly of heatsinked components. For example, Chomerics Laminates, Inc. (77 Dragon Court, Woburn, MA 01888) has developed a "greaseless" thermal washer, the Cho-Therm *1678*, which is a rugged fiberglass-cloth reinforced, boron-nitride-filled silicone-elastomer material that provides exceptionally good thermal conductivity.

A similar heatsink washer is manufactured by Berquist (5300 Industrial Blvd., Minneapolis, MN 55435); it is shown in Fig. 4 beside a traditional silicone "glob" assembly. The Berquist unit does not require thermal grease, and has a special laminate that helps suppress EMI.

AAVID Engineering (One Kool Path, Laconia, NH 03246) has developed the new heatsink, shown in Fig. 5, for use with plastic DIP's. That slide-on heatsink has two conducting surfaces (one on the

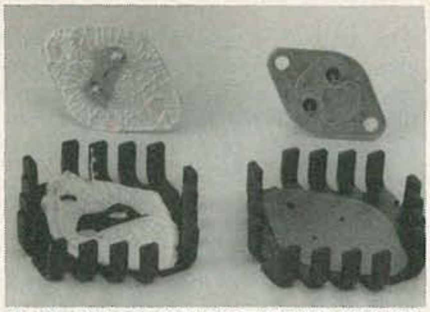


FIG. 4—THE GREASELESS THERMAL WASHER on the right replaces the messy assembly on the left.

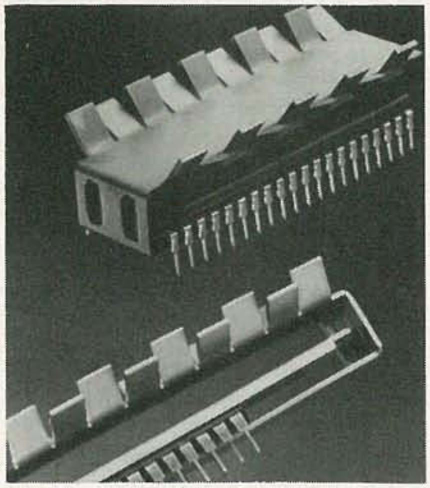


FIG. 5—THIS SLIDE-ON HEATSINK allows an IC to operate 10°C cooler and still dissipate the same amount of power.

top, and one on the bottom) that provide more effective conduction. Fins are slotted and staggered, to provide better convection. The 40-pin DIP shown in the photo dissipates one watt in normal operation; using the heatsink allows the IC to operate 10°C cooler.

So far we have focused our attention mostly on thermal conduction and radiation using heatsinks. At times, however, heatsinks alone cannot provide sufficient cooling; and that forces us to consider the

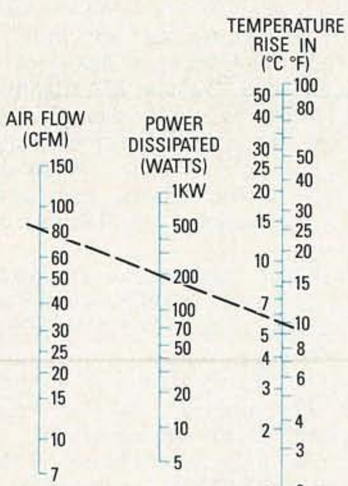


FIG. 6—AIR FLOW IN CFM may be determined easily, given temperature rise and power dissipated.

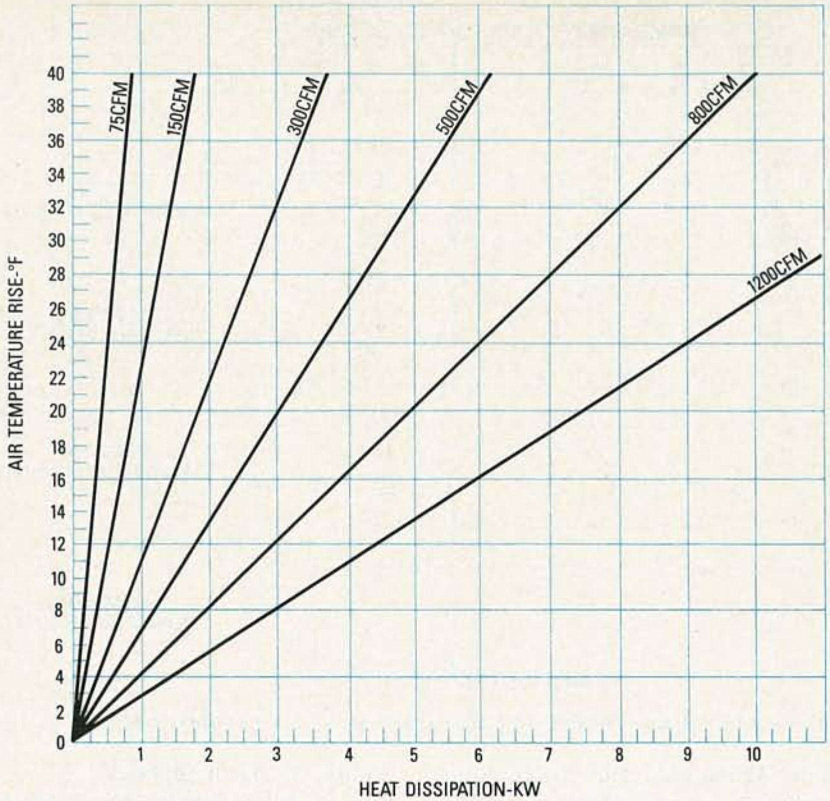


FIG. 7—AIRFLOW is related to temperature rise and heat dissipation for higher-powered units than the nomograph in Fig. 6.

third means of keeping components and assemblies cool: forced-air convection cooling. Basically, there are four convection-cooling methods

- Forced-air convection cooling
- Air-to-air heat exchange
- Air-to-water heat exchange
- Air conditioning

We will discuss convection cooling and air-to-air heat exchangers in this article. The final two cooling methods are not covered here.

Fans and blowers

The main component of a blower is a wheel that revolves to displace air; blowers are most efficient when operating near maximum static (non-moving) pressure. The main component of a fan is a propeller blade; fans operate best when moving large volumes of low-pressure air.

Cost (and noise) considerations aside, using a blower to pressurize a cabinet by pumping filtered air in is far more desirable than using a fan to exhaust air. The main advantage is that cracks between panels, around doors, etc., are better used as part of the exhaust area than as sources for the intake of dust and dirt.

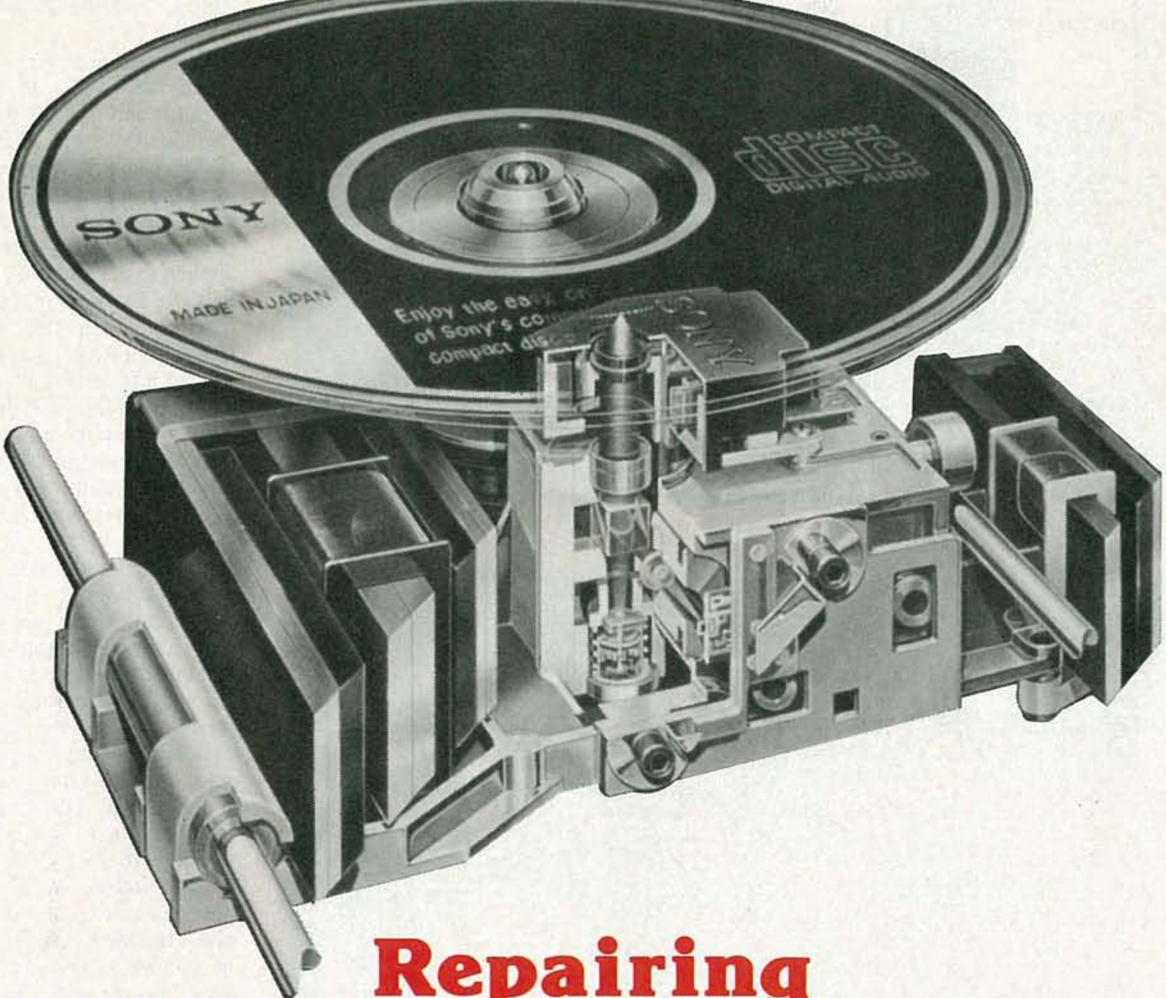
For forced-air cooling systems:

- The cross-sectional area of the air stream throughout the flow path should be approximately equal to the total effective area of the intake.
- The exhaust area must be located "downstream" from the heat-producing components.
- A baffle may be used to channel a small volume of air across a hot component at high velocity.
- Ducts may be used to maintain even cooling throughout the cabinet. If an even temperature must be maintained throughout a cabinet vertically, place ducts along the sides of the cabinet.

Calculating the size fan necessary to achieve a specific cooling effect is simple. The volume of air required at the inlet equals 1.76 watts × 1.25/°C, or 3.17 watts × 1.25/°F. The power to be dissipated is expressed in watts, and the temperature rise in the cabinet is expressed in the first equation in degrees Celsius, and in the second, in degrees Fahrenheit. The constant 1.25 provides a 25% safety factor. You may calculate air flow using the equation above, or simply use the nomograph in Fig. 6. The graph in Fig. 7 provides a way of determining the air flow for dissipating power in the kilowatt range.

Now let's go through a design example. Assume we have to dissipate 200 watts of power, and that we can only withstand a 10°F rise in temperature in the cabinet. Our formula is: Air flow = (3.17 × power in watts × 1.25)/°F. So (3.17 × 200 × 1.25)/10 = 79.25 cubic feet per minute (CFM). Note that the dashed line in the nomograph in Fig. 6 indicates a flow of approximately 80 CFM.

That's all we have room for now. Next time, we'll look at yet more convection-cooling schemes and then turn our attention to air-to-hear exchangers. **R-E**



Repairing Compact Disc Players

Compact disc players are the most exciting development in audio in years. In this article we'll show you how those devices work, and how you can repair them when something goes wrong.

Part 3 THIS MONTH, WE'LL continue our look at CD player service by looking at some more typical player circuits. We'll also look at the mechanical systems found in a CD player, and finally begin to examine some adjustments that you can make.

Figure 13 shows the D/A converter and audio circuits. The D/A converter IC406 is à 16-bit device and is capable of producing 65,536 audio-output levels. The audio is amplified by IC407 and multiplexed into right and left channels by a sample-and-hold circuit, IC408; the operation of IC408 is regulated by the controller. (Note that only the left-channel circuitry is shown in Fig. 13.) When the left-channel is in the sample status (audio from IC406 is passing), the right-channel is being held (audio not passing), and vice versa. The S/H outputs are amplified by IC409, and applied through low-pass filter CP501 to amplifier IC503. Filter CP501 produces a sharp dropoff between 20 and 25 kHz, so any frequencies above the audio spectrum that might produce distortion are rejected. Further filtering and amplification are performed by IC503 and IC504, both of which are preamp IC's with equalization or emphasis networks. In some cases, the networks are under control of relays and switches (RY552 in the circuit of Fig. 13), which are in turn controlled by the system microprocessor.

The outputs of both channels are routed to the rear and front panels. In Fig. 13, there are both fixed and variable outputs on the rear panel, and a variable output at the front panel (for the headphones). In most players, the audio outputs can be muted by relays. In this circuit the audio outputs are applied to the outputs through RY551. That relay is under the control of the mute signal generated by the system microprocessor; that signal is designated MU2. The same signal is also used to mute the digital signal path.

Figure 14 shows the slide or pickup motor control circuits. A motor is required to keep the beam moving across the disc at a constant speed, even though the

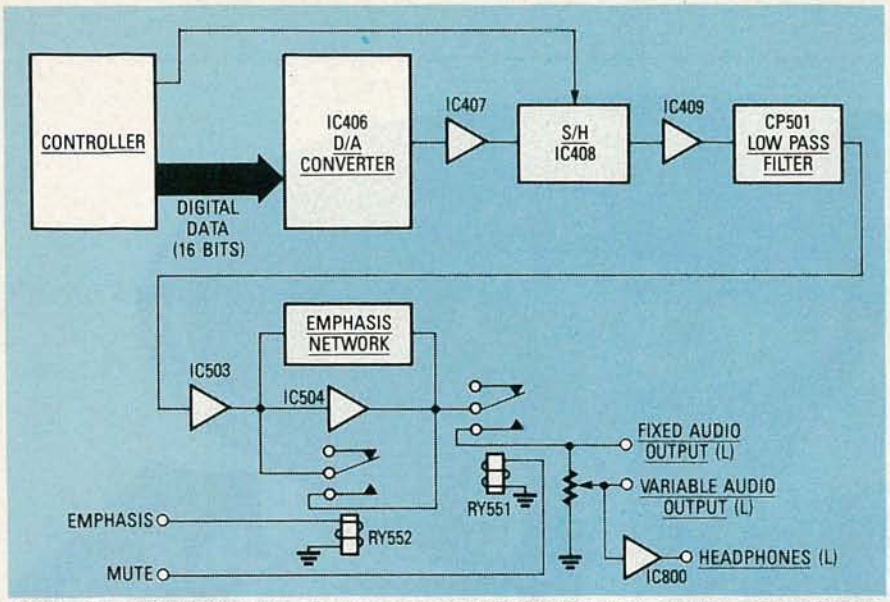


FIG. 13—THE D/A CONVERTER converts the 16-bit digital information into an audio signal. Only the left-channel circuitry is shown here.

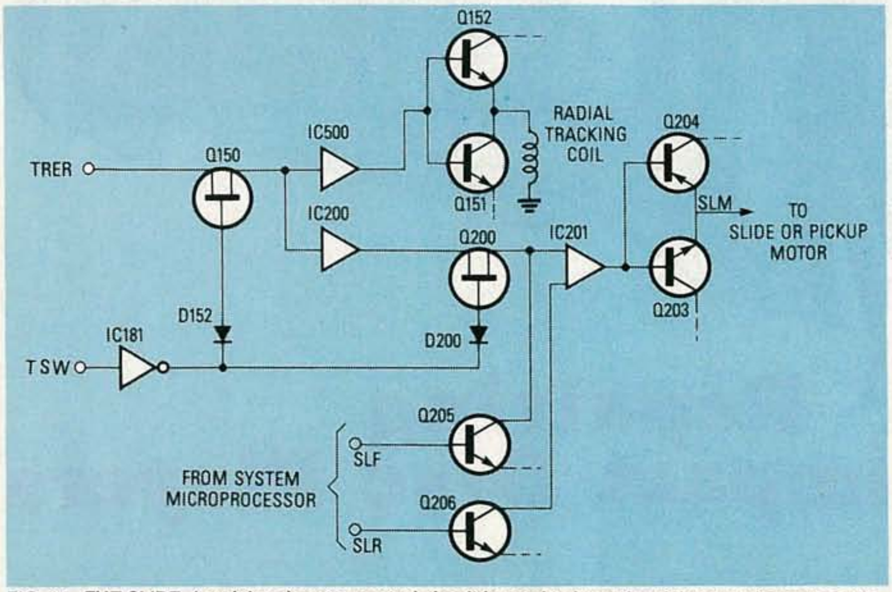


FIG. 14—THE SLIDE- (or pickup-) motor control circuit is used to keep the pickup moving across the disc at a constant speed.

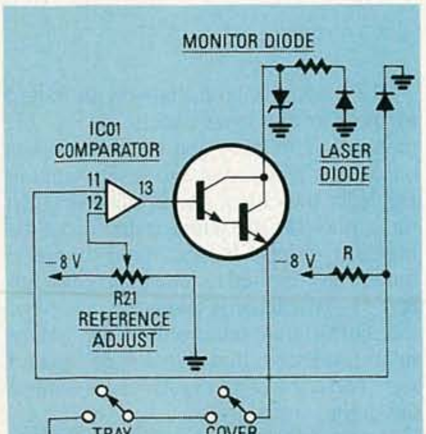


FIG. 15—THIS CIRCUIT MONITORS and controls the amount of light emitted by the laser diode.

disc speed changes. The radial tracking error or TER signal is applied to the slide motor as a fine control. The TER signal is applied through Q150, low-pass filter IC200, analog switch Q200, amplifier IC201, and drive transistors Q203 and Q204. The direction of current through the motor (and the direction of motor rotation) is set by the polarity of the signal applied to Q203 and Q204. Note that the TER signal is passed only when there is a TSW (*T*racking *SW*itch) signal from the microprocessor. The TSW signal is inverted by IC181, and applied to Q150 (through D152) and Q200 (through D200), permitting the TER signal to pass.

During search operation, the pickup must move at a faster rate than during normal play. This is done by SLR and SLF pulses from the microprocessor. The SLR and SLF pulses, applied through Q205 and Q206, produce inputs to IC201 much larger than the inputs from Q200. That produces increased current in Q203 and Q204, and increases the slide motor speed.

The laser monitor and control circuits are shown in Fig. 15. It is necessary to monitor and control the amount of light emitted by the laser diode to ensure proper performance of the player optics. (A low output from the laser can produce tracking errors, as well as audio dropouts.) In those circuits, the output of the monitor diode is applied to the input of a comparator within IC01. The other input to the comparator receives an adjustable reference voltage. If the laser-diode output goes above the desired reference level, the monitor-diode output increases, and the comparator output goes more positive. That reduces the laser-diode output back to normal. It is possible to set the amount of laser output by setting the reference voltage (with R21) to IC01.

The laser diode is cut off when the outer cover is removed or when the tray is in the extended position (ready to insert or remove a disc.) That prevents the user from coming in direct contact with the laser. The drive circuits are controlled by two series-connected microswitches. Both switches must be closed (player cover in place and tray retracted) before the drive circuits can pass the comparator output to the laser diode.

Figure 16 shows the disc-drive motor-control circuits. A CD player disc is rotated at a varying speed so that the rate at which the track is moving with respect to the pickup is constant. Speed variations are necessary since there is less data on the tracks near the inside of the disc (start) than near the outside (end); that's because the tracks are of different lengths. Most CD players use some form of "unitorque" motor with Hall-effect elements to get the variable speed. Typically, disc speed varies from about 480 rpm (inside) to 210 rpm (outside) so as to maintain a constant linear velocity (CLV) of about 1.25 to 1.3 meters per second.

Looking at Fig. 16, the Hall-effect elements are used to monitor and maintain motor speed; their outputs are fed to the control circuits, which in turn control the current fed to the motor-drive windings. In addition to speed information from the motor itself, the Hall-effect elements are fed signals from the controller under the direction of the system microprocessor; those signals contain information that pertains to the appropriate motor speed at a particular moment and are derived by the CLV signals within the controller. The CLV circuits set the appropriate motor speed by monitoring the EFM (*E*ight-to-*F*ourteen *M*odulation) signal to determine the rate at which information is passing the pickup.

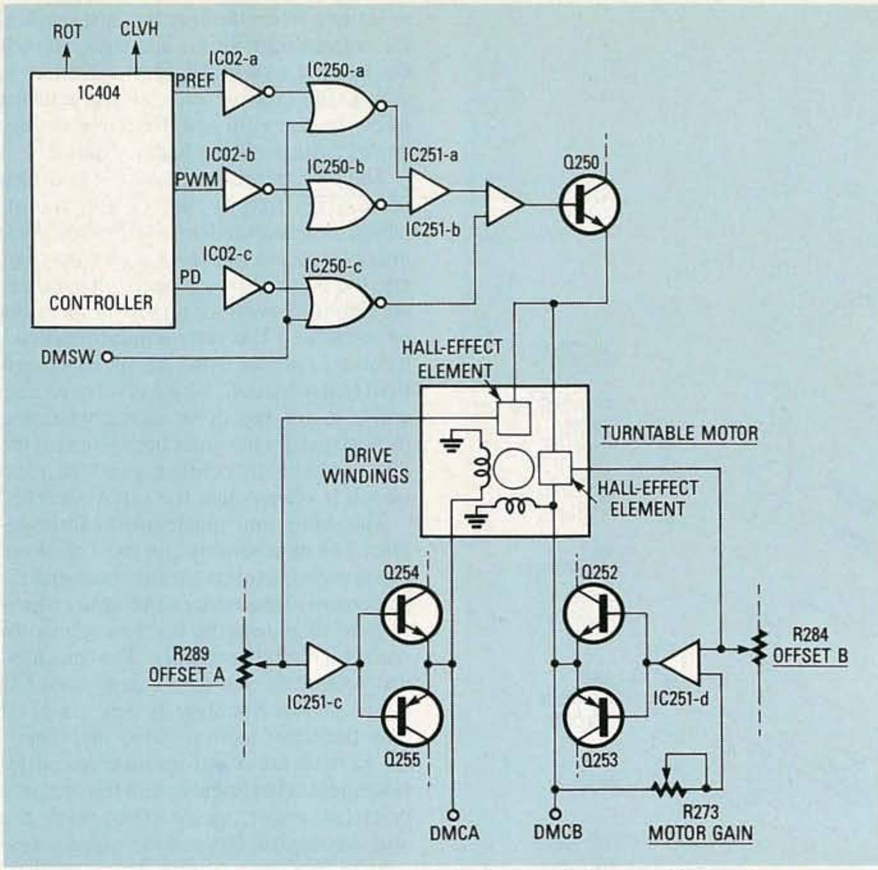


FIG. 16—THE TURNTABLE DRIVE-MOTOR control circuit controls the turntable speed.

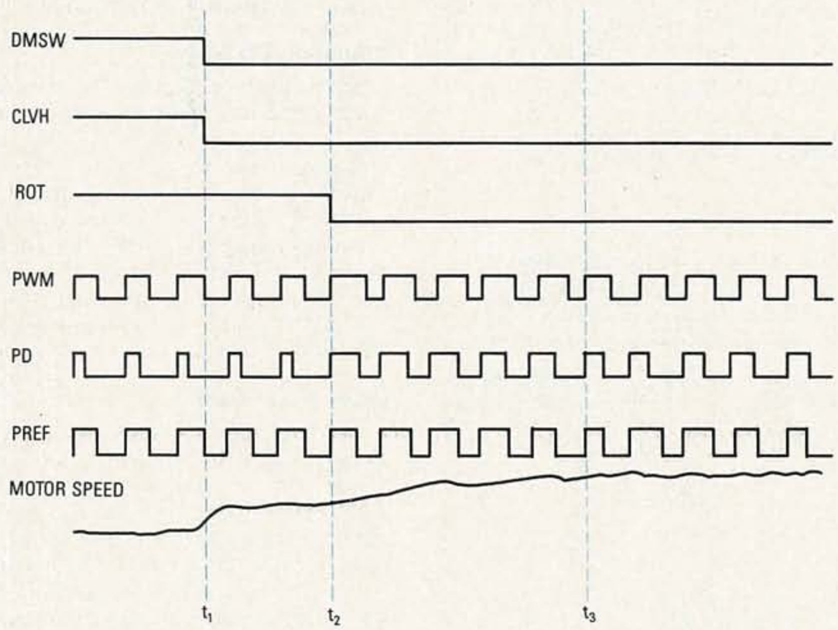


FIG. 17—TURNTABLE MOTOR-CONTROL signals. Note the relationships between the various signals.

Figure 17 shows the relationships of the signals that control the drive circuits in Fig. 16. The outputs of the Hall-effect elements are applied to the motor windings through Q252–Q255, and amplifiers within IC251. Resistors R284 and R289 provide for offset or balance adjustments, and R273 sets the gain. Operation of the disc motor can be divided into two phases: *start servo* and *regular servo*.

Let's start with the *start servo*. When power is first applied, the disc motor runs free, the DMSW and CLVH signals are low, and the ROT output is high (as shown in Fig. 17). Under those conditions, the motor accelerates, and begins to turn at a constant velocity. IC404 produces essentially similar outputs at PMW, PREF, and PD. After a free-run period (set by the system microprocessor), ROT goes low and the motor starts to accelerate. The EFM signal is read by IC404, and compared to a reference. The difference between the reference and the EFM is the PWM output from IC404. During the acceleration portion of initial read, the PWM duty cycle(which varies above and below 50% as determined by motor speed) is compared with the PREF signal (which has a fixed duty cycle). The result of that comparison is applied to the motor circuits to control speed.

Looking next at the *regular servo*, when the motor reaches the desired speed, the PWM signal has a 50% duty cycle, and the pickup reads the disc data at a constant linear velocity. That condition is maintained with a ±1% accuracy by means of the PD pulse from IC404. The duty cycle of the PD pulse is set by comparing the EFM signal to a reference within IC404. In turn, the PD signal is compared with the output from the PWM and PREF comparator (IC251). The result of that comparison is applied to the motor to maintain the ±1% accuracy.

CD mechanics

The mechanical systems in a CD player perform two primary functions: loading and unloading the disc, and driving the optical pickup across the disc. In horizontal front-load players, the tray is opened by a drive motor, a disc is inserted (manually) in the tray, the tray and disc are returned within the player (by the same drive mechanism, and usually the same drive motor). Some front-load players use a fourth drive motor to clamp or "chuck" the disc onto the turntable. Operation of drive motors is controlled by limit switches and the system microprocessor, so it is necessary to study both the mechanical drawings and the wiring. We give you both in this section, but keep in mind that the descriptions here are "typical," and must be compared with the descriptions found in the service literature.

Figure 18 shows the major mechanical components of a CD player. Note that most of the components are part of a *unit mechanism* secured to the mainframe by two rails. The *tray* is moved out of the player front panel by the loading motor (LIDM). This action also raises the *clamp* or *chuck*. A disc is installed manually in the tray, and the tray is pulled within the player by the LIDM. That action also lowers the clamp so that the disc is pressed against the *turntable motor assembly.* In most players, the coil assembly can be separated from the turntable motor, and replaced as a separate component.

As shown in Fig. 19, the LIDM receives open/close drive signals from the system microprocessor through IC110 and Q116/

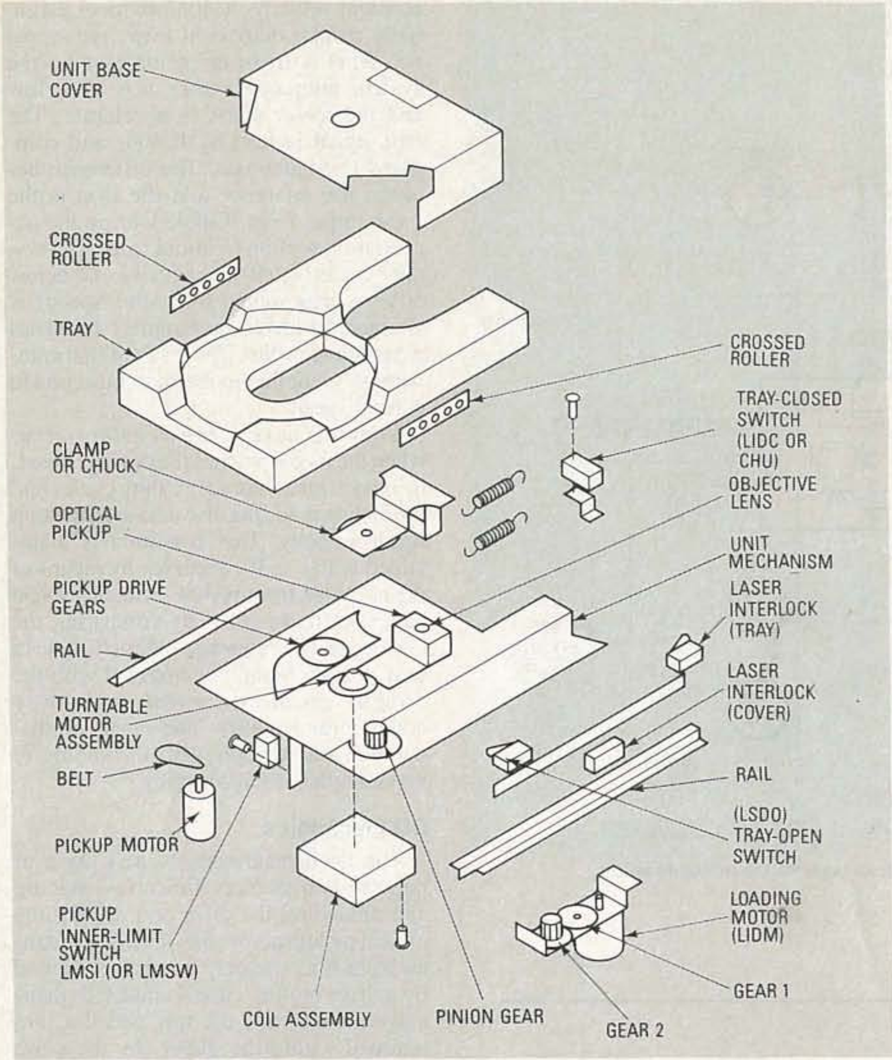


FIG. 18—THE MAJOR MECHANICAL components of a CD player. Most of the components shown are part of the "unit mechanism," which is secured to the main part of the player via two rails.

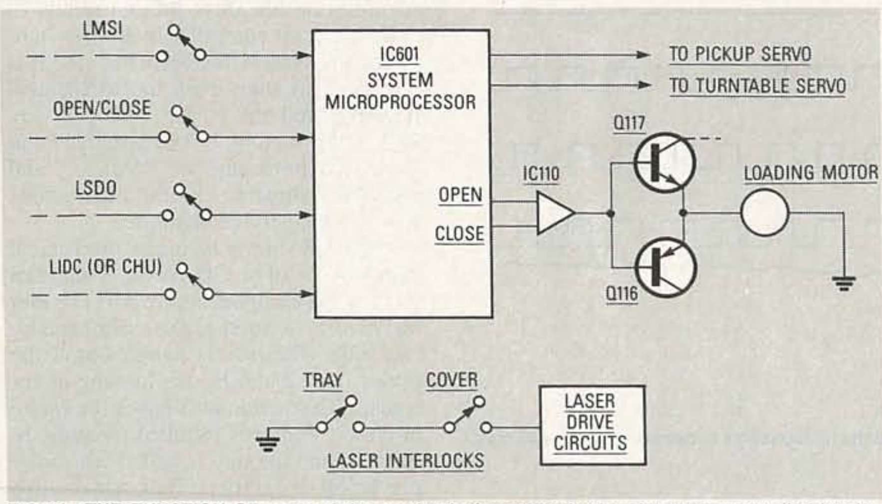


FIG. 19—THE FUNCTION OF most of the mechanical systems in the player are controlled by the microprocessor.

Q117. In turn, the microprocessor receives control signals from the front-panel OPEN/CLOSE switch. The microprocessor also receives indicator signals from the tray-open (LSDO) switch and the tray-closed (LIDC) switch. The LIDC switch is actuated only when the tray is in, and the clamp is in the fully-down position. The LIDC switch is called the chuck or CHU switch in some literature. The LSDO is set to actuate when the tray has just reached the correct open limit, and thus cuts off the loading motor. No matter what it is called, the LIDC or CHU switch actuates when the tray is in and the clamp is fully down, cutting off the loading motor.

The *optical pickup assembly* is driven across the disc by the pickup motor, which is connected to the *pickup drive gears* by means of a *belt*. (On most players, the belt can be replaced when covers are removed, without removing the pickup or motor.) The system microprocessor receives a signal from the pickup inner-limit (LMSI) switch, which is set to actuate and turn off the drive motor when the pickup reaches the inner limit (start) of the disc. (Again, to confuse you, the LMSI switch is often called the LMSW switch).

The entire unit mechanism can be replaced as an assembly (on most players). Some manufacturers also recommend replacement of the motors and limit switches (and they describe the procedures for replacement/adjustment). The mechanical section is one area where most CD player service literature is very good. (If only the other sections were that clear!) So we will not dwell on mechanical replacement/adjustment here. However, as a practical matter, *never disassemble* the unit mechanism beyond the point necessary to replace or adjust a given part. *Never* make any adjustments unless the troubleshooting procedures lead you to believe that adjustment is required.

Adjusting CD players

The adjustment sections of most CD player literature are good, up to a point. That is, they give you the step-by-step procedures, and show you the physical location of the adjustment controls. Unfortunately, they do not tell you what you are doing when you make the adjustments. We will bridge that gap by describing the adjustment procedures for a typical CD player, using adjustment diagrams not found in any service literature.

Laser diode output

Normally, the laser diode should not be adjusted unless the pickup has been replaced or troubleshooting indicates a laser problem. Also, be aware that laser diodes can be damaged by current surges. Typically, the laser diodes used in CD players have drive-current limits in the 40- to 70-mA range, though some may be as high as 100 mA. Generally, 150 mA is sufficient to damage (if not destroy) any CD laser diode. Note that as laser diodes age they may require more drive current to produce the required light. If the current is increased for that reason, it should obviously be kept within the "safe" limit for the diode.

That's all we have room for now. When we continue, we will show you how to adjust the laser's output. **R-E**

DESIGNING WITH DIGITAL IC'S

One-shots and clocks are among the most important digital circuits. This month we learn about those circuits and how they are used.

JOSEPH J. CARR

Part 8 THE MONOSTABLE multivibrator (or "one-shot") can be used in a variety of applications. Those circuits are used to clean up noisy digital signals, to "stretch" pulses, as timers, and on and on. The circuit is termed "monostable" because it has only one stable output state. That stable state might be either high or low depending on the design. Normally, the monostable remains in the stable state. But when a valid trigger pulse is received, the monostable goes to the unstable state, but only for a predetermined period of time. The monostable output then reverts back to the stable condition.

There are two main categories of monostable multivibrators: retriggerable and nonretriggerable. Of those, the latter is the type most people think of when considering those circuits. Thus, unless otherwise stated, assume that a monostable multivibrator is nonretriggerable.

Figures 1 and 2 show the timing diagrams for the two types of monostables. Figure 1 shows a nonretriggerable monostable in which the stable state is low. A trigger pulse is received at time t_1, so the output snaps high and remains so for period T. When period T expires, the output returns to the low state. It remains low until another valid trigger pulse is received (t_4).

The essential characteristic of a nonretriggerable circuit is shown in Fig. 1. That characteristic can be seen by examining what happens at t_2. At that time, a second trigger pulse is received, but since the output is in the unstable (active) state that pulse is ignored. The pulse at time t_2 has no effect on the output; such a trigger pulse is considered invalid.

One common application of nonretriggerable monostables is switch debouncing. Ordinary mechanical switches are quite noisy when the contacts close. That's because the two electrical contacts inside the switch "bounce" one or more times before a solid connection is made. The period of contact bounce might be several milliseconds, during which each bounce creates a noise pulse. Those pulses can cause many problems for digital circuits, so they must be suppressed.

To use a nonretriggerable monostable for that task, select one whose output period, T, is longer than the bounce period (5 ms, for instance). When the monostable is inserted in series with the switch, its output will go high when the first bounce pulse is received, and will remain in that state until after the bounce pulses die out. As for the balance of the digital circuit, all it will see is the 5 ms one-shot pulse; it is thus spared the indignity of a noisy signal.

The timing diagram for a retriggerable monostable is shown in Fig. 2. Again, the period of the monostable multivibrator is T, which is initiated by a trigger pulse at time t_1. Normally, the output would remain high until T expired at time t_3. But at time t_2, a second trigger pulse is received. That pulse "retriggers" the circuit for another period T. The total time that the output remains high is not 2T, but T plus the expired portion of the first period (i.e. $T + (t_2 - t_1)$).

One application of the retriggerable monostable is in alarm circuits designed to monitor repetitive events. For example, consider its use in a medical respiration alarm. The alarm senses the patient's breathing and generates a pulse in response to that breathing that is used to trigger the monostable. The period of the monostable is set such that a normal breathing pattern will cause continuous retriggering. If the breathing pattern is disrupted, the monostable does not receive a retriggering pulse so the circuit "times out" and the alarm sounds.

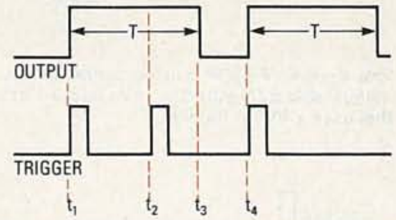


FIG. 1—TIMING DIAGRAM for a non-retriggerable monostable multivibrator.

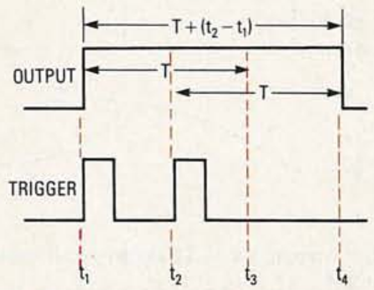


FIG. 2—TIMING DIAGRAM for a retriggerable monostable multivibrator.

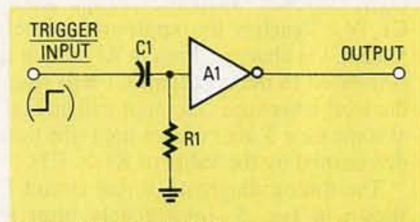


FIG. 3—INVERTER-BASED monostable multivibrator. As shown, the circuit is positive-edge triggered.

Some circuit examples

The simple circuit of Fig. 3 is an example of a half-monostable or quasi-monostable multivibrator. A1 is a CMOS inverter (or a CMOS gate wired as an inverter). When a trigger pulse is received, the output will snap low (active), and it remains low for a period of time determined by the values of R1 and C1. A serious constraint on that circuit is that the trigger pulse must be longer than the output period set by R1 and C1. As shown, the circuit goes low on the positive (leading) edge of the triggering pulse; that is called positive-edge triggering. To obtain negative-edge triggering (triggering on the negative, or trailing edge of the pulse), tie R1 to +V instead of ground.

Figure 4 shows a monostable based on a 4013 CMOS D flip-flop. In that circuit, the D input of the 4013 is connected to +V, so that input is always high. The CLR

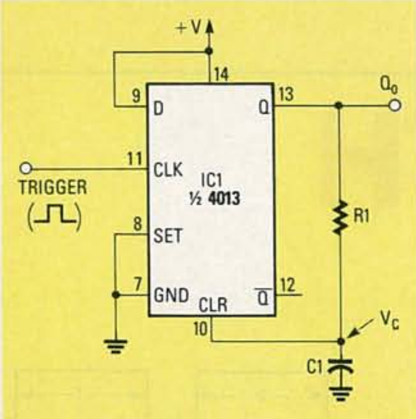


FIG. 4—A FLIP-FLOP can be configured as a monostable multivibrator. Here is one circuit that uses a 4013 D flip-flop.

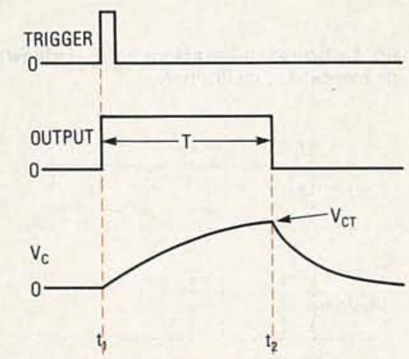


FIG. 5—TIMING DIAGRAM for the circuit shown in Fig. 4.

input is connected to capacitor C1, so it will initially be low. That input will go high, however, when the voltage across C1, V_C, reaches the appropriate level. Since C1 is charged through R1, which is connected to the Q output, C1 will reach the level where the CLR input will go high at some time T after Q goes high (the time determined by the value of R1 × C1).

The timing diagram for that circuit is shown in Fig. 5. Immediately prior to time t_1, the voltage across C1 (i.e. V_c) is zero, and the Q output is low. At t_1, a trigger pulse is received, which causes the Q output to go high. That causes a current to flow through R1, which causes C1 to charge and V_C to rise. Voltage V_c will continue rising until it reaches the "clear trip" voltage. That is the voltage required at the CLR input to force the Q output low. At that instant, t_2, Q snaps low and capacitor C1 begins discharging through R1. The output was high for a fixed period ($t_1 - t_2$) that was determined by the time constant R1 × C1 and the voltage required to clear the flip-flop.

But note what happens between time t_2 and t_3. That time is a "refractory" period during which the flip-flop either won't retrigger, or will produce an erroneous output period, because capacitor C1 was partially charged at the instant the trigger pulse was received (i.e. V_C is not 0).

The refractory period can be shortened considerably by the adding a quench diode (D1 in Fig. 6) to the circuit. The quench diode is placed in parallel with R1 in such a way that it is reverse-biased when Q is low (or unbiased if V_C is less than or equal to 0.6 volts). During the active period ($t_1 - t_2$), diode D1 is reverse-biased so it will not affect the timing. (An exception to this rule is long-duration timers where the value of R1 is very large, and the leakage resistance of D1 is less than 100 × R1.) But when the flip-flop is cleared, and Q goes low, voltage V_C forward-biases D1, forcing it to conduct. The charge on C1 is thus "dumped" through diode D1, shortening the discharge time and, as a result, the refractory time.

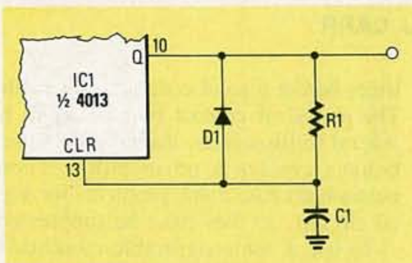


FIG. 6—ADDING A QUENCH DIODE shortens the refractory period.

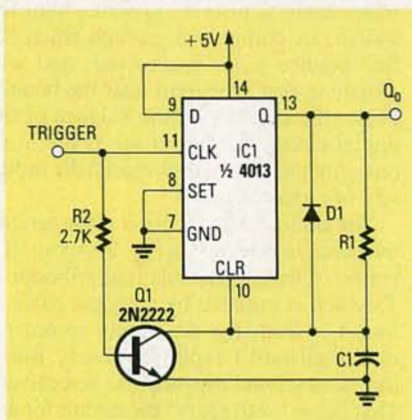


FIG. 7—THE CIRCUIT of Fig. 4 can be made retriggerable by modifying it as shown here.

Figure 7 shows a version of the retriggerable monostable built around a D flip-flop. In that circuit, a transistor switch is added. Its purpose is to discharge V_C when a positive trigger pulse is received. Such a pulse will forward bias Q1, thereby connecting its low collector-emitter resistance across C1. That transistor must have a high enough beta to be fully saturated by the trigger pulse, and a $V_{CE(SAT)}$ rating of 0.6 volts or less.

Note that neither circuit shown in Fig. 5 and Fig. 6 will return to exactly 0 volts until long after the $t_1 - t_2$ period has expired. That's because D1 will quench V_C down to only 0.6 or 0.7 volts, which is the level required to forward-bias the diode. Normally, however, that poses no serious problems.

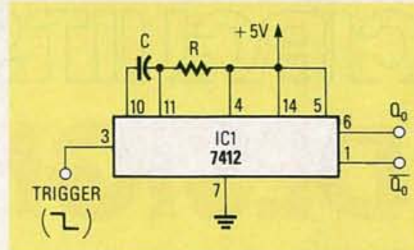


FIG. 8—A TTL ONE-SHOT, the 74121 is configured here to be negative-edge triggered.

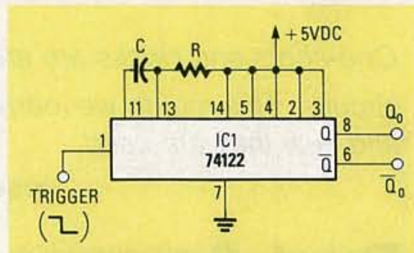


FIG. 9—THE PERIOD of this 74122 TTL one-shot is determined by R1 and C1.

A pair of TTL one-shot devices are shown in Figs. 8 and 9: the 74121 and 74122. Both of those devices are shown with negative-edge triggering inputs. The period of the output pulse is determined by: T = 0.69R1C1, where T is the period in seconds, the resistance of R1 is measured in ohms, and the capacitance of C1 is measured in microfarads.

That relationship can be rearranged to yield either C1 or R1 in terms of T, which is the usual situation when selecting values. (Normally, we know the desired T, will select an arbitrary C1, and then calculate R1.) Let's work out an example. Suppose we want a 10 microsecond (10μs) pulse. Let's select a trial value of .001 μF for C1 and see if the required value of R1 is reasonable:

$$R1 = T/0.69C1$$

$$R1 = \frac{1 \times 10^{-5}}{(0.69)\ 1 \times 10^{-9}}$$

$$R1 = 14{,}493 \text{ ohms}$$

For most applications, a 15 kilohm unit (a standard value) can be used.

Both 74121 and 74122 are TTL devices, so the Q output will be 0 to 0.8 volts for low, and 2.4 to 5.0 volts for high. The $\overline{Q}$ outputs use the same voltages levels.

The 555 is an extremely popular timer/oscillator that uses bipolar technology. The device will operate at supply voltages ranging from +4.5- to +18-volts DC, so it is compatible with most IC digital logic families. In addition, standard 555 outputs sink or source up to 200 mA of current, so the device can be used to drive relays, LED's, and some incandescent lamps without the need for external transistors.

Figure 10 shows a 555 configured as a monostable multivibrator. The trigger in-

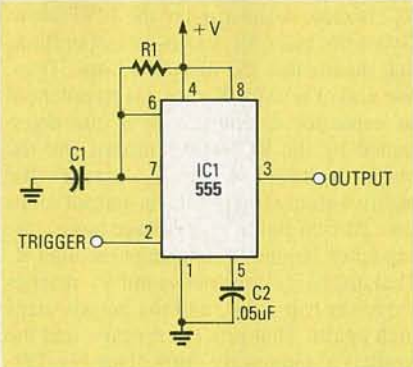


FIG. 10—A POPULAR DEVICE, the 555 timer IC is shown here configured as a monostable multivibrator.

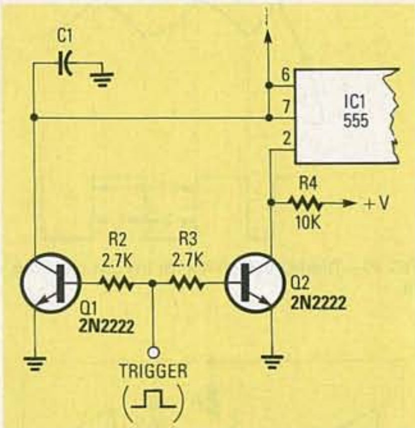


FIG. 11—THE CIRCUIT of Fig. 10 can be modified to make it retriggerable as shown here.

put is normally high. That input must be dropped below +V/3 for triggering to occur. When such a trigger pulse is received, the output terminal snaps high for a period that is determined by T = 1.1R1C1, where T is the time in seconds, the resistance of R1 is measured in ohms, and the capacitance of C1 is measured in farads.

For example, find the period of the output pulse when R1 = 47K and C1 = 0.1µF. Solving, $T = (1.1)(47{,}000)(1 \times 10^{-7})$; T = 0.0052 seconds = 5.2 ms.

A retriggerable 555 monostable multivibrator circuit is shown in Fig. 11. Similar to the D-flip-flop based circuit we looked at earlier, that circuit uses an external transistor switch to dump the charge in the timing capacitor. Both transistors are turned on by the positive-going trigger pulse.

Note that the polarity of the trigger pulse is reversed from the circuit of Fig. 10. Normally, the trigger input of the 555 (pin 2) is held at +V by pull-up resistor R4. But when a positive trigger pulse forward-biases Q2, pin 2 is brought near ground—so triggering is effected. At the same time, transistor Q1 is also forward-biased, so it will have an extremely low collector-emitter resistance. Since that resistance is shunted across capacitor C1, the charge on C1 is bled off rapidly to ground. That action has the effect of resetting the timing of the output pulse to zero. The output pulse will remain high for period T = 1.1R1C1, plus whatever percentage of the period that had expired prior to receipt of the second trigger pulse.

Our last monostable multivibrator is the operational amplifier version shown in Fig. 12; its timing diagram is shown in Fig. 13.

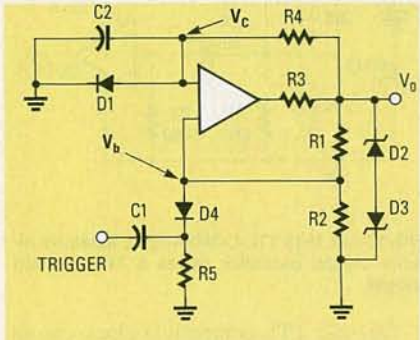


FIG. 12—AN OP-AMP COMPARATOR is used here as the heart of a monostable multivibrator.

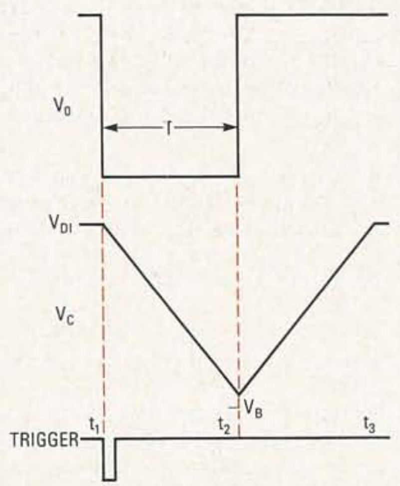


FIG. 13—TIMING DIAGRAM for the circuit of Fig. 12.

That circuit uses an operational amplifier as a comparator. A comparator is an op-amp that is used to compare the relative states of its two inputs. Thus, if one input is a known reference level, and the other is variable, the output of the comparator will indicate whether the variable input is at a higher or lower voltage than the reference.

The stable state of the circuit in Fig. 12 is high. While the circuit is in that stable, untriggered state, the output is at $+V_O$, while V_C is clamped to approximately 0.7 volts by diode D1. On receipt of a trigger pulse, the output snaps to $-V_O$, which causes V_C to begin charging through R4 towards $-V_O$. At some point (t_2), $-V_C$ will be equal to $-V_B$, and the output will snap high again (clamped to 0.7 VDC by D1). The duration of the active-low output pulse ($t_1 - t_2$) is:

$$T = (RC)\ln\frac{1 + (V_{D1}/V_O)}{1 - \beta}$$

Where T is the output duration in seconds, R is the resistance of R4 in ohms, C is the capacitance of C2 in farads, and β is equal to R2/(R1 + R2). If V_O is much greater than V_{D1}, and R1 = R2, then that equation can be simplified to T = 0.69RC.

Diodes D2 and D3 are used to clamp the output to some specific value. $+V_O$ is clamped to V_{D2} + 0.7 volts, while $-V_O$ is held to V_{D3} + 0.7 volts. Normally, $V_{D2} = V_{D3}$, and the output voltage is symmetrical.

Clocks

Many circuits and devices depend upon a clock signal for proper operation. Even certain circuits made from non-clocked devices require a clock signal for synchronization of events.

But, what is a clock signal? It is a chain of squarewaves or pulses that is generated by a circuit called an astable multivibrator. As its name indicates, an *a*stable is a circuit that has no stable states. Once triggered the output of the circuit will snap back and forth between high and low.

Some of the clock circuits we'll be looking at in the rest of this article are based on inverters (TTL or CMOS). Instead of using dedicated IC's to generate a clocking signal, it is often possible to use spare NAND or NOR gates to form inverters. Figures 14-*a* and 14-*b* show two ways to use two-input NAND gates as inverters—either tie both inputs together or tie the unused input permanently high. Figures 14-*c* and 14-*d* show how NOR gates can be used as inverters. That is done either by tying the two inputs together, or by tying the unused input *low*.

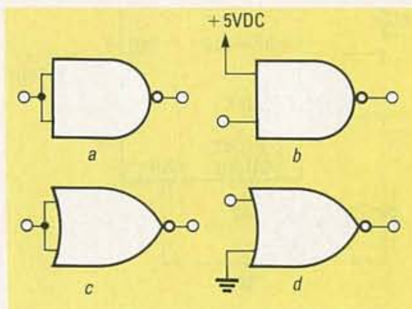


FIG. 14—INVERTERS can be fashioned from leftover NAND and NOR gates.

TTL Clocks

Figure 15 shows the use of two TTL inverters (or inverter-connected gates per Fig. 14) in a clock circuit. Two resistors are used to bias the inverters, and each resistor is connected from the output back

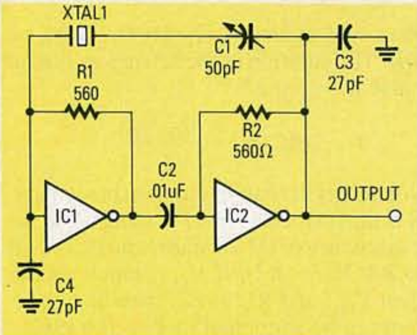


FIG. 15—TWO INVERTERS are used in this astable multivibrator.

to the input of its own inverter. The output of IC1 is capacitor-coupled to the input of IC2. A feedback network, consisting of a variable capacitor and a crystal, determines operating frequency. That network is connected between the output of IC2 and the input of IC1.

The operating frequency is determined mainly by the crystal, and to a lesser degree by capacitor C1. The effect of C1 is to change the resonant frequency of the crystal a small amount by changing its capacitive load. Thus the capacitor acts as a "fine-tuning" control. If operating frequency is not critical, C1 can be replaced with a fixed capacitor.

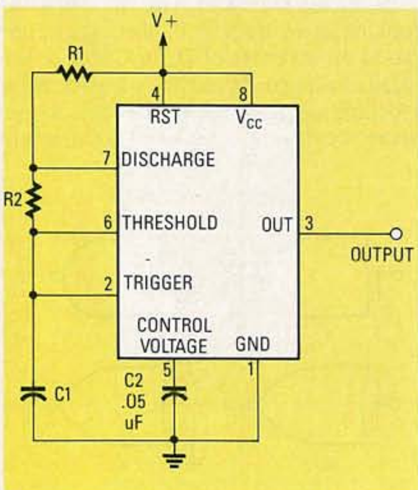


FIG. 16—THE FREQUENCY of this 555-based astable is determined by R1, R2, and C1.

The clock circuit shown in Fig. 16 is based upon the 555 IC timer. The output frequency is a function of R1, R2, and C1, and is found from:

$$f = \frac{1.44}{C1(R1 + 2R2)}$$

where f is the frequency in hertz, the resistances of R1 and R2 are measured in ohms, and the capacitance of C1 is measured in farads.

Note that the 555 is not actually a TTL circuit. It is a bipolar IC that can operate at supply voltages from +4.5- to +18-volts DC. If a supply voltage of +5 is used, then the 555 will work with TTL circuits. The 555 output (pin 3) will sink or source up to 200 mA, so it can drive more TTL devices than a "standard" TTL output.

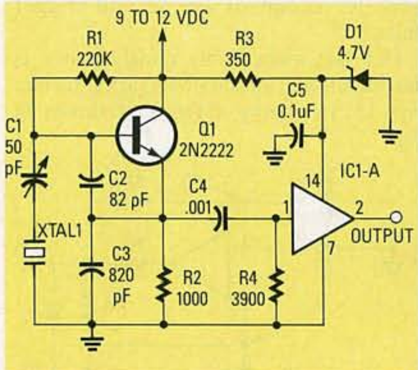


FIG. 17—IN THIS TTL-COMPATIBLE astable a bipolar crystal oscillator drives a 7414 Schmitt trigger.

One last TTL-compatible clock circuit is shown in Fig. 17. That circuit uses a bipolar crystal oscillator that drives a 7414 TTL Schmitt trigger. The oscillator shown operates from about 700 KHz to 15 MHz, depending on the crystal used. The exact frequency is set by using trimmer capacitor C1. Ordinarily one would not use a circuit such as the one shown in Fig. 17 unless a precise oscillator frequency is required.

CMOS clock circuits can operate from a wider range of supply voltages than TTL, and they generally require less current. Several different forms of CMOS astable multivibrator/clock circuits are possible.

Figure 18 shows a simple RC-timed circuit based on the 4093 CMOS Schmitt trigger. The trigger-circuit output will snap high when a positive-going input reaches a given voltage (V1), and snaps low when the same input voltage reaches a second point (V2) in the negative-going direction. The values of V1 and V2 vary with supply voltage used. In the circuit shown, when +V = 5, V1 = 2.9 and V2 = 2.3; when +V = 10, V1 = 5.9 and V2 = 3.9. The hysteresis of a Schmitt trigger is V1 − V2, so it is 0.6 volts when +V = 5, and 2 volts when +V = 10.

The 4093 is basically a two-input NAND gate with Schmitt inputs. Since one input is tied permanently high, circuit action is controlled entirely by the input that is connected to R and C. When power is first

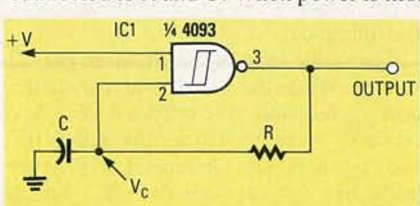


FIG. 18—THIS CMOS ASTABLE is based on the 4093 Schmitt trigger.

applied, the voltage across the capacitor, V_C, is zero, so the input to the 4093 is low. Given the rules for NAND-gate operation, that means that the output is high. Thus, one end of resistor R sees a high potential so capacitor C charges at a rate determined by the RC time constant and the output voltage. When V_C reaches the positive-going trip point, the output snaps low. At that point, the voltage across the capacitor begins to discharge through R. That discharge continues until V_C reaches the lower trip point, and the output snaps high again. That process repeats, and the result is a squarewave output (see Fig. 19).

Figure 20 shows another CMOS clock circuit; that one is based on either a pair of

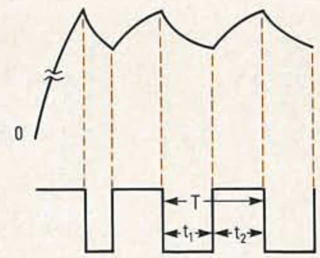


FIG. 19—TIMING DIAGRAM for the circuit of Fig. 18.

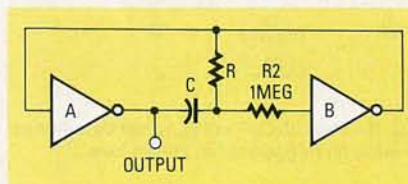


FIG. 20—THE OUTPUT FREQUENCY is determined by the values of R and C.

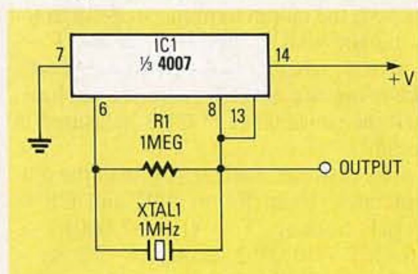


FIG. 21—THE CRYSTAL in this circuit controls the operating frequency.

inverters or inverter-connected gates. The circuit of Fig. 20 bears a certain similarity to the TTL oscillator shown earlier, but its frequency is determined by the R-C combination (not a crystal). The operating frequency, in hertz, is approximately 1/(2.25RC), where R is measured in ohms and C in farads.

A 1-MHz CMOS crystal oscillator, based on the 4007 is shown in Fig. 21. The crystal in the feedback path controls the operating frequency.

The so-called "classic" CMOS crystal oscillator shown in Fig. 22 first appeared in some of the earliest RCA applications

continued on page 112

PC SERVICE

One of the most difficult tasks in building any construction project featured in **Radio-Electronics** is making the PC board using just the foil pattern provided with the article. Well, we're doing something about it.

We've moved all the foil patterns to this new section, where they're printed by themselves, full sized, with nothing on the back side of the page. What that means for you is that the printed page can be used directly to produce PC boards!

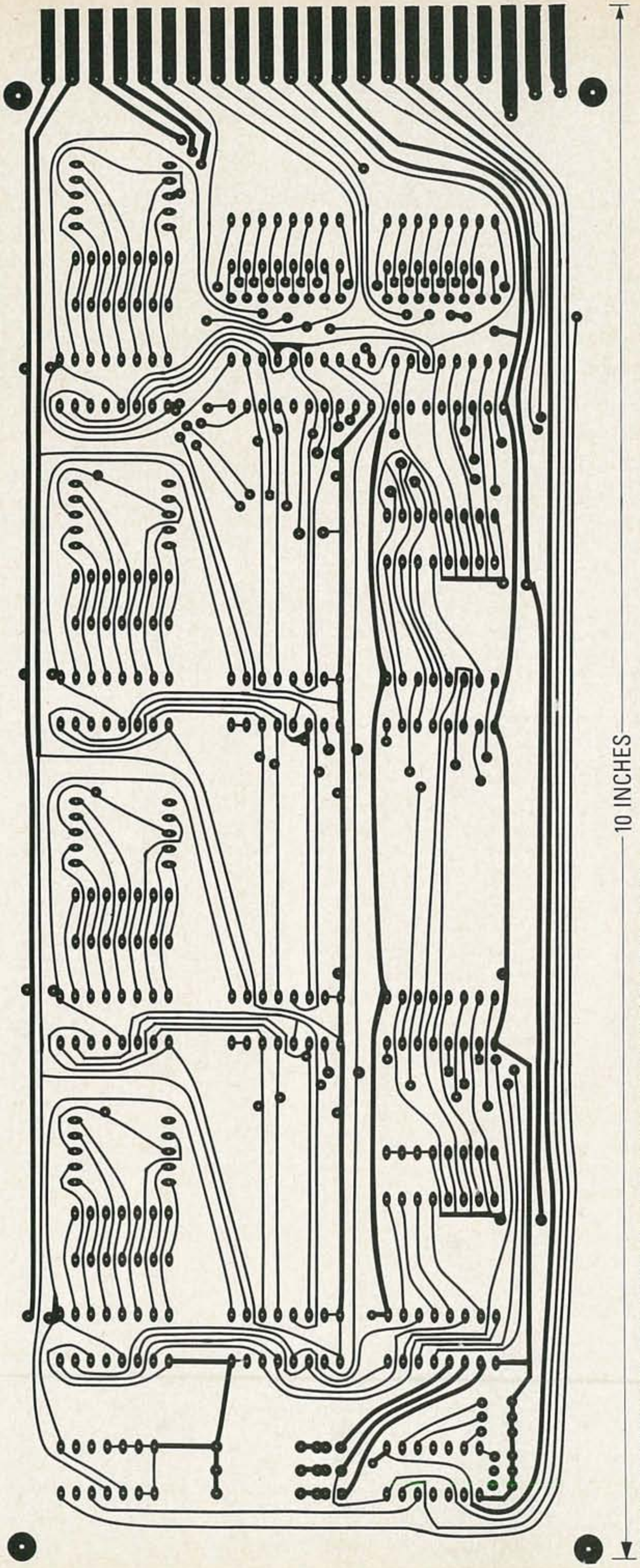
In order to produce a board directly from the magazine page, remove the page and carefully inspect it under a strong light and/or on a light table. Look for breaks in the traces, bridges between traces, and, in general, all the kinds of things you look for in the final etched board. You can clean up the published artwork the same way you clean up you own artwork. Drafting tape and graphic aids can fix incomplete traces and doughnuts, and you can use a hobby knife to get rid of bridges and dirt.

An optional step, once you're satisfied that the artwork is clean, is to take a little bit of mineral oil and carefully wipe it across the back of the artwork. That helps make the paper transluscent. Don't get any oil on the front side of the paper (the side with the pattern) because you'll contaminate the sensitized surface of the copper blank. After the oil has "dried" a bit—patting with a paper towel will help speed up the process—place the pattern front side down on the sensitized copper blank, and make the exposure. You'll probably have to use a longer exposure time than you are used to.

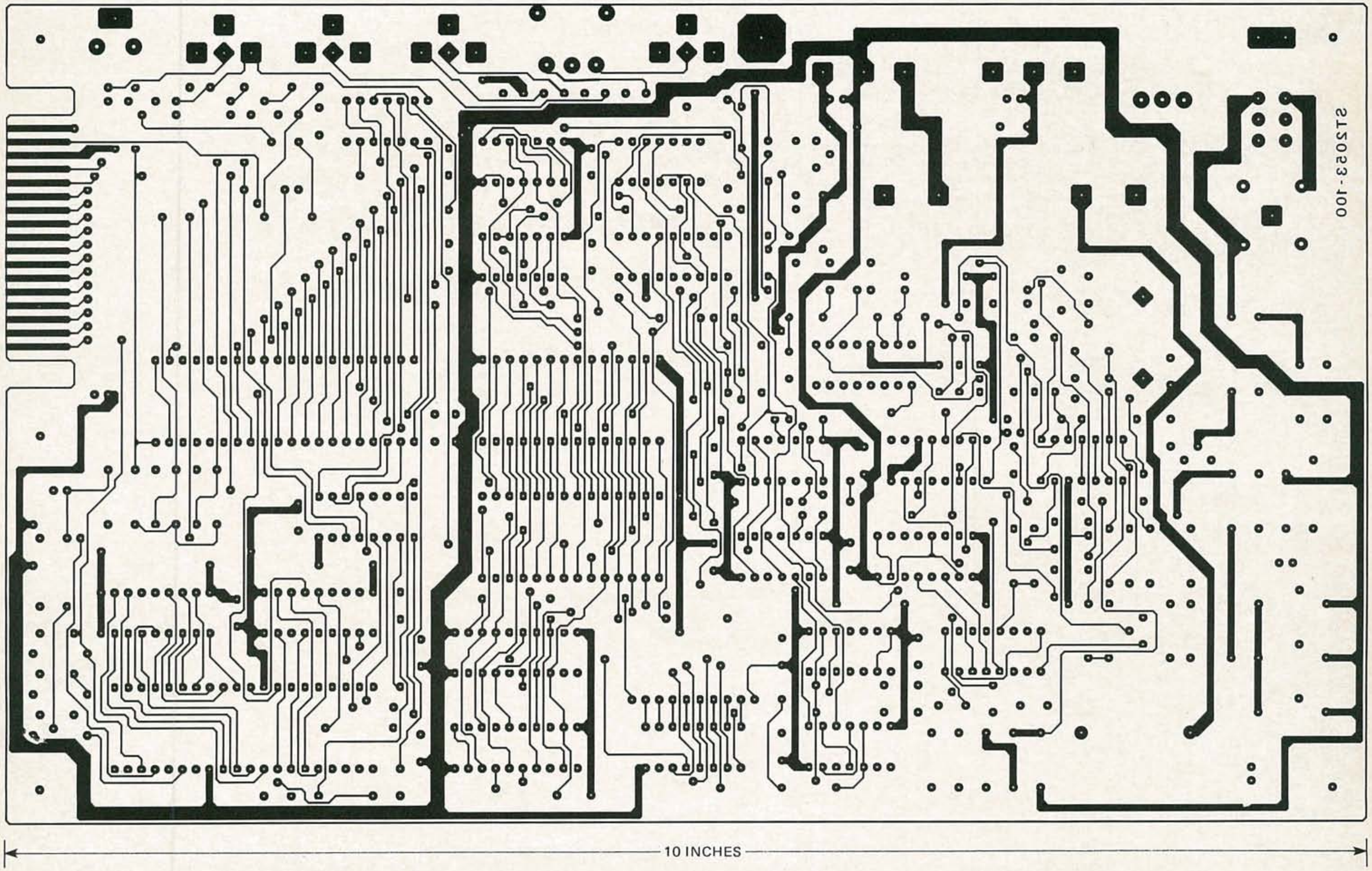
We can't tell you exactly how long an exposure time you will need because we don't know what kind of light source you use. As a starting point, figure that there's a 50 percent increase in exposure time over lithographic film. But you'll have to experiment to find the best method to use with your chemicals. And once you find it, stick with it. Don't forget the "three C's" of making PC boards—care, cleanliness, and consistency.

Finally, we would like to hear how you make out using our method. Write and tell us of your successes, and failures, and what techniques work best for you. Address your letters to:

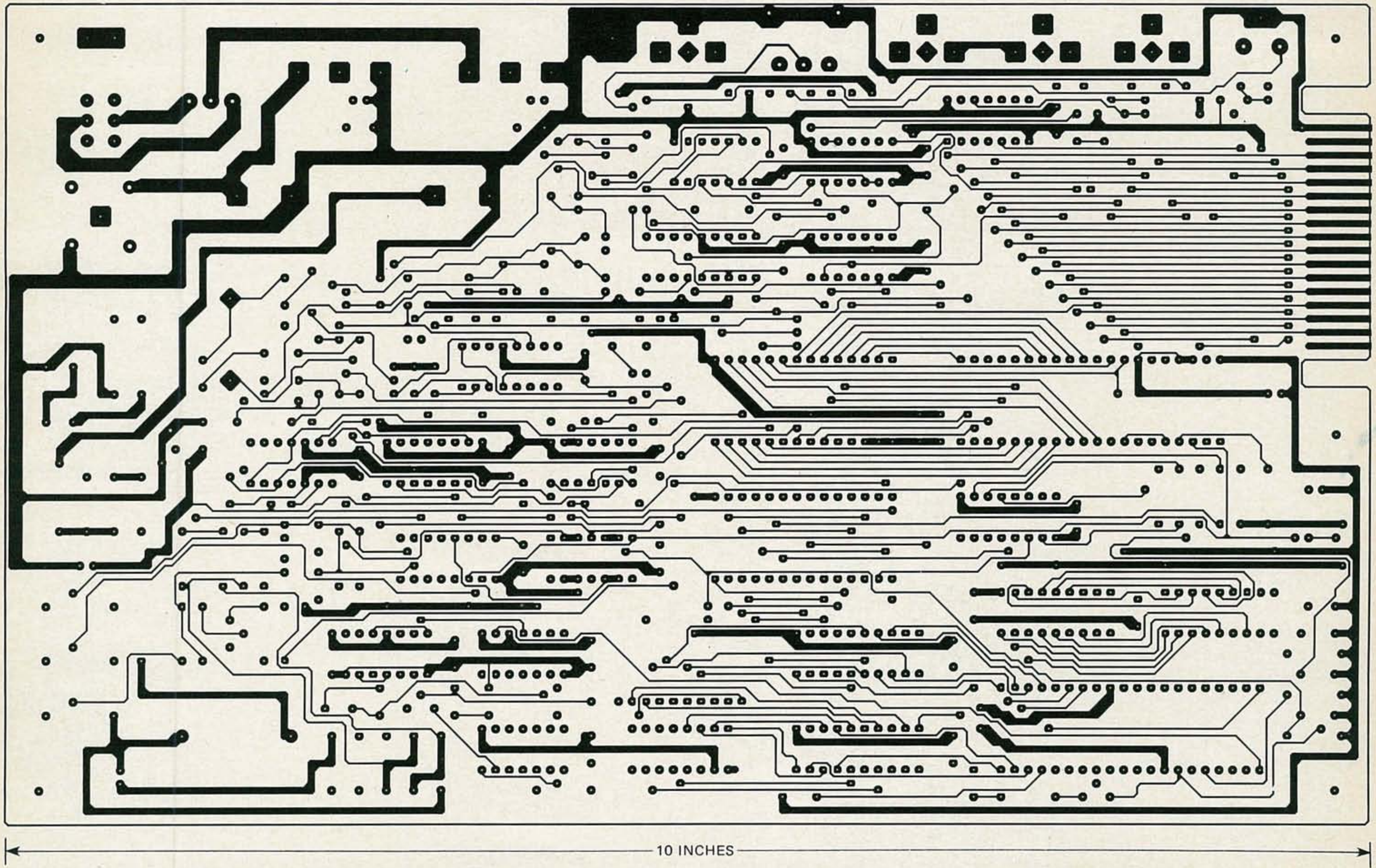
Radio-Electronics
Department PCB
200 Park Avenue South
New York, NY 10003



THE DISPLAY BOARD for the home-security system is shown here as a full-size mirror image. This side of the page must be toward the board you expose.

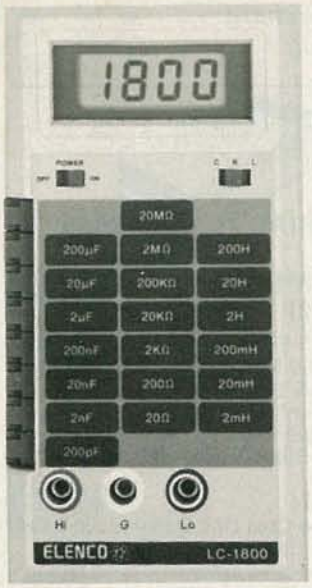


COMPONENT SIDE OF THE VIDEO TITLER BOARD is shown here as a full size mirror image. This pattern, and the others shown in this section, must be placed face down on a positive-etch resist board.



THE SOLDER SIDE OF THE VIDEO TITLER BOARD is shown here as a full-size mirror image. Turn to page 49 for more information on the titler.

ELENCO PRODUCTS AT DISCOUNT PRICES!



DIGITAL LCR METER

Measures Inductance, Capacitance and Resistance

At Last! An LCR meter that everyone can afford. Now you can measure coils, transformers, chokes from 1μ H to 200 H, capacitors from .1 pfd to 200 mfd and resistors from .01 ohms to 20 megohms. All in one handheld instrument.

NEW

MODEL LC-1800

$148

SPECIFICATIONS

Capacitors	
Range	• 200 pF, 2 nF, 20 nF, 200 nF, 2 μF, 20 μF, 200 μF
Resolution	• 0.1 pF, 1 pF, 10 pF, 100 pF, 1 nF, 10 nF, 100 nF
Accuracy	• < 0.5 μF ± (2% + 1 dgt) > 0.5 μF ± (3% + 1 dgt)
Inductance	
Range	• 2 mH, 20 mH, 200 mH, 2 H, 20 H, 200 H
Resolution	• 1 μH, 10 μH, 100 μH, 1 mH, 10 mH, 100 mH
Accuracy	• ≤ 0.5 H + (3% + 1 dgt) > 0.5 H ± (5% + 1 dgt)
Resistance	
Range	• 20, 200, 2 k, 20 k, 200 k, 2 M, 20 MΩ
Resolution	• .01, .1, 1, 10, 100, 1 k, 10 kΩ
Accuracy	• <1 M Ω ± 1% + 1 dgt

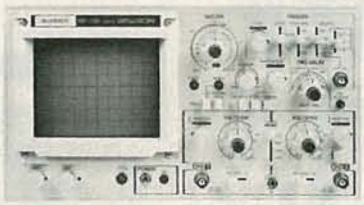
GF-8016 Function Generator with Freq. Counter

$229

- Sine, Square, Triangle,
- Pulse, Ramp, .2 to 2 MHz
- Frequency .1 thru 10 MHz

GF 8015 without Freq. Meter $169

35 MHz Dual Trace Oscilloscope



$550 **Model MO-1252**

- Delayed Trigger
- 2 Year Guarantee
- 2 Probes Included

MO-1251 20 MHz Dual Trace $385.00

AC Current Meter

$98 **Model ST-1000**

- Reads 20, 200, 1000 A
- DC & AC Volts, Resistance
- 3½ LCD Digits
- Deluxe Carry Case

True RMS 4½ Digital Multimeter

$135 **Model M-7000**

- .05% DC Accuracy
- .1% on Resistance
- .5% True RMS AC
- .5% Freq. Counter 1-200 kHz
- Deluxe Case Included

AC Current Meter

$48 **Model ST-310**

- Reads 300 Amps (5 ranges)
- DC & AC Volts, Resistance
- Case & Leads Included

3½ Digital Multimeter

$25 **Model M-1600**

- 1% DC Accuracy
- 1% on Resistance
- 1.5% AC Accuracy
- Reads 10 DC Amps

C&S SALES, 8744 W. North Ter.
Niles, IL 60648 • (312) 459-9040

VISA MasterCard

15 DAY MONEY BACK GUARANTEE

2 Year Limited Guarantee! Add 5% for Postage ($10 Max.), Ill. Res., 7% Tax

CIRCLE 279 ON FREE INFORMATION CARD

ASSOCIATED RESEARCH, INC. B+K PRECISION BMI DATA PRECISION

RAG ELECTRONICS, INC.

New and Used Electronic Test Equipment
Sales • Service • Rental • Leasing

LOGICAL SHOOTER LOW-COST EPROM BLASTER

- Ideal for Hobbyists or Light Usage
- 128K RAM Buffer
- Build-In RS-232 Port
- Completely Assembled & Tested
- Programs 2716 through 27256
- Fast Intelligent Algorithm
- Works with Any Computer or Dumb Terminal
- Stand-Alone Mode. Copies and Verifies
- Upload/Download in Intel/Motorola/ Binary Formats
- 90 Day Warranty Parts & Labor

$395.00

INDUSTRIAL MODEL WITH TIMER

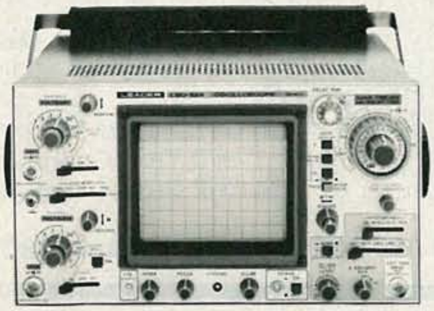
MODEL T8/2T **$97.50**

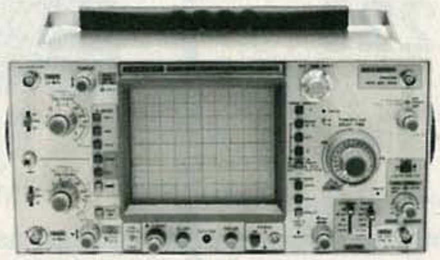
- Erases 15 EPROMs in 20-30 Minutes
- Rugged 60 Minute Auto Shut-Off Timer and Safety Interlock
- 5" x 8" Tray with Indicator
- Conductive Pad
- Attrative Steel Enclosure

MODEL T8/1 **$49.95**

This is a Low Cost Unit Designed in a Two Part Plastic Case.
This unit erases as many as 8 EPROMS in 15-20 minutes.

LEADER Instruments Corporation PORTABLE OSCILLOSCOPE





LBO 524L DC to 40 MHz

The LBO-524L is designed to meet a broad range of applications in design, testing and servicing of both analog and digital circuits and equipment. Its large 8x10 cm PDA CRT provides sharp, bright displays even at highest sweep rates. Comprehensive triggering controls including holdoff, alternate triggering and delayed sweep triggered functions permit stable displays for even the most complex signals. With 0.5 millivolt sensitivity, extremely low-level signals can easily be observed. A channel 1 output is available on the rear panel to drive other less sensitive instruments such as a frequency counter with an input level as low as 500 microvolts. The dual time base permits accurate observation and time interval measurements of complex waveforms. Includes probes and 2 year warranty.

$749.00 *Plus free Hitachi DMM. See page 5.*

LBO-516 DC to 100 MHz

The LBO-516 is an economical 100-MHz, 3-channel, alternate time base oscilloscope. It has all of the important features that are expected in a 100-MHz oscilloscope such as full front panel operation, alternate triggering for simultaneous view of asynchronous signals and independent or simultaneous display of main and delayed time bases. The bright 20-kV PDA CRT and 0.5mV sensitivity permit sharp, bright displays of even those normally tough to see critical signals.

Eight trace capability is possible by displaying main and delayed versions of CH-1, CH-2, CH-3, and CH-1+CH-2. Also included are comprehensive triggering facilities with video sync separators, variable trigger holdoff, excellent trigger sensitivity and more. Includes probes and 2 year warranty.

$1195.00 *Plus free Hitachi DMM. See page 5.*

B+K PRECISION FUNCTION GENERATOR

MODEL 3010 **$189.00**

- Sine, square and triangle output
- Variable and fixed TTL outputs
- 0.1 Hz to 1 MHz in six ranges
- Typical distortion under 0.5% from 1 Hz to 100 kHz
- Variable DC offset
- VCO input for sweep tests

ESCORT

3½-Digit Capacitance Meter

Range: 200PF - 20mF

MODEL EDC110A **$89.00**

Accuracy:
20PF-20uF ±(0.5%rdg+1dgt+0.5PF)
200uF ±(1.0%rdg+1dgt)
2000uF-20mF ±(2.0% rdg+ 1dgt)

LICATEK 30 VDC POWER SUPPLY

$135.00

MODEL 30-3/0-30 VDC/0-3A

NOW OPEN! Saturday, 9:00 a.m.-3:00 p.m.
Monday - Friday, 6.30 a.m.-5:30 p.m.

CIRCLE 276 ON FREE INFORMATION CARD

CALL US TOLL FREE
1-800-732-3457
IN CALIFORNIA TOLL FREE
1-800-272-4225

- Master Charge
- VISA ■ COD
- Money Order
- Check

ADD FOR SHIPPING AND INSURANCE	
$0 to $250.00	$4.50
$251.00 to $600.00	$6.50
$501.00 to $750.00	$8.50
$751.00 to $1000	$12.50
over $1000.00	$15.00

Prices subject to change without notice.

RAG ELECTRONICS, INC. / 21418 Parthenia Street/Canoga Park, CA 91304 / 1-818-998-6500

IWATSU KEITHLEY LEADER Instruments Corporation LOGICAL OK Polar

FLUKE · GLOBAL SPECIALTIES · HAMEG · HHSmith · HITACHI Hitachi Denshi, Ltd

HITACHI 3.5 Digit DMM FREE with any Scope purchased from RAG. See page 5 for details.

HITACHI Hitachi Denshi, Ltd — CCTV Cameras & Monitors

MODEL KP-120

MODEL HV-720

Meet the new generation of TV cameras that brim with useful features, thanks to the MOS solid-state imaging devices.

- Compact size and light weight
- Long life and high reliability
- Extreme low-light handling capabilities
- No geometric distortion
- Reduced lag and no sticking
- Excellent immunity to vibration and shock
- No effects of magnetic fields
- Sensitive to near-infrared
- C mount

MODEL KP-120 Camera Head
Lenses available

$775.00

- Owing to the use of an automatic sensitivity adjusting circuit, the only necessary camera operation is focusing
- A white suppressor circuit ensures faithful reproduction on the video monitor, even for subjects with stong contrast.
- Camera mounting screws are provided at the top and bottom of the camera, facilitating mounting of the camera.
- Switchover to external synchronization takes place automatically when an external drive signal is input, hence no switch operation is necessary.*
- Synchronizing System: Line-lock 2:1 interlace.
- Pick-up tube: Vidicon tube.
- Includes 16mm f1.6 lens

MODEL HV-720	**$144.00**
***MODEL HV-730**	**$199.00**

B&W MONITORS

VM-900A	9"/500 line/video loop	$126.00
VM-910	9"/500 line/video loop/ DC restoration/rack mountable	$164.00
VM-906	9"/700 line/video loop/ DC restoration/rack mountable	$210.00
VM-129	12"/700 line/video loop/ DC restoration	$276.00
VM-173	17"/700 line/video loop/ DC restoration	$312.00

SOLDERING STATION

SA-3-115 **$84.00**

Special tip-mounted sensor and sophisticated control circuitry. Temperature stability within 5% over the range of 100°C to 500°C (200°F to 930°F). For 115 VAC. 50/60 Hz operation; 230 VAC model also available. Lighted power and heater indicators, proportional temperature control and temperature indication meter, iron holder and tip cleaning sponge standard. Rugged, compact enclosure. Supplied with special 24 volt, 48 watt, low-leakage iron and SAT-3-01 (1/32 inch) conical tip.

MULTI-FUNCTION COUNTER

MODEL WD-755 **$248.00**

- 5 Hz to 125 MHz
- 8 Digit LED Display
- Period Measurement 5 Hz to 2 MHz
- Totalizes to 99,999,999 Plus Overflow
- Frequency Ratio Mode
- Time Interval Mode
- Switchable Attenuator & Low Pass Filter

POWER SUPPLY SALE

WP-705A single 0-50VDC, 0-2A
WP-706A single 0-25VDC,0-4A
WP-707A dual 0-25VDC, 0-2A
WP-708A triple 2 each 0-20VDC, 0-2A and 5V, 4A
WP-709A single 3.5-6.5VDC or 11.5-14.5VDC, 0-7.5A

- Automatic short circuit shutdown
- Ripple 5mV P-P
- 0.075% regulation
- Digital meters V&A
- Measure external 0-99.9 VDC
- Isolated supplies

WP-705A	**$309.00**
WP-706A	**$318.00**
WP-707A	**$369.00**
WP-708A	**$453.00**
WP-709A	**$326.00**

B+K PRECISION TRIPLE OUTPUT POWER SUPPLY

MODEL 1650 **$319.00**

- Functions as three separate supplies
- Exclusive tracking circuit
- Fixed output 5 VDC, 5A
- Two 0 to 25 VDC outputs at 0.5A
- Fully automatic, current-limited overload protection
- + and − terminals of each output are fully isolated, in all modes
- All three outputs may be connected in series or parallel for higher voltage or current

CIRCLE 276 ON FREE INFORMATION CARD

POWER DESIGNS · Simpson · PRIMELINE A SOLTEC PRODUCT · STACO ENERGY PRODUCTS CO · VACO · VIZ · WAYNE KERR

ROBOTICS

MARK J. ROBILLARD
ROBOTICS EDITOR

Robots and voice recognition

THERE ARE FEW THINGS MORE FRUSTRATING than buying one of today's high-tech home appliances and finding out that you have to sit down and read the manual simply to turn the machine on, much less to use it. The ever-increasing performance we demand from our appliances is making it difficult to perform even simple tasks with those machines. And the problems we have communicating with home appliances are miniscule in comparison with the problems we have communicating with robots. But the two are similar in that both involve communication from a living being to an electro-mechanical device.

If you've had an opportunity to work (or play) with a hobby robot, I'm sure you're well acquainted with the fact that there are more than a few not-so-trivial commands to master. Home robots are intended to be used by electronics hobbyists who are familiar with many concepts of computer programming. However, the hobbyist might welcome an easier method of communicating with his robot than the cryptic control language usually provided by the manufacturer. (I think that the popularity of Apple's MacIntosh computer also illustrates the point that many people are looking for a more natural way of interacting with computers.) There is no inherent reason for robot communication to occur in a highly technical language.

Communication levels

There are basically three levels of communication: The lowest level is called the device level. From there we move up to the pro-

tocol level, and finally to the presentation level.

The device level is probably most familiar to electronics hobbyists. At that level are the actual electrical connections between two communicating parties. The famous (or infamous) RS-232C is one much-used device-level communications standard. It specifies voltage levels and timing sequences for the serial transmission of data among computers, peripheral devices, and other computers. Since it involves serial transmission, only a few electrical connections are necessary. That may be an advantage when mobility is important—as in robot control.

There are other device-level interfaces by which we might communicate with a robot (parallel, HPIB, RS-422, etc.), but what is important is to bridge the gap from device- to presentation-level communications, that is, the level at which information is presented to human beings. One very effective means of communication is oral. For example, programming your robot by simply stating the commands is probably one of the most desired items on many wish lists.

You might say "keep dreaming," but I've just been playing with the neat voice-recognition system shown in Fig. 1. It sells for only $99; it's called EARS (for Electronic Audio Recognition System); and it requires a separate personal computer to operate. It's available from Speech Systems, 38W 255 Deerpath Road, Batavia, IL 60510.

The reason I'm so impressed with EARS is that in my office I have a voice-recognition system that cost well over $5000 when it was introduced, and the accuracy of the new unit appears to be better than that of the higher-priced system. EARS is also more versatile.

The CoCo connection

I do a tremendous amount of robot-control work using a simple *TRS-80 Color Computer* (CoCo for short). The 64K model sells for well under $200, and it has the most advanced graphics BASIC of all the eight-bit personal computers. The 6809-microprocessor bus is accessible through a cartridge port connector, and the EARS system plugs directly into that bus.

Because the system is well integrated into the *Color Computer*, voice recognition can be an integral part of your BASIC programs. So it is simple to write a program to recognize your spoken commands and translate them to the commands required by your robot. Those commands could then be sent out the *Color Computer's* RS-232 port to your robot. You can train EARS to recognize 64 different words, sounds, musical notes, etc.

The voice-recognition hardware is contained in a small module that

Do you hear bullets ricocheting across your living room, or turbulent waterfalls crashing down the stairs when you watch TV?

If you hear dump trucks roaring across your living room, cannons exploding all around you, and rain drops splattering the floor when you watch TV, then you probably already have a Teledapter. However, if you don't, read on.

If you have a TV and a stereo system you can enjoy the excitement you've been missing...now! The Teledapter's unique electronics will combine your TV and stereo into a powerful entertainment center that would easily cost thousands of dollars.

Imagine having the best front row seats in town for ball games, musicals, and movies.

Teledapter works with any TV, VCR, or satellite receiver, regardless of age or model, and conveniently plugs into the auxiliary, tape, or tuner input on any stereo amplifier or receiver system.

All TV, satellite, cable, and VCR programs will have the same powerful sound as your stereo system and speakers.

FEATURES

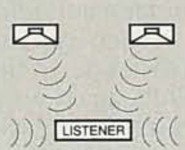
Stereo-Plex™ Circuitry is for all those mono TV's and VCR's. It transforms their mono sound into sparkling two-channel stereo effects. Got a stereo TV or VCR? No problem. Just plug them in. Since most TV and cable programming is mono, the Stereo-Plex circuitry will pick up where your stereo TV or VCR stops short.

Mono sounds, even when played through two speakers, appear to come from one direction (the center).

Stereo sounds come from two directions.

The stereo/mono test is really simple; plug the Teledapter up, push the mono-stereo button on your stereo. When you go from mono to stereo, listen to the sounds spread out across the room. Perform the test without a Teledapter and a mono signal will remain in the center.

Ambiance and Spatial Circuits expand a stereo signal to greater separation than it normally has.



At the same time, indirect delayed signals and echoes are accentuated.

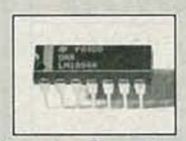
DNR® is the latest marvel in noise reduction. It works with all mono or stereo programs, and preserves the Teledapter's excellent 20 to 20,000Hz frequency response.

Tape Monitor Loop allows all the features of Teledapter to be used with all other stereo or mono components, FM, tapes, records, AM, etc.

Other Features include up to four mono or stereo inputs, input level control, isolated and protected low impedance input, and a beautiful walnut and anodized aluminum cabinet. This unit will serve you for years.

NO MAGIC—JUST HIGH TECH

Technology using the latest integrated circuits and manufacturing techniques, are combined in an instrument designed and built in America, from the company that invented *Good TV Listening*™



THE MANUFACTURER

For over 12 years we've manufactured TV audio products for home and industry with the best standards we know.

Offering our products direct enables you to make sure that the sales person you speak to is able to answer your questions knowledgeably. And if a Teledapter ever needs service, it will be done quickly, and it will be done correctly.

Teledapter comes complete with all cables, instructions, and a FREE HELP-line phone number.

*DNR is a registered trade mark of National Semiconductor Company.

TRY THE TELEDAPTER AT NO RISK

Take the first 30 days with Teledapter™ as a test. If you're not completely satisfied, return it for a complete refund and your mailing costs. You can't lose.

Teledapter™ is also backed with a two-year warranty on parts and labor.

Teledapter™ TE-600, $145.00 plus $4.00 postage and handling.

TOLL FREE 1-800-251-8608
In Tennessee Call Collect
1-615-381-9001

VISA 24 HOURS MasterCard

Send mail orders to address below. Credit card and money orders processed immediately. Checks require 18 days.

RHOADES
NATIONAL CORPORATION
Department 204
Highway 99 East • P.O. Box 1316
Columbia, TN 38402

Turn your TV into a powerful entertainment center with the STEREO TELEDAPTER®

CIRCLE 284 ON FREE INFORMATION CARD

consists of a PC board with a General Instrument SP1000 IC, and assorted bus-interface circuitry. The manufacturer provides a useful control program and several useful demonstration programs. Also, an optional speech-synthesis unit is available at extra cost.

The control program gives fifteen new commands to the *Color Computer's* BASIC. The most important are LISN and MATCH. For example, if you want the computer to learn how you pronounce the word *robot*, you type LISN "ROBOT". The computer and EARS then wait for you to say "robot" into the microphone (which is provided with EARS). Your voice is sampled, stored in memory, and it will be associated from then on with the string "ROBOT". You may save the word patterns in memory to disk or tape and reload them later.

When you type the command LISN:MATCH, the computer and EARS again wait for you to speak, but this time, your speech sample is compared to all the patterns you have stored in memory. The string representing the closest match will be returned.

Remote communication

Using a computer to control your robot from a remote location is useful, but it might be even more useful to build your robot with a computer as its (local) brain. I know what you're thinking, but the answer is no, you don't need a 117-volt AC power source for the computer! Many computers use only five volts internally. A twelve-volt car battery with a suitable DC-to-DC converter will work just fine. In fact, next month we'll look into ways of doing just that. **R-E**

Electronics Paperback Books

NEW OFFERINGS AT SPECIAL INTRODUCTORY PRICES

☐ WRITE ZX SPECTRUM GAMES PROGRAMS ..... Reg Price ~~[illegible]~~ NOW ONLY $5.00. Step-by-step guide shows how to write graphics games.

☐ INTO THE QL ARCHIVE ..... Reg Price ~~[illegible]~~ NOW ONLY $5.00. How you can use this database program supplied with the Sinclair QL.

☐ ART OF PROGRAMMING THE ZX SPECTRUM ..... Reg Price ~~[illegible]~~ NOW ONLY $6.25. Using BASIC to make your Spectrum do clever things.

☐ 20 PROGRAMS FOR ZX SPECTRUM & 16K ZX81 ..... Reg Price ~~$5.00~~ NOW ONLY $4.00. Programs with flow charts. Card games, Battleships, Calendar, and more.

☐ LINEAR IC EQUIVALENTS AND PIN CONNECTIONS ..... $12.50 (shipping free). 247 pages, 7 × 10-in, shows equivs and pin connections for popular user oriented ICs.

☐ ELECTRONIC PROJECTS USING SOLAR CELLS ..... Reg Price ~~$5.00~~ NOW ONLY $4.00. Simple circuits powered by the energy of the sun.

☐ ELECTRONIC HOUSEHOLD PROJECTS ..... Reg Price ~~[illegible]~~ NOW ONLY $3.75. Includes 2-tone Door Buzzer, Auto Porch Light, Lamp Dimmer, and more.

☐ INTRODUCTION TO VIDEO ..... Reg Price ~~$5.00~~ NOW ONLY $4.00. For the person who has just or is about to buy a video recorder.

☐ ELECTRONIC SECURITY DEVICES ..... Reg Price ~~$5.00~~ NOW ONLY $4.00. Three basic sections. Switch activated alarms; infra-red & ultrasonic systems; smoke, gas, water detection.

☐ ELECTRONIC GAMES. Reg ~~[illegible]~~ NOW $3.50.
☐ BUILD SW RADIO RCVRS. Reg ~~$5.00~~ NOW $4.00.
☐ 50 LED CIRCUITS, Bk 2. Reg ~~[illegible]~~ NOW $3.25.
☐ INTRO TO 6502 MACHINE CODE. Reg ~~$5.00~~ NOW $4.00.

☐ THE PRE-BASIC BOOK. Reg ~~[illegible]~~ NOW $5.50.
☐ BUILD TREASURE LOCATORS. Reg. ~~[illegible]~~ NOW $4.00.
☐ AUDIO AMPLIFIER CONSTRUCTION. Reg ~~[illegible]~~ NOW $4.50.
☐ AUDIO PROJECTS. Reg ~~$5.00~~ NOW $4.00.

☐ SECRETS OF THE COMMODORE 64. ..... $5.00. Masses of useful info and programming tips not found in any user's manual.

☐ INTRO TO PROGRAMMING THE ATARI 600/800 XL ..... $5.00. Perfect complement to the Atari user's manual. Even shows how to use animated graphics.

☐ COMPUTER TECHNOLOGY EXPLAINED ..... $5.00. Explanations for computer terms often encountered. A dictionary for computer lingo.

☐ INTRO TO Z-80 MACHINE CODE ..... $5.75. Speed up your programs. They may be harder to write, but it's worth learning how. Some demo programs are included.

☐ MICRO INTERFACING CIRCUITS—BOOK 1 ..... $5.00. Practical add-ons transform your computer into control or measurement equipment.

☐ MICRO INTERFACING CIRCUITS—BOOK 2 ..... $5.75. Interfacing sound and speech generators, temperature and optical sensors, motor controllers, and more.

☐ ANTENNA PROJECTS ..... $5.00. Practical radio antenna designs that deliver good performance and are relatively simple and inexpensive to build.

☐ WHITE'S RADIO LOG.....$4.94. An up-to-date directory of AM, FM and TV stations, including a section on worldwide shortwave stations.

☐ CONFIDENTIAL FREQUENCY LIST, 6th edition. ..... $13.95. Latest info on usual and exotic shortwave broadcast stations.

☐ INTRODUCTION TO RADIO DXING ..... $5.00. How to optimize the reception of distant short-wave broadcast and amateur stations.

☐ 25 SIMPLE AMATEUR BAND ANTENNAS ..... $5.00. All kinds of antennas for all kinds of amateur radio reception.

☐ INTRODUCTION TO RADIO DXING ..... $5.00. Get into this fascinating hobby. This book tells you just about everything you need to know to get started.

Quality Paperbacks

☐ LONG DISTANCE TV DXING ..... $5.00. A practical and authoritative introduction to this unusual aspect of electronics.

☐ HOW TO DESIGN ELECTRONIC PROJECTS ..... $5.75. How to use standard circuit elements to make custom electronic projects.

☐ HOW TO GET YOUR ELECTRONIC PROJECTS WORKING ..... $5.00. How to find the faults in your projects, repair them and get them working.

☐ DESIGN & MAKE YOUR OWN PC BOARDS ..... $5.75. Everything you need to know before you make printed-circuit boards for your projects.

☐ ELECTRONIC SCIENCE PROJECTS ..... $5.75. Simple to complex, a group of projects with a strongly scientific flavor.

☐ CRYSTAL SET CONSTRUCTION ..... $4.50. A variety of crystal radio receivers for the experimenter and hobbyist.

☐ HANDBOOK OF IC EQUIVALENTS AND SUBSTITUTES ..... $5.00. Includes digital and linear IC's made in US, Great Britain, Japan, etc.

☐ INTERNATIONAL TRANSISTOR EQUIVALENTS ..... $7.50. Locates possible substitutes for a popular user-oriented selection of modern transistors. Japanese, European and American types.

☐ PRACTICAL ELECTRONIC BUILDING BLOCKS. Book 1 ..... $5.75. Build the blocks and then combine them to form almost any custom project of your choice.

☐ PRACTICAL ELECTRONIC BUILDING BLOCKS. Book 2 ..... $5.75. Amplifiers of all kinds to add to the circuits from Book 1 of this series.

☐ MICROPROCESSING SYSTEMS AND CIRCUITS ..... $7.50. Guide to the elements of microprocessing systems. Teaches all the fundamentals.

☐ PRACTICAL ELECTRONICS CALCULATIONS AND FORMULAE ..... $7.50. A workshop manual that bridges the gap between complicated tech theory and cut and try.

Affordable Prices

☐ FIRST BOOK OF DIODE CHARACTERISTICS, EQUIVS, AND SUBS ..... $5.00. Shows full interchangeability data for thousands of diodes.

☐ MODERN OP-AMP PROJECTS ..... $5.00. Includes a Slide Timer, AF Signal Gen, Mike Preamp, Scratch Filter, and much more.

☐ ELECTRONIC SYNTHESIZER PROJECTS ..... $4.50. How to assemble the elements of a synthesizer and then put them all together.

☐ ELECTRONIC TIMER PROJECTS ..... $5.00. Timing circuits to fit just about every application. Required for every experimenter.

☐ ELECTRONIC MUSIC AND CREATIVE TAPE RECORDING ..... $5.00. Shows how you can make electronic music at home with simple and inexpensive equip.

☐ COUNTER DRIVER & NUMERICAL DISPLAY PROJECTS ..... $4.50. Numerical indicator devices make it easy to count, divide and display.

☐ SINGLE IC PROJECTS ..... $4.25. All projects in this book are based on one IC and are simple to construct. Great way to get started with IC's.

☐ POPULAR ELECTRONIC PROJECTS ..... $4.75. A collection of a wide range of electronic projects and circuits for the experimenter.

☐ IC PROJECTS FOR BEGINNERS ..... $5.00. Written especially for the less experienced experimenter. Complete parts layouts and wiring diagrams.

☐ POPULAR ELECTRONIC CIRCUITS. Book 1 ..... $5.00. More circuits for hobbyists. Audio, radio, test, music, household and more.

☐ 555 PROJECTS ..... $5.00. So useful that this IC has an unparalleled reputation. Here's a book full of useful applications.

☐ POPULAR ELECTRONIC CIRCUITS. Book 2 ..... $5.75. More useful circuits. None of these projects duplicate those in Book 1 of this series.

CHECK OFF THE BOOKS YOU WANT

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

RE 1-6

Name ______________________
Address ______________________
City __________ State __________ Zip __________

*Canadian Shipping ($1.50 1st two books 50¢ ea. additional)

Number of books ordered ☐

Total Price of Books .... $______

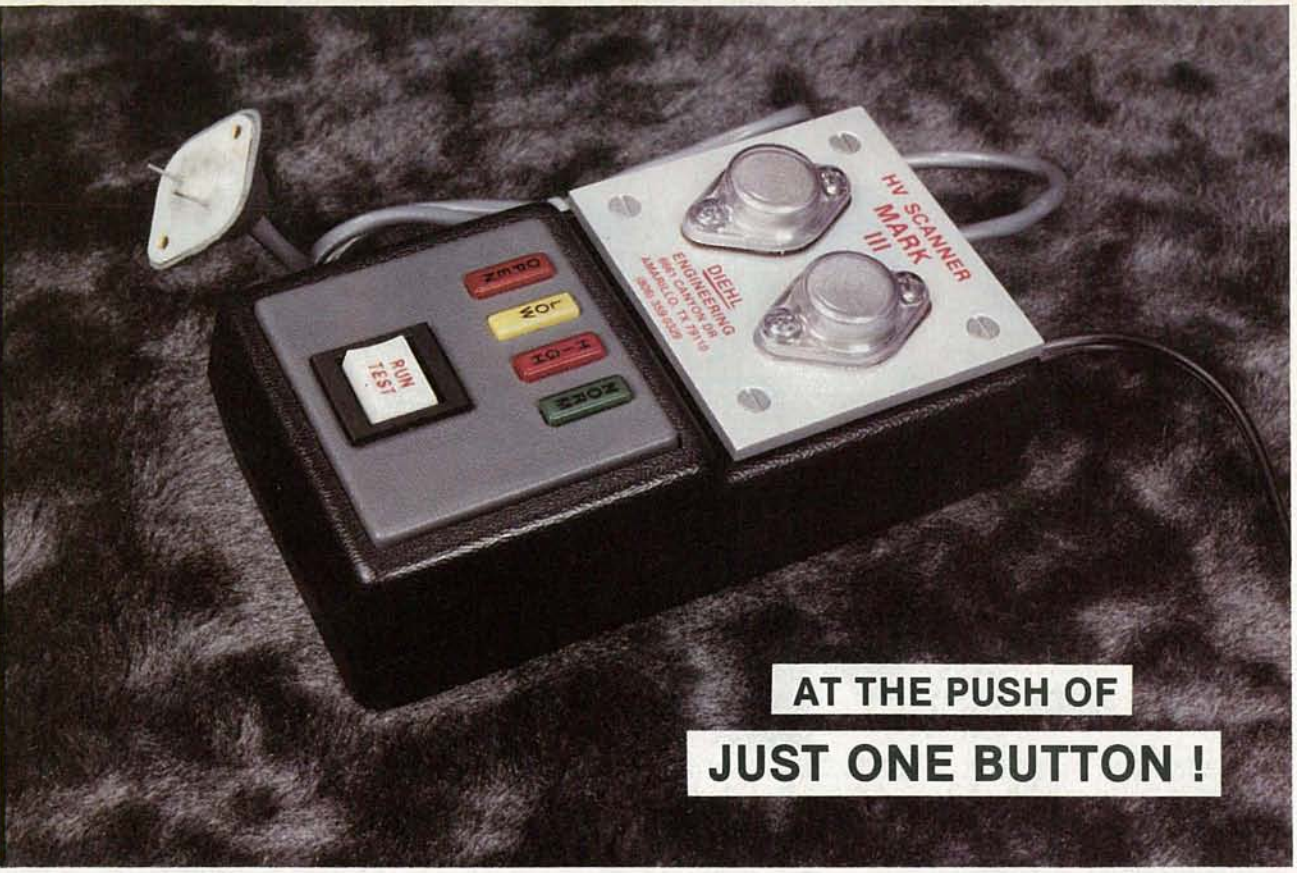
Sales Tax (NY State Residents) .... ______

*Shipping in U.S. only
($1.00 1st two books, 40¢ ea additional) .... ______

TOTAL ENCLOSED .... $______

CIRCLE 302 ON FREE INFORMATION CARD

FAST AND EASY



THE MARK III

HV CIRCUIT SCANNER

- ★ Checks the horiz output circuit for open / shorts,
- ★ Checks the flyback, yoke, PC, and HV mult,
- ★ Checks all scan derived B + sources,
- ★ Checks all circuits that rely on scan derived B + voltage,
- ★ Checks for open safety capacitor,
- ★ Checks the emitter circuit of the horiz output,

THEN,

- ★ Provided the green normal light is lit, the Mark III will safely power up the TV set so that **you** can "look" for open circuits by examining the picture on the CRT.
- ★ Circumvents all start up and horiz drive related shut down circuits.

APPLICATIONS: The Mark III will analyze the horiz, flyback, hi-voltage, scan derived B + sources, yoke, pin cushion, HV multiplier circuits in any TV set that employs either an **NPN** transistor or a single **SCR** for its horiz output device. This applies to any age, any model, any chassis, any brand - - - including Sony.

In brief, the "test" function scans for shorts, the "run" function permits you to observe any "open" circuits via the symptoms that appear in the CRT screen.

HOOK - UP: Simply remove the set's horiz output device and replace it with the scanner's interface plug. No wires to disconnect, no other connections required (not even a ground connection).

MISTAKE PROOF: No damage will result if an error is made during hook up. The scanner simply won't turn on until the error is corrected.

PUSH THE TEST BUTTON Just one of the four lights will lite.

RED OPEN LIGHT means the emitter circuit of the horiz output stage is open (no ground path).

YELLOW SHORT LIGHT means the flyback primary, HV multiplier, vertical output, horiz driver, and R-B-G color output stages are **not** shorted. Instead, a circuit that normally draws a small amount of current is shorted (i.e. the tuner, IF, AGC, video chroma, matrix, vertical or horiz oscillator).

RED SHORT LIGHT means either the flyback, the HV multiplier, the vertical output, horiz driver or one of the **R-B-G** output transistors is shorted.

GREEN NORMAL LIGHT means the TV set's entire flyback circuit is totally free of shorts. It also means that it is safe to power up the TV set with the "run" button so that you can look for open circuits by observing the symptoms on the CRT screen.

FEATURES: All **start up** circuits and all horiz drive related **shut down** circuits are automatically circumvented by the Mark III during all test and run functions. During the test function all flyback secondary output is limited to approx 80% of normal. 2nd anode voltage is limited to approx 5 KV.

This means all circuits that are not shorted will have some 80% of thei normal B + voltage during the "test" phase. It also means that an shorted circuit will have zero DC volts on it. This feature makes an short easy to isolate.

The MARK III sells for only 595^{00}

The money you are now spending for unnecessar flybacks alone will easily pay for your Mark III. Wh not order yours today!

Visa and Mastercharge Welcome !

Diehl Engineering • 6661 Canyon Drive "F" • Amarillo, TX 7911
Phone: (806) 359-0329 or (806) 359-1824

A M A Z I N G

- ★ Checks the horiz output stage for opens / shorts,
- ★ Checks flyback, yoke, PC, and HV mult,
- ★ Checks all scan derived B+ sources,
- ★ Checks for open safety capacitors
- ★ Checks for open ground path for horiz output stage
- ★ Checks for open primary LV supply,
- ★ Checks for error in interface connections,
- ★ Checks for proper LV regulation,
- ★ Checks for proper start up circuit operation,
- ★ Checks for shorted horiz driver transistor,
- ★ Checks the operation of the horiz osc / driver circuits,
- ★ Checks B+ "run" supply for the horiz osc / driver circuits,
- ★ Checks all circuits in the TV set that rely on scan derived B+,
- ★ Automatically circumvents all start up circuits and horiz drive related shut down circuits.

HOOK UP: (Identical to Mark III)

OPERATION: Turn the Mark V on, turn the TV set on, then, simply look at the lights.

RED "HOOK UP" LIGHT means that you have made an error in hook up. No damage has been done, correct the problem then continue.

RED "EMITTER" LIGHT means that the ground path for horiz output stage is open. Correct the problem then continue.

RED "B+ OPEN" LIGHT means that the primary LV supply in the TV set is open. Correct the problem then continue.

No "top row lights" equals normal.

Look at the middle row of lights

RED "START UP" LIGHT means that the start up circuit in the TV set is not working (no start up pulse).

GREEN "START UP" LIGHT means the start up circuit in the TV set is working normally. Yes, it is 100% accurate. Even on Zenith's single pulse start up circuit !

RED "HORIZ DRIVE" LIGHT with a green start up light means that the horiz driver transistor in the TV is shorted (E to C).

GREEN HORIZ DRIVE LIGHT means that the horiz oscillator and driver circuits are operational.

READ THE DC VOLTAGE METER THEN,

PUSH THE TEST BUTTON

If the meter comes up to, or, falls back to, factory specified DC collector voltage, the LV regulator circuit is working. If it fails to do so, it is not working!

RED "B+ RUN" LIGHT means that the B+ source that normally keeps the horiz osc / driver circuits running after the start up B+ pulse has been consumed has become open.

GREEN "B+ RUN" LIGHT means that the B+ resupply voltage (scan derived) is being provided. All is normal if all three lights are now green.

The scan circuit short detector in the Mark V is identical in all ways to that which is used in the Mark III. Operation is also identical. Both units are virtually indestructable when simple directions are followed. Both units carry a full year's warranty against defects in materials and workmanship (parts and labor). Either unit can be easily repaired by almost any technician in his own shop.

If the green "circuits clear" light is now lit

It is now safe to push the "run" button and examine the symptoms that appear on the CRT screen, for the purpose of isolating any "open" circuits.

Except for hook up and CRT filament warm up time, this test can easily be completed in two to five seconds!

The Mark V sells for only $995⁰⁰

Stop losing money on start up / shut down scan derived B+ problems; order your Mark V today!

Visa and Mastercharge Welcome !

Diehl Engineering • 6661 Canyon Drive "F" • Amarillo, TX 79110
Phone (806) 359-0329, or (806) 359-1824

SATELLITE TV

BOB COOPER, JR.
SATELLITE TV EDITOR

C, Ku, and DBS

MOST DISCUSSIONS OF SATELLITE TV center on the 3.7- to 4.2-MHz C-band that was originally allocated (in the early 1960's) to international satellites like Intelsat. Unfortunately, the C-band is shared with point-to-point microwave-transmission systems, like the one shown in Fig. 1, that are operated by the nation's telephone carriers (AT&T, GTE, MCI, and others).

From a historical perspective, the telephone-company microwave circuits were there first, and satellite TV was allocated shared use of the C-band, provided that the satellite systems didn't interfere with the terrestrial services.

There have been no documented occurrences of a C-band satellite-TV transmission causing interference with a terrestrial microwave circuit. The main reason is that satellite transmitters, located more than 22,000 miles above the equator, simply are not powerful enough to interfere with a terrestrial microwave link receiving a signal from a transmitter 20, 30, or even 60 miles away.

To ensure that shared use of the C-band does not cause interference, the FCC (and similar agencies in other countries) have required satellite transmitters to *dither*, or time-vary, their operating frequency. Dithering disperses transmitter power by radiating it across a range of frequencies, rather than emitting it all on a single frequency. That procedure is similar to the armed forces' spread-spectrum technique. The result is that the total power output of a transmitter is never delivered to a single frequency in the spectrum at any given instant in time.

Further, terrestrial systems are line-of-sight, and they are never aimed "up" at a satellite. As any home-TVRO owner knows, even the slightest misalignment of a dish causes a total loss of received signal. So the sort of interference feared by the FCC is unlikely ever to occur, especially given present power levels.

When it was initially decided that satellite transmitters could share the C-band with the terrestrial transmitters, a nervous terrestrial-microwave industry reluctantly accepted the FCC decision that permitted satellites to transmit with five watts of power. They would have preferred to see much lower power levels: 0.5 watts, for example. But the satellite industry gradually got maximum power levels increased. And that allowed antennas to become smaller.

Power levels increased over time to the point that RCA got approval for an 8.5-watt transmitter in 1980. Hughes then followed with a nine-watt transmitter, and recently some ten-watt transmitters have been approved. But even the latter are a far cry from the 100, 200, and 250 watt-transmitters that will be allowed on the Ku-band.

As we've mentioned in the past, the Ku-band is the next higher internationally-recognized range of frequencies for satellite transmission. There is still a lack of agreement as to exactly which frequencies will actually compose the Ku-band, but for the immediate future the most likely seems to be the 10.95- to 11.70-GHz band. Some time in the future (perhaps as much as ten years), the 12.2 to 12.7 GHz band may also become important to DBS. But more on that in a moment.

The lowdown on Ku

The Ku-band, unlike the C-band, does not compete with the telephone companies. The Ku portion of the electromagnetic

TVRO dealer "Starter Kit" available

Bob Cooper's *CSD Magazine* has arranged with a number of TVRO equipment suppliers to provide a single-package of material that will help introduce you to the world of TVRO dealership. A short booklet written by Bob Cooper describes the start-up pitfalls to be avoided by any would-be TVRO dealer, in addition, product data and pricing sheets from prominent suppliers in the field are included. That package of material is free of charge and is supplied to firms or individuals in the electronics service business as an introduction to the 1984/85 world of selling TVRO systems retail.

You may obtain your *TVRO Dealer Starter Kit* free of charge by writing on company letterhead, or by enclosing a business card with your request. Address your inquiries to: *TVRO STARTER KIT, P.O. Box 100858, Fort Lauderdale, FL 33310.* That kit *not* available to individuals not involved in some form of electronics sales and service.

spectrum does have users, but they are not nearly as important—nor as organized—as the telephone companies. And, with a few minor exceptions, that is true world-wide.

C-band grew as a direct-to-home and direct-to-cable service quite by accident. Government regulators did not sit down in 1965 (or even in 1975) and reason out the probability that satellite TV would become a robust, rapidly-growing industry. Officials simply believed the tales told by Intelsat and telephone-company engineers. For example, it was claimed that an antenna with a diameter of at least 30 feet would be necessary to receive those weak five-watt satellite signals on earth. But the regulators did come up with a new plan in the 1970's: a Direct-to-Home satellite service they called *DBS*.

To make their DBS plan concrete, the FCC had to organize around one specific frequency band. After some searching, and some international negotiation, they settled on the Ku-band; more specifically, the 12.2- to 12.7-GHz portion of it. In a meeting held in Geneva, Switzerland, in 1979, more than 150 nations agreed that that band would be used for DBS worldwide. That was an important decision, because now several things could begin happening.

- Satellite designers and builders like Hughes, RCA, and Spar could begin designing and testing real systems.
- Reception-system designers could also begin designing and testing real systems.
- In countries where DBS would be partially or totally funded by government agencies, funds could be planned for and policies established.
- In countries where system costs would be borne by private investment, corporations could be formed, business plans created, and the search for funding begun.

Activities like those have been going for more than six years now, but we have seen few concrete results. For all practical purposes, six years after DBS was approved, we still have no real DBS systems anywhere. And the reasons for that are mostly technological.

DBS, as envisioned in 1979, was to be a multiple-channel service built with 250-watt transmitters and one- to three-foot receiving antennas. Small antennas, of course, cost less, require less space, are easier to install, and are not as unsightly as big antennas.

Unfortunately, reliable 250-watt Ku-band transmitters have yet to be operated in space; they are something of a curiosity, even in the laboratory. So, in a very real sense, the unavailability of 250-watt satellite transmitters has placed Ku-band DBS on indefinite hold. However, that is not stopping advanced-system planners from trying an end-run.

The officials who determined, in 1979, that DBS would require 250-watt transmitters based their thinking on receiving systems of a performance level that has since been surpassed. Satellite receiving systems have a performance criterion known as *noise temperature;* a low noise-temperature is more desirable than a high noise-temperature. In 1979, a practical receiver noise-temperature was in the vicinity of 800°K. But times have changed, and noise temperatures in the 200°K to 300°K range are now possible. What does the availability of low-noise temperature receivers mean?

The most obvious and important consequence of the foregoing is that lower receiver noise-temperatures allow you to get the same level of performance with smaller receiving antennas on earth, lower transmitter powers in space, or some combination of the two. By using a 300°K receiver, for example, reducing transmitter power from 250 to 100 or 125 watts will give the same reception as with an 800°K receiver (assuming the size of the dish remains the same). That suggests that we could have DBS today by using 125-watt transmitters, and the small antennas those paper planners envisioned back in 1979. But there is a catch to all of that: Can a reliable 125-watt transmitter be built?

The answer to that question is unknown. The 100-watt satellite transmitters launched into space so far have failed at a brisk rate. The most recent of those failures was a Japanese unit put into service early in 1985; two of its three 100-watt transmitters quit within months of turn-on. At best, the results thus far have not been encouraging, even at the 100-watt power level.

The good news is that RCA has recently launched a pair of satellites; each has 16 on-board transponders and each of those transponders is capable of outputs of 45 watts. RCA seems confident, and Hughes and other competitors agree, that the misfortunes of the 100-watt units are not likely to be experienced at the 45-watt level.

We'll have to wait till next month to see what all of that portends for the rapidly changing TVRO industry and those that use TVRO installations. **R-E**

VOL. 3 NO. 1 January 1986

COMPUTER DIGEST

A NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS

HARD DISK TECHNOLOGY

An In-Depth Review Of The State Of The Art.

555 TIMER DESIGNS

Use Your Computer To Select Components.

A GERNSBACK PUBLICATION

LOUDSPEAKER ENCLOSURE DESIGN

Use Your Computer to Optimize Enclosure Dimensions.

CONTENTS

Computer Digest

Vol. 3 No. 1 January 1986

ON THE COVER

Alloy's QICSTOR-PLUS is a personal computer subsystem that integrates five additional IBM™ Personal Computer compatible expansion slots, high-capacity hard disk and an advanced, high-speed file-oriented streaming cartridge tape backup unit. It fits under a personal computer and combines a 5¼ Winchester hard disk with formatted data capacities from 30MB to 110MB on a single 600-foot cartridge.

™IBM is a registered trademark of International Business Machines.

COMING NEXT MONTH

Look for an in-depth article on Monitors. After you read this one, you'll be far-better prepared to talk to that computer-store salesman! We'll also have the last part of the two-part article on using your computer to help design loudspeaker enclosures, . begun this month, and we'll be starting a three-part article on a hi-res graphics adapter for your Apple II.

ComputerDigest is published monthly as an insert in Radio-Electronics magazine by Gernsback Publications, Inc., 200 Park Avenue South, New York, NY 10003. Second-Class Postage Paid at New York, N.Y. and additional mailing offices.

Hugo Gernsback (1884-1967) founder
M. Harvey Gernsback, editor-in-chief
Larry Steckler, CET, publisher
Art Kleiman, editorial director
Byron G. Wels, editor
Brian C. Fenton, technical editor
Carl Laron, associate editor
Robert A. Young, assistant editor
Ruby M. Yee, production manager
Robert A. W. Lowndes, production associate
Karen Tucker, production assistant
Geoffrey S. Weil, production assistant
Andre Duzant, Technical Illustrator
Jacqueline P. Cheeseboro circulation director
Arline R. Fishman, advertising coordinator

Gernsback Publications, Inc.
200 Park Ave. South
New York, NY 10003
Chairman of the Board: M. Harvey Gernsback
President: Larry Steckler

ADVERTISING SALES 212-777-6400
Larry Steckler
Publisher

EAST/SOUTHEAST
Stanley Levitan
Radio-Electronics
200 Park Ave. South
New York, NY 10003
212-777-6400

MIDWEST/Texas/Arkansas/Okla.
Ralph Bergen
Radio-Electronics
540 Frontage Road—Suite 325
Northfield, Illinois 60093
312-446-1444

PACIFIC COAST
Mountain States
Marvin Green
Radio-Electronics
15335 Morrison St., Suite 227,
Sherman Oaks, CA 91403
818-986-2001

LETTERS

Warning!

The October, 1985 issue had an article by Elliott S. Kanter entitled "Saving Your Delicate Electronic Equipment." I was compelled to write to you at once. General Electric says, "Varistors initially fail in a short-circuit mode when subjected to surges beyond their peak current/energy ratings... When the device fails in the shorted mode, mechanical rupture of the package accompanied by expulsion of package materials in solid and gaseous form can occur. The potential hazard can be minimized by fusing the varistor to limit high fault currents, or by locating the varistor in a shielded container and away from other components"—S. R. B. Ft. Geo. Meade, MD.

Thank you for bringing this to our attention.

No Sale

I don't know anything at all about computers, but I'm willing to learn. If you will provide me with a decent computer system, I'll write an article about how I learned to compute. How much would you pay for such an article. Would you be interested? J. P., Kansas City, KS.

No.

Timex

Timex/Sinclair 1000's used to be everywhere and now I can't find a thing on them. How about peripherals? Did they just disappear?—G. S., Cheektowaga, NY.

I'm afraid they've gone the way of the Reo, the Cord, and the Studebaker. But it was a good computer, low enough in cost so that you didn't mind experimenting with it. Like you, I wish that somebody would bring it (or one like it) back again!

555 Timer

Can you provide some additional information on the 555 timer? It seems to keep cropping up everywhere and I'd like to learn more about it. R. D., Waco, TX.

See page 8 of this issue!

More Space!

I've noticed in recent issues that **ComputerDigest** is not as large as it used to be. I'd like to know if there's anything I might do to help get it expanded again? R. W., Cincinatti, OH.

Hey! Now that's a good idea. Why don't you write a letter to our publisher and tell him you miss those extra pages.

COMPUTER PRODUCTS

For more details use the free information card inside the back cover

TAPE-DRIVE OPTION, is a 10-megabyte tape cartridge drive, designed for the *CompuPro 10 Plus* multi-user microcomputer system.

Built directly into the *CompuPro 10 Plus* enclosure, the tape drive replaces one of the floppy-disk drives and has a "start/stop" feature that allows users to backup selected files. The option is also available as an upgrade for users with already installed *CompuPro 10* and *CompuPro 10 Plus* systems.

The tape-drive option can be ordered simultaneously with a *CompuPro 10 Plus* and is priced at $825. As an upgrade, the tape drive has a list price of $1095.00.—*Viasyn Corporation,* 450 Newport Center Drive, Suite 200, Newport Beach, CA 92660.

CIRCLE 11 ON FREE INFORMATION CARD

PERSONAL COMPUTER, the Tandy model *1200 HD,* is functionally identical to the IBM model *PC/XT*, using the same software and option cards. It is designed for business customers who require much higher speed, more detailed graphics, more memory, and more disk capacity than is possible with the model *PC/XT.*

Standard features of the model *1200 HD* computer parallel those of the model *PC/XT* by providing a single 360K full height, double-sided, double-density 5¾ inch floppy disk drive and a 10-MB hard disk drive housed in the desktop unit. The 84-key detachable keyboard with tilt legs has the same layout as in the model *PC/XT*, with improved placement of the keys and other valuable features. The model *1200 HD* is priced at $2999.00.—**Tandy Corporation/Radio Shack,** 1800 Tandy Center, Fort Worth, TX 76102.

CIRCLE 12 ON FREE INFORMATION CARD

SOFTWARE REVIEW

TYPERITE— $49.00

Now you can get rid of your typewriter!

■When the new girl came into the office, she looked balefully at the computer terminal. "I don't know how to work a computer," she said hesitatingly. "Don't worry about it," we assured her. "This one is different." By lunchtime, she didn't want to leave her new-found love even to go out for a cup of coffee. Why? Because the *TYPERITE* software from Selfware makes your computer so like a memory typewriter, that even the most-raw beginner will interface with a computer with no trouble at all! And once you've developed a facility with it, which might take all of fifteen minutes or so, you'll be looking around to find a place for your typewriter. You aren't going to be needing it anymore.

What makes this software so appealing is the graphic display that is presented to the operator. Along the bottom of your CRT screen, you get representation of the top of a typewriter. It's actually what a typist sees when using an ordinary non-computerized typewriter. The result is a warm, comfortable feeling of security that takes away some of the stigma attached to learning something radically new. What's more, this representation is indeed functional as well. It's not just fancy graphics put up there as a part of the display.

While this system may have originally been designed to facilitate routine typing work on the computer, we've found that it also makes an excellent bridge for people who have been trained on typewriters and are now faced with the problem of learning to operate a computer. However, its value extends far above and beyond that.

But let's get down to the nitty-gritty. With *Typerite* you can easily address envelopes and fill out forms using your computer. The new computer user experiences immediate and positive results. And you can actually type a letter and spend your brain time thinking about what you want to say instead of worrying about complicated computer commands and involved word processing.

Hard to use? Not at all. Put the disk in your disk drive, type the letters TR and hit the carriage return. Just follow the easy-to-understand instructions on the screen. You actually *see* a representation of a typewriter carriage on the screen and can quickly and easily set tabs, margins, underline, and center text. It works with all printers and with no special installation procedures

Typerite has two operational modes, standard and document. In both modes, you type a single line, review and/or change the line, and when you are satisfied, hit return and the line gets printed. The difference between the two modes is that in document, the software saves what you write.

With *Typerite* you can quickly and easily fill out forms. Simply type the necessary information in just as you would have with a typewriter. Using document, you can set up a template for your form. The template is simply a document that you create with "stop marks" at the places where you want to add information to the form. When you print out, the system stops at each stop mark and waits for you to type what is to be printed on the form. Once you set it up, you can use the template again and again.

Some of *Typerite's* features include: (in the standard mode) Save seven different margin and tab settings, set margins, set and clear a tab, clear all tabs, margin release, bell ring before end of margin, set tab every five spaces. It provides backspace/delete, cursor movement within a line, switch between insert and overtype, center between margins, single or double spacing, underlining and page eject.

In the Document Mode, you have all standard typerite features and can create forms templates, save documents as file, stop marks to allow data entry during printing, print a document line-by-line while creating or turn print off, save initial margins and tabs, save underlines or page ejects. You can change saved margins and tabs, delete or add underlines, page ejects and stop marks, print or not while revising, store with same name or new name, stop at stop marks to allow typing during printing, abort printing at any time, or abandon revisions.

There's a lot more that space won't allow for. For more information, contact Selfware, 3545 Chain Bridge Road, Fairfax, VA 22030.

HARD DISK DRIVES

A hard disk...And all that memory!

Marc Stern

■Every computer hobbyist faces a time when his needs outgrow his mass storage system. That's when the cassette recorder gives way to the floppy disk and the floppy to the hard or fixed disk. Each new storage medium offers the user a leap in speed and capability.

For example, the typical cassette holds about 500K of information sequentially, but, its data transfer rate is a slow 1200 to 2400 bits per second. A user becomes tired of this slowdown and the lack of random access. He must go through file after file to find the one he wants on the tape.

The next step is the floppy disk and, although some forms have less capacity—190K—they make up for it in speed and random access. Programs that took minutes to load and run with the cassette take only seconds to a minute or two to load and run. Instead of searching through a tape, looking for information, the floppy disk's read-write head sweeps across the surface of the diskette and finds the data in seconds.

Hard disks revealed

Also known as a fixed disk, the hard disk's attraction is its information density. A couple of years ago, the standard hard disk in the microcomputer world was the 5-megabyte unit. Today, the minimum disk density is 10 megabytes, with 20-megabyte units available.

When you compare the capacities of floppies and hard disks, you can see the hard disk wins. Today's double-sided, double-density floppy disk holds about 360,000 bytes of data, while the hard disk holds 10 million bytes. This means it would take 28 or more floppy disks to hold the same amount of information. The access time—the amount of time it takes to find a specific sector of information on a hard disk—is on the order of 35 to 85 microseconds, while a floppy's time can run in the 20 to 40 millisecond range. Its a quantum jump in information retrieval speed.

There are high-density floppy disks on the market, capable of holding 1.25 megabytes of data, but, they are expensive—some running as much as $850 to $1000—and they still don't hold the sheer bulk of which a fixed disk is capable.

These points make the hard disk much more attractive as a mass storage device. Hard disks aren't portable—there are some cartridge hard disk models which allow you to change disks, but their reliability is still in question—and you must backup the hard disk for insurance, which can take as many as 30 floppy disks and can take the better part of a day. But most small-computer users feel the speed and information density advantages outweigh the latter aspects.

Let's look more closely at a typical hard disk for a better understanding of this technology. If you look closely at Fig. 1, you'll see the typical 5.25-inch hard disk drive—now the standard size in the microcomputer world—contains one or more platters or rigid disks, each of which has its own read-write head.

Most disks today are constructed on an aluminum base, whose surface is covered with a paste containing gamma-ferric oxide particles. This layer is cured and polished and then covered with a Teflon-based lubricant. The entire layer is then burnished smooth. The platters are enclosed in a sealed box which also includes air filtering to keep the surfaces free of contaminants which could cause a head crash and damage the disk.

Thin-film plated disks also use an aluminum substrate. However, rather than being coated with the oxide paste during construction, they are dipped in a series of plating solutions and the platter is coated with thin films of metallic material. The top layer, where the data storage and transactions take place, is a cobalt alloy, which can be as thin as three microinches.

A thin-film sputtered disk takes the aluminum platter through another process. The aluminum platter is coated with a nickel phosphorus layer, which is then polished. Then, using the sputtering processing—a continuous vacuum deposition process—magnetic layers are laid down on the disk. In this way, layers as thin as two microinches can be deposited.

The importance of the type of material on the platter can hardly be understated because it relates to the information density of which the hard disk is capable.

As the platter's coating becomes thinner, the disk is capable of greater information density for a given diameter. Therefore, the thin-film plated and sputtered disks are capable of greater information densities than the oxide-coated disk.

This advantage extends to another area which also affects disk information density, the read-write head. Unlike floppy disk read-write heads which literally

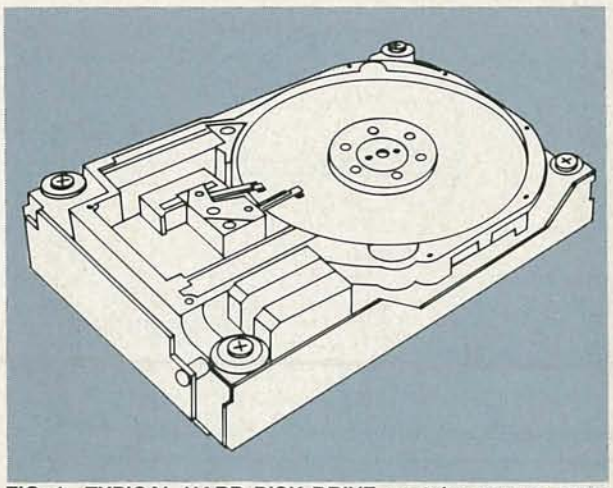


FIG. 1—TYPICAL HARD DISK DRIVE contains one or more rigid disks made of aluminum substrate coated with a magnetic material.

touch the surface of a disk, the read-write heads of a fixed disk fly above the surface on a layer of air. The closer the head skims along the surface the greater the information packing capability. The ability to fly near the surface of the plate is directly affected by the smoothness of the surface.

If you were to look at the oxide-coated surface of a traditional hard disk, it would look smooth. However, a microscopic examination of it would reveal that it is filled with peaks and valleys. (See Fig. 2) The same is true for a plated hard disk.

The read-write head must run as much as 8 microinches off the surface of this type of disk to prevent the head from coming into contact with those peaks.

By contrast, the sputtered disk is so smooth that the head can fly as little as two microinches off the surface, which means its data density can be greater. Thus, it's possible to achieve data densities of up to 20 megabytes on 5.25-inch hard disks.

Head examined

Another critical factor in hard disks is the read-write head itself.

Typically, the read-write head is like that found in a cassette recorder, it is a ferrite unit. The nature of this head effectively constrains the information transfer speed and density of which the fixed disk is capable. A more recent development in read-write heads, the thin-film electromagnetic head, allows the fixed disk to read information more quickly and in greater density than the conventional ferrite read-write.

The head's construction also affects its speed capability and long-range reliability. Look at Fig. 3 and you can see the number of pieces which make up the fixed disk's so-called Winchester arm. It carries the read-write head. From its construction—side rails, load beam and slider—you can see how complicated the mechanism is. This contributes to its aerodynamic inefficiency and affects the speed at which it can fly across the disk surface. The number of moving parts also makes this mechanism more prone to wear.

A newer development—the Whitney arm—promises

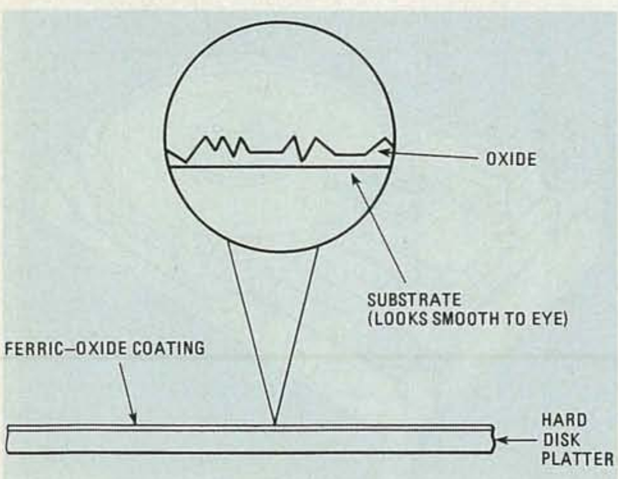


FIG. 2—MICROSCOPIC VIEW of oxide-coated hard disk. Note peaks and valleys in coating (not to scale).

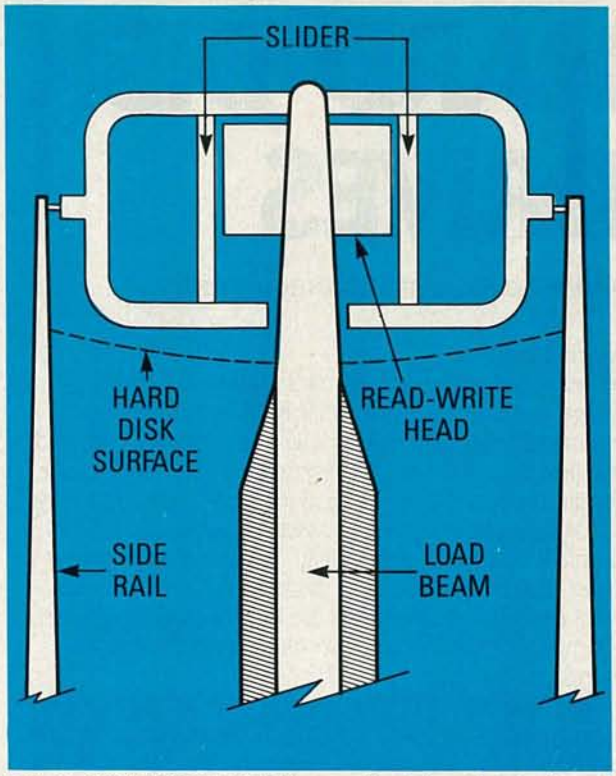


FIG. 3—WINCHESTER ARM is complicated mechanically and aerodynamically. It is less efficient than the Whitney arm.

higher speeds and consequently greater data packing and transfer rates. More efficient aerodynamically (See Fig. 4) it has several advantages over the mechanisms used today.

Speed demon

This adds up to a capable unit which has another innate advantage over just about any other form of mass storage, high speed.

With a rotational speed of 3,600 revolutions per minute, the hard disk drive has a tenfold advantage over the standard floppy disk's 300 to 360 rpm.

This means programs which normally take a minute or two to load and run from a floppy disk will load in seconds. Huge data files will be stored in seconds.

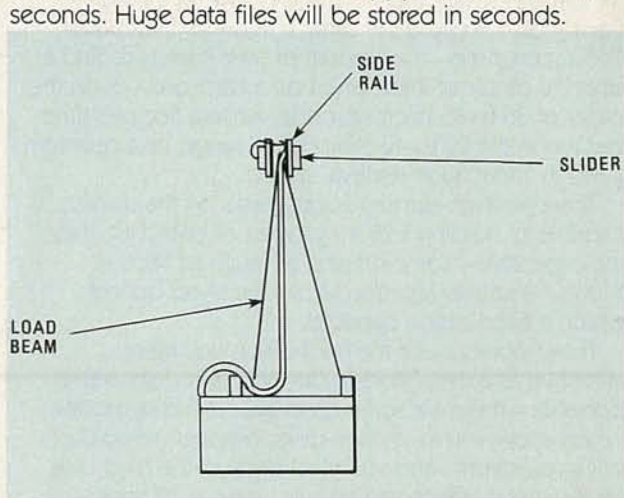


FIG. 4—THE WHITNEY ARM is much more streamlined and efficient.

And data can be manipulated quickly.

With this type of speed, you need a precise read-write head positioning mechanism and there are currently two types used, the open-loop stepper motor and the rotary voice coil positioner.

The open-loop stepper motor is a mechanical system which relies on the stepper motor for precise head positioning. In action, the open-loop stepper motor works with the commands issued by the hard disk controller circuitry. When a program makes a request for data, the circuitry issues a command to the head positioning system which instructs the motor to move the head to a certain track on the disk. As it begins to move, the stepper motor clicks off the number of tracks until it reaches the required spot.

The chief drawback of this method is wear over the long term. The mechanical parts wear and exact head positioning becomes more difficult and data access times become longer.

The voice coil system relies on closed-loop positional feedback for head positioning. In action, the system works in conjunction with information contained either in a special buffer area on the hard disk or in each track to locate a particular track and sector. This information tells the head-positioning circuitry its location in relation to the specific spot the system is seeking and the head uses this information as it moves to the spot. Since it has fewer moving parts than the stepper motor system, it is more reliable than the conventional stepper motor. Its chief drawback is in increased cost.

Read the specifications

With all the foregoing information, there are still several other items to think about, especially if you're in the market for a hard disk. The first is average access time and the second is latency. The first is actually a function of the second.

Average access time refers to the amount of time it takes for the read-write head to move from one piece of data on a hard disk to another. It is a function of the latency or rotational delay of the high-speed hard disk.

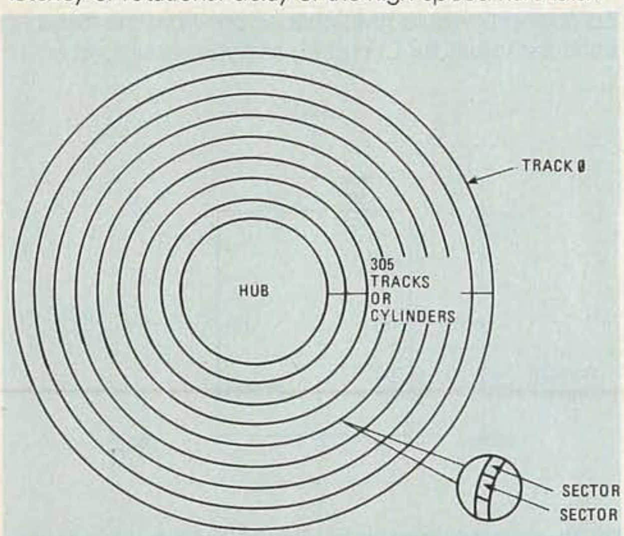


FIG. 5—TRACKS ON HARD DISK are laid out concentrically. Track 0 is used for positional and other data.

Average access time also varies from hard disk to hard disk and with the type of head positioning arrangement used.

Another specification which can prove confusing is the data transfer rate. It is the speed at which data moves from between the hard disk controller and the drive. Most manufacturers quantify this in terms of bits per second of data transfer and some hard disks can have a transfer rate of up to 5 million bits per second. To lessen confusion, you can compare this to the baud rate of a serial communications device, although its speed is manifestly higher.

Disk organization

The final piece of the hard disk puzzle is the organization of the disk. To help put this into perspective it is useful to picture the hard disk as a phonograph record.

Each hard disk is divided into a series of tracks. (See Fig. 5) A typical 10 megabyte hard disk has 305 tracks for information, each of which contains 34,816 bytes of information. Like the grooves in a phonograph record, the tracks are laid out concentrically on the disk's surface, with each track concentric to the one inside it. Unlike a record, the tracks are separate, while the grooves are actually interconnected.

Each track on the disk surface is divided into specific sectors. An index sensor indicates the start of each track.

In action, the hard disk controller head looks first at Track 0—at the outside of the disk—rough positional information and then hunts for the specific track on the disk containing the information which has been requested. When it arrives at the right track, it hunts for the sector containing the header data for that particular file. The header is the identification mark for the file. The head then reads that identification mark, determines where the rest of the information is stored and moves along from sector to sector assembling it. When it has finished, it's ready to use.

The 5.25-inch standard

When hard disks were first introduced more than a decade ago, they were huge, routinely 14 inches in diameter. They didn't make their appearance in the microcomputer world until about four years ago when the first 5.25-inch hard disks were sold. These early disks were only 5 megabyte affairs and it looked for a time as if these would become the standard of the microcomputer world. But, times quickly changed.

Within a year or so, 10-megabyte 5.25-inch hard disk drives began to appear and within another year, these units became the standard as the lower density disks began to disappear from the scene.

About the only thing which was common to the two units was their size. Both were 5.25-inch units, which is still the most common size for a hard disk unit.

Times are changing on this front, too, as 3.5-inch drives make their appearance. Further, even the standard sized drive is changing as it is becoming thinner and half-height drives, capable of 10 and 20 megabytes of data storage are appearing.

555 DESIGN PROGRAM

Use your computer to shortcut those tedious 555 oscillator design problems.

Jeff Holtzman

■Some design chores in the electronics lab are quite repetitive, and after the 1000th time we think, "there must be a better way!" Well, if you have a personal computer in your lab, here's a little program that will reduce the tedium of one such chore: Designing 555 monostable and astable oscillator circuits. It's fast, allowing you to make several "runs" quickly, so you can see the effect different component values will have on circuit operation.

Our program will help you determine resistor and capacitor values for the standard circuits shown in Fig. 1a and 1b. The program has been written in MBASIC-80, and it should run as-is on just about any personal computer. We also include several suggestions for improving the program, if you have a taste for such experimenting.

What the program does

When you run the program it asks you to choose between Astable and Monostable circuits (or you may just Exit). If you choose Astable, the program then asks you the frequency you will be working with. Next, you're presented with a menu (lines 220-320) allowing you to choose which parameter you want to work with. Choices 1 and 2 calculate values for R2 and C1, respectively, assuming a value of 1K for R1, and a value entered by you for the third component—C1 and R2, respectively. We chose a default value for R1 of 1000 ohms, but if that doesn't suit your fancy, feel free to change it.

Choice 3 also calculates a value for C1, but here no assumption is made regarding the value of R1: You must enter the values for both resistors. Choice 4 allows you to calculate the frequency that will be obtained; and with that choice, you enter the value for all three components. That allows you to try values for components you can actually buy—which probably won't be the same as the ones calculated above—to see what frequency will result.

For example, suppose you need a 1 kHz oscillator. Suppose further that you happen to have a junk box full of .01 disks that you want to use. Well, run the program, enter "1000" at the "Frequency?" prompt, choose the first item, and enter ".01" at the next prompt. The program will tell you that you need a resistor of 71,500 ohms for R2. The closest standard value is 72,000 ohms, so choose item 4. Entering values of .01, 1000, and 72,000 yields a frequency of about 993 Hz—pretty darn close! In fact that's an error of 7/1000, or .007%. Not bad. Of course, that's only a calculated value; chances are the components you use won't have exactly their nominal values. For more accuracy you could use a 47K resistor in series with a 50K trimmer, and adjust the 555's output with a frequency counter.

The monostable circuit works on a similar basis, but is even simpler, since there are only three variables to take account of: The duration of the trigger pulse, and the values of R1 and C1. The menu (shown in lines 580-710) has three choices. Each asks for two values and then calculates the third. For example, assume you need a pulse one second wide, and that you want to use a 1 μF capacitor. You want to find the appropriate resistor to use, so choose two from the menu. You should get an answer of 909091 ohms. The closest standard value is 1 Megohm, so to find the time those components would give, choose one from the menu, enter the values for C1 and R1, and you should get an

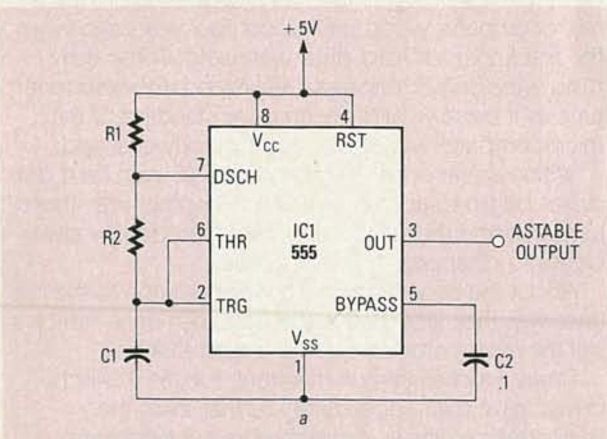


FIG. 1a—The value of R1, R2 and C1 determine the frequency of oscillation of this circuit, and the program simplifies calculating the values of those components.

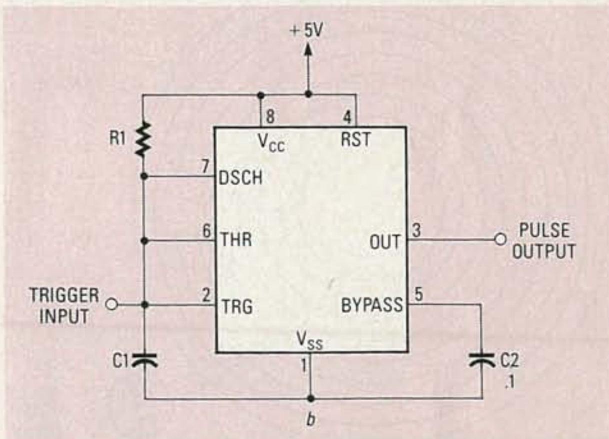


FIG. 1b—A negative-going trigger wil cause the 555 to output a pulse with a width determined by the values of R1 and C1. The program simplifies calculating the values of those components.

```
100 REM 555 timer calculations for RE mag.  jkh  3 August 1985
110 FOR I=1 TO 24:PRINT:NEXT I
120 PRINT "555 Timer Calculations    jkh    3 August 1985"
130 PRINT:PRINT:PRINT:PRINT:
140 INPUT "Astable/Monostable/Exit (A/M/E)? ", IN$
150 IF IN$="E" OR IN$="e" OR IN$="" THEN END
160 IF IN$= "M" OR IN$="m" THEN GOTO 580
170 IF IN$="A" OR IN$="a" THEN GOTO 190
180 GOTO 140
190 REM do astable calculations
200 PRINT
210 INPUT "Frequency? ",F
220 PRINT
230 PRINT "0.  END"
240 PRINT "1.  FIND R2, GIVEN R1 = 1000, C1 = USER ENTRY"
250 PRINT "2.  FIND C1, GIVEN R1 = 1000, R2 = USER ENTRY"
260 PRINT "3.  FIND C1, GIVEN R1 = USER ENTRY, R2 = USER ENTRY"
270 PRINT "4.  FIND F, GIVEN C1, R1, R2 USER ENTRIES"
280 PRINT
290 INPUT "     CHOOSE: ",IN
300 PRINT
310 IF IN=0 THEN GOTO 140 ELSE ON IN GOSUB 330, 390, 450, 510
320 GOTO 220
330 REM FIND R2 GIVEN R1=1K, C1 ENTERED
340 R1 = 1000
350 INPUT "C1 = ",C1
360 R2=(1.44/(F*C1/1E+06)-R1)/2
370 GOSUB 870
380 RETURN
390 REM FIND C1 GIVEN R1=1K, R2 ENTERED
400 R1=1000
410 INPUT "R2 = ",R2
420 C1= 1.44/(F*(R1+2*R2))*1E+06
430 GOSUB 870
440 RETURN
450 REM FIND C1 GIVEN R1, R2 ENTERED
460 INPUT "R1 = ",R1
470 INPUT "R2 = ",R2
480 C1=1.44/(F*(R1+2*R2))*1E+06
490 GOSUB 870
500 RETURN
510 REM FIND F GIVEN C1, R1, R2 ENTERED
520 INPUT "C1 = ",C1
530 INPUT "R1 = ",R1
540 INPUT "R2 = ",R2
550 PRINT
560 PRINT "NEW FREQUENCY WOULD BE:"; 1.44/(C1*.000001*(R1+2*R2));"Hz"
570 RETURN
580 REM do monostable calculations
590 PRINT
600 PRINT "0.  END"
610 PRINT "1.  FIND T, GIVEN R AND C"
620 PRINT "2.  FIND R, GIVEN T AND C"
630 PRINT "3.  FIND C, GIVEN R AND T"
640 PRINT
650 INPUT "     CHOOSE: ",IN
660 PRINT
670 IF IN=0 THEN GOTO 140 ELSE ON IN GOSUB 720, 770, 820
680 PRINT
690 PRINT "C=";C1;"uF";TAB(15);"R=";R1;"ohms";TAB(30);"T=";T*1000;"msec"
700 PRINT
710 GOTO 580
720 REM FIND T, GIVEN R AND C
730 INPUT "R = ",R1
740 INPUT "C = ",C1
750 T=1.1*R1*C1*.000001
760 RETURN
770 REM FIND R, GIVEN T AND C
780 INPUT "T = ",T
790 INPUT "C = ",C1
800 R1=T/1.1*C1*1E+06
810 RETURN
820 REM FIND C, GIVEN R AND T
830 INPUT "R = ",R1
840 INPUT "T = ",T
850 C=T/1.1*R1*.000001
860 RETURN
870 REM PRINT ASTABLE VARIABLES
880 PRINT
890 PRINT "F=";F;"Hz";TAB(15);"C1=";C1;"uF";TAB(30);
900 PRINT "R1=";R1;"ohms";TAB(45);"R2=";R2;"ohms"
910 PRINT
920 RETURN
930 END
```

answer of 1.1 seconds.

In both the astable and monostable sections of the program, enter resistor values in ohms and capacitor values in microfarads. For example, 100 pF would be entered .0001. In the monostable section, time would be entered in seconds, although time is reported in milliseconds. For example, you would enter one millisecond as .001; the program would print it "1 msec."

Improvements

The program is very useful as it is, but some improvements could be made (they always can). First of all, in the astable mode it's sometimes necessary to know the duty cycle a combination of components will give. Doing the calculation is easy; the formulae are available in standard databooks.

A somewhat more complex improvement would be to have the program suggest only standard values for the resistors. One way to do that would be to create an array and fill it from DATA statements containing scaled standard values (1.0, 1.1, 1.2, . . . 9.1). Then after calculating a resistor's value, it would be scaled down to a number between one and ten, and the array would be searched for the closest match. That value would then be scaled up by the same amount the original value was scaled down. That's all there is to it!

COMPUTER-AIDED DESIGN OF LOUDSPEAKER ENCLOSURES PART I

Here's how to let your computer predict an enclosure's performance.

Michael Raleigh and Robert Raleigh

■The most-complex system is the ducted port enclosure. The other systems can be thought of as simplifications of this type. Figure 1 shows a cross section of a dynamic loudspeaker mounted in a ducted port enclosure. When driven at low frequencies, the behaviour of this system is simpler than it is at higher frequencies. The cone moves as a single, rigid mass. All the air inside the duct moves in unison, acting as another single mass. The volume of air within the enclosure acts like a spring, coupling the cone mass to the mass of air in the duct. The front of both the cone and the air in the duct experience a frictional drag due to the acoustic power they radiate. This effect is called the radiation resistance, and is frequency dependent. The program retains only the first term in the Taylor expansion of the Bessel function that gives this frequency dependence. A small additional mass is added to the cone and the duct by the effect of the outside air and, here too, we keep only the first term of the Taylor expansion. Additional springiness and resistance result from the cone surround and the coil spider. More resistance is sometimes included in such enclosures in the form of fiberglass batting lining the box, across the port, or behind the woofer.

When the simplifications described are applicable, a ducted port enclosure behaves much like the lumped parameter mechanical device shown in Figure 2. For this mechanical system comprised of masses, springs and dampers there are two electrical circuits composed of capacitors, inductors and resistors which exhibit analagous behaviour. They have the same governing equations with a renaming of the quantities

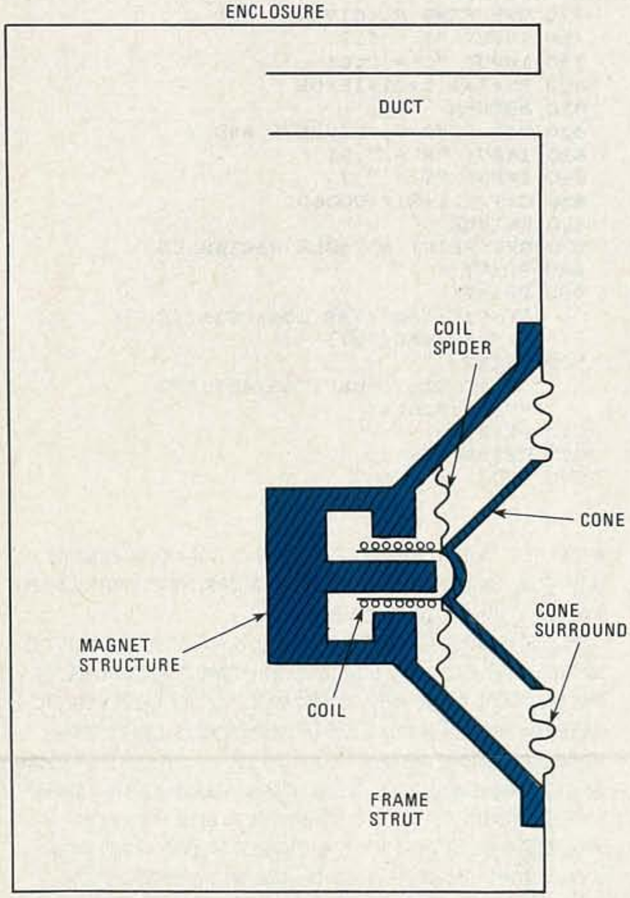


FIG. 1—CROSS SECTION of a dynamic woofer mounted in a ducted port enclosure.

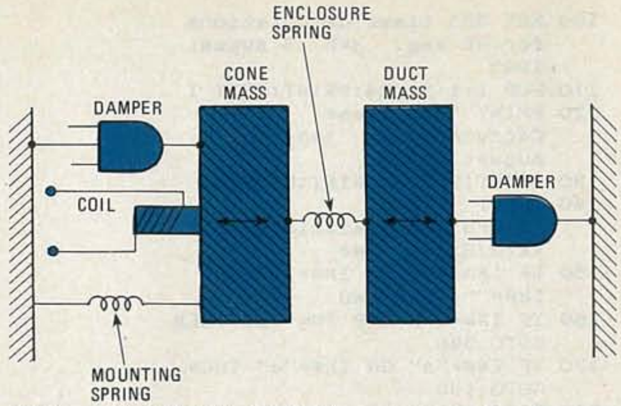


FIG 2.—MECHANICAL SYSTEM, equivalent at low frequencies, to the speaker shown in Fig. 1. Cone mass and the mass of air are assumed to move only in one direction, indicated by arrows. Coil applies oscillatory force to cone in this direction. Dampers are sources of mechanical resistance. One end of each damper and mounting spring has a fixed point of attachment.

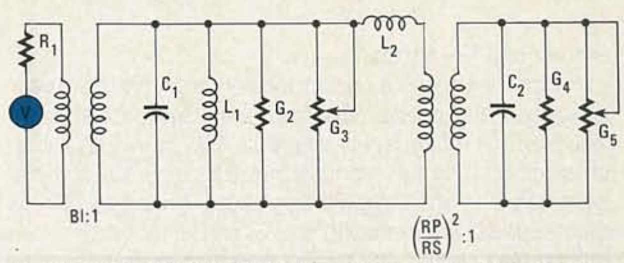


FIG. 3—ELECTRICAL CIRCUIT analagous to systems in Figs. 1 and 2. Corresponding parameters are: R1 = Coil resistance, C1 = Mass of cone and co-moving air, L1 = Compliance of cone mountings, G2 = Mechanical resistance of cone mountings, G3 = Radiation resistance of cone, L2 = Compliance of enclosure volume, RP = Port (duct) radius, RS = Speaker radius, C2 = Mass of air in duct and co-moving air, G4 = Mechanical resistance, G5 = Radiation resistance of duct.

involved. In Figure 3, you see one of those circuits which is equivalent to Figure 2. The equivalent quantities are as follows:

Voltage = Velocity
Current = Force
Capacitance = Mass
Inductance = Spring Compliance
Electrical Conductance = Mechanical Resistance

Each mass in Figure 2 has associated with it a capacitor to ground in Figure 3 whose voltage is numerically equal to the velocity of the mass. The force being applied to the mass equals the current flowing into the capacitor. The sources of this current (force) are the resistors (dampers) and inductors (springs) attached to the capacitor (mass).

The computer program assumes that a 1-volt AC source is attached across the coil. The program establishes a set of differential equations (the node equations) which describe the behaviour of the circuit in Figure 3. The assumption of a steady-state response causes these equations to take the form of a set of simultaneous algebraic equations in terms of complex variables. These are solved for a selection of frequencies between 15 and 250 Hz. Outputs from the program include the acoustic intensity one meter from the speaker (resulting from the vector sum of the woofer and port amplitudes and given in watts per square meter), and the current drawn at the speaker terminals (which is the admittance since we assume a one-volt input, given in mhos). The program asks only for fundemental system parameters and does so using prompts to guide the user. Quantities such as the radiation resistances as a function of frequency are calculated internally. The program is listed and may be checked by running the design example described. The tabular output for this case is also given.

Parameter measurements

There are several of the woofer parameters which must be determined experimentally. These include cone radius, DC coil resistance, the Bl product for the magnet-coil combination, the compliance of the cone mountings, the free resonance of the woofer and the mechanical resistance of the cone mountings. Let's talk about how to make these measurements and present typical numbers from a design example using a 12-inch woofer. We use MKS units exclusively.

The effective cone radius may be measured from the center line of the cone to the mid-point of the cone surround. This number will be less than the nominal radius of the woofer. In the design example, the effective cone radius is .125 meters (4.92 inches).

The DC resistance of the coil may be measured with a multimeter. For the design example, this was 5.3 ohms. (This number is not to be confused with the nominal AC impedance of eight ohms.)

The Bl product is the product of the magnetic induction (B) in the magnet gap, and the length of coil wire, (l) in the gap. B is measured in Teslas. The Bl product determines the force exerted on the cone for a given coil current. This product is measured, as shown in Figure 4, by placing the woofer face-up on a

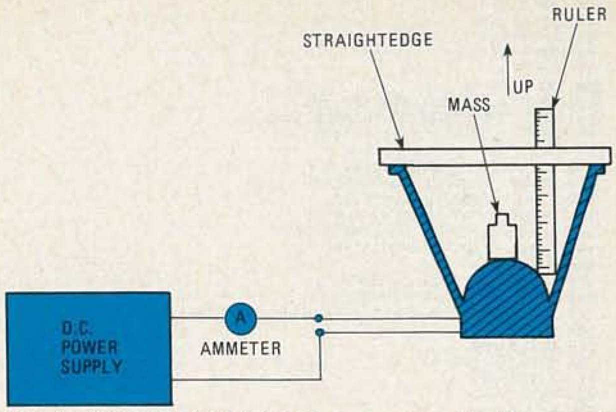


FIG. 4—ARRANGEMENT USED to measure the Bl product and the mounting compliance.

horizontal surface with a DC power supply and an ammeter attached to the coil. A straightedge is laid across the face of the woofer, and a light plastic ruler is stood upright in the cone so that the vertical position of the cone may be measured. Determine the position of the cone with no current in the coil, a known mass (M) is then carefully placed in the cone and current (I) necessary to,lift the cone and mass back to the unloaded position is determined. The Bl product is then given as:

$$C\left(\frac{M}{Nt}\right) = \frac{d\ (M)}{9.81 \times M\ (kg)}$$

The design example needed .237 amps to lift a .305 Kilogram mass back to the unloaded position, implying a Bl of 12.6 (T × M).

The compliance is also measured while the woofer is lying on its back with the straightedge and plastic ruler in place. The power supply is disconnected. The distance, d, which the mass causes the cone to depress is determined from the difference in the readings on the plastic ruler in both loaded and unloaded conditions. The compliance is then given by:

$$Bl\ (T \times M) = \frac{9.81 \times M\ (kg)}{I\ (A)}$$

For the design example, the .305 kilogram mass depressed the cone by .002 meters thereby implying a compliance of .000668 (Meters/Newton).

The free resonance and mechanical resistance of the woofer are determined using the arrangement shown in Figure 5. The bare woofer is suspended in a large room away from any objects or walls. We measure the current drawn and the voltage applied at various frequencies. At each frequency, we divide the current by the voltage to obtain the admittance. Note that if the same multimeter is used for both current and

Fig. 5—HOW WOOFER ADMITTANCE was measured. Admittance is used as a diagnostic to determine several parameters.

```
10 DIM G(4,4)
20 DIM C(4,4)
30 DIM B(4,4)
40 DIM A(4,4)
50 DIM T(4)
55 E=1
60 INPUT "COIL RESISTANCE?";RC
70 INPUT "MOUNTING COMPLIANCE?";MC
80 INPUT "SPEAKER RADIUS?";RS
90 INPUT "ENCL VOLUME?";V
100 INPUT "BL PRODUCT?";BL
110 INPUT "FREE RESONANCE?";FO
120 INPUT "PORT RADIUS?";RP
130 INPUT "PORT LENGTH?";LP
134 INPUT "SPEAKER DAMPING?";SD
136 INPUT "PORT DAMPING?";PD
140 B1=1/MC
150 C1=B1/(39.478418*FO*FO)
160 B2=1.43E6*RS*RS*RS*RS/V
170 C2=(3.83*LP+5.69*RP)*RS*RS*RS*RS/(RP*RP)
180 B(1,1)=-(B1+B2)
190 B(1,3)=B2
200 B(2,2)=-(B1+B2)
210 B(2,4)=B2
220 B(3,1)=B2
230 B(3,3)=-B2
240 B(4,2)=B2
250 B(4,4)=-B2
260 C(1,1)=C1
270 C(2,2)=C1
280 C(3,3)=C2
290 C(4,4)=C2
300 IS=BL/RC
305 PRINT#-2,TAB(5)"FREQ.";TAB(28);"POWER";TAB(48)"ADMIT."
306 PRINT#-2
310 F=10
320 FOR Z=1 TO 48
330 F=F+5
340 G0=.219*F*F*RS*RS*RS*RS
350 G1=G0+BL*BL/RC+SD
360 G(1,2)=G1
370 G(2,1)=-G1
375 G2=G0+PD
380 G(3,4)=G2
390 G(4,3)=-G2
400 FOR I=1 TO 4
410 FOR J=1 TO 4
420 A(I,J)=39.4784*F*F*C(I,J)+6.2832*F*G(I,J)+B(I,J)
430 NEXT J
440 NEXT I
450 GOSUB 1010
460 A0=D
470 FOR I=1 TO 4
480 T(I)=A(I,1)
490 A(I,1)=0
500 NEXT I
510 A(2,1)=-6.2832*F*IS
520 GOSUB 1010
530 A1=D
540 FOR I=1 TO 4
550 A(I,1)=T(I)
560 T(I)=A(I,2)
570 A(I,2)=0
580 NEXT I
590 A(2,2)=-6.2832*F*IS
600 GOSUB 1010
610 A2=D
620 FOR I=1 TO 4
630 A(I,2)=T(I)
640 T(I)=A(I,3)
650 A(I,3)=0
660 NEXT I
670 A(2,3)=-6.2832*F*IS
680 GOSUB 1010
690 A3=D
700 FOR I=1 TO 4
710 A(I,3)=T(I)
720 A(I,4)=0
730 NEXT I
740 A(2,4)=-6.2832*F*IS
750 GOSUB 1010
760 VA=A1/A0
770 VB=A2/A0
780 VC=-A3/A0
790 VD=-D/A0
792 IA=IS-VA*BL*BL/RC
794 IB=-VB*BL*BL/RC
796 IM=SQR(IA*IA+IB*IB)/BL
800 P=3.49E-2*(F^2*RS^4)
810 PS=P*((VA+VC)*(VA+VC)+(VB+VD)*(VB+VD))
880 PRINT#-2,TAB(5)F;TAB(25)PS;TAB(45)IM
900 NEXT Z
910 END
1010 D=0
1020 FOR I=1 TO 4
1030 FOR J=1 TO 4
1040 IF J=I THEN GOTO 1220
1050 FOR K=1 TO 4
1060 IF K=I THEN GOTO 1210
1070 IF K=J THEN GOTO 1210
1080 FOR X=1 TO 4
1090 IF X=I THEN GOTO 1200
1100 IF X=J THEN GOTO 1200
1110 IF X=K THEN GOTO 1200
1190 D=D+E*A(1,I)*A(2,J)*A(3,K)*A(4,X)
1195 E=-E
1200 NEXT X
1210 NEXT K
1215 E=-E
1220 NEXT J
1230 NEXT I
1240 RETURN
```

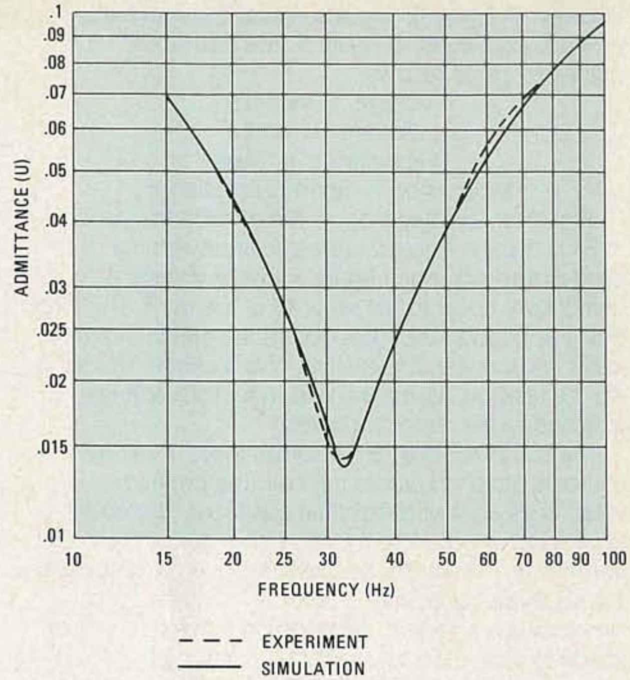


FIG. 6—MEASURED AND COMPUTER SIMULATED admittance of the woofer used as a design example in text. Curves represent behaviour of bare, unenclosed woofer.

voltage measurements, the low-frequency roll-off of that instrument is cancelled in the division of one quantity by the other. A graph of the admittance for our design example is offered in Figure 6. The free resonance is that frequency at which the minumum admittance occurs. (33 Hz for the design example.)

We determine the mechanical resistance by running the computer program with various assumed mechanical resistances until the computed admittance versus frequency matches the experimental results (Fig. 6). In the program we approximate suspending the bare woofer in a large room by assuming a very large enclosure volume (1000 cubic meters) and port dimensions (.001 meter radius, 1000 meter length) for which the port has no effect at any frequency of interest. The design example shows a good match between the computer result and the experimental measurement for an assumed mechanical resistance of 2.45 mechanical ohms.

Computer experiments with various enclosures

Continuing with the design example previously introduced, we use the measured parameters and compute the response for this woofer in several different enclosures. Figure 7 shows the response given by an infinite baffle of .2 cubic meters. For this run, the lack of a port is simulated by using a port radius of .001 meters and a port length of 1000 meters. As it happens, this is a rather lightweight woofer and does not perform well in a small closed box. The frequency response begins to roll off above 100 Hz.

We're sorry, but we've run out of space in this issue. This article will be concluded next month.

ANTIQUE RADIOS

Battery-powered antique radios

RICHARD D. FITCH
CONTRIBUTING EDITOR

MOST OF OUR PREVIOUS DISCUSSIONS have concentrated on antique radios from the 1930's. Alternating current was available then, but it wasn't completely standardized. For example, power-line frequencies of 25, 40 and 60 Hz (or CPS, as we said at the time) were used, as were assorted DC voltages. Those inconsistencies did little to hold down the prices of radios produced then. And that problem continued on into the 1940's.

Power-line standards were not the only problems facing radio owners and manufacturers. You must remember that, back in the 1930's, not everyone enjoyed the convenience of home wiring. Thus, there was still a great demand for battery-powered radios. Of course batteries were not without their own set of problems. They often had to be removed and charged (or replaced!) weekly.

One attempted solution was the so-called "battery-electric radio," a receiver that got its "B" (plate) supply from the light socket, and its "A" (filament) supply from batteries. However, batteries for the A, B, (and, sometimes, C) supplies were the main sources of power until well past the mid 1920's. (I'll discuss some of those early radios, many of which were built from kits, or just schematics, in a future column.) As more areas became wired, the old battery sets could be used by purchasing an ABC power supply.

Antiques of the month

This was a busy month, so we have the three radios shown in Fig. 1 to talk about. All three are battery-operated, broadcast-band receivers that got *all* of their power from batteries. Both the Westinghouse (shown on the left) and the Crosley (shown on the right) are from the pre-electric-light-socket era, around 1925. The oversized Silvertone (shown in the center) received the standard broadcast band and two short wave bands that "put the world at your fingertips," as the sales pitch went. That later-model battery-operated Silvertone was marketed to rural America where most of the homes and farms were still not wired. Radios like the Silvertone were originally purchased via catalogue.

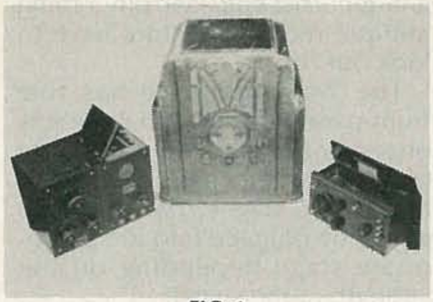


FIG. 1

The Crosley *Model 51*

The Crosley compares in size—although certainly not in weight—to a modern table radio. The weight differential is due, of course, to the cumbersome batteries. They were usually stored beneath a specially-built table. The battery leads plug into terminals on the front panel. Antenna and ground wires, and headphones, also plug into terminals on the front panel.

The Crosley *Model 51* was a regenerative receiver licensed for manufacture under Armstrong's 1914 patent. The circuit rarely regenerated into neighboring receivers, since they were few and far between. The Crosley's tube compliment consisted of two 01A's. Two WD11 tubes could be used by changing the filament voltage. The WD11 has a 1.1-volt filament, and the 01A has a 5-volt filament. Neither has a cathode because the filament serves as the cathode. It's interesting to note the Crosley type "D" tuning capacitor and the volume control (which is wired in series with the filaments.) The 0–100 graduations on the tuning dial were popular in that era.

The Crosley *Model 51* was popular in its day, and some modern-day interest has also been generated since we first discussed that antique in the February 1985 issue of **Radio-Electronics.** Probably there are not enough originals left to go around, but duplicating the cabinet and the chassis for a replica would be fairly simple. Let me know if you're interested; we can publish complete plans for both cabinet and chassis.

The Westinghouse

The Westinghouse (shown on the left in the photo) is also a battery-operated radio; it has one 01A tube used as a detector, and more as two audio stages. That radio has two chassis in the cabinet that are identified as No. 307189 and No. 307180, the receiver-tuner and detector-amplifier sections, respectively. The tuning range of 180 to 700 meters well overlaps the AM broadcast band. Like the Crosley, that radio has 0–100 graduations on the tuning dial.

Before any further technical talk, let me mention that when I bought that radio I noticed there was insulation missing from many of the wires in the receiver chassis. Nearby, there was an elliptical hole in the lid of the cabinet. Opening the lid revealed a huge ball of yarn inside. Not wanting the seller to think I didn't know all about antique radios, I didn't ask what that ball of wool was doing in the radio.

When I got it home, I disassembled it, and then I found out more about the wool, the hole and the missing insulation. I realized a rodent of some sort lived in that antique. That's just one other thing antique radio collectors have to look out for.

The Westinghouse has five front-panel controls and three sets of earphone jacks. The jacks were provided for the first, second, and third audio stages. The earphone would be plugged into the appropriate stage depending on the strength of the signal.

The detector and both amplifiers each had "rheostats" in their filament circuits for controlling volume. The rheostat also came into play as the batteries weakened. A horn-type loudspeaker could also be plugged in the jack from the second audio stage.

The main tuning, tickler, and vernier dials complete the front-panel controls of that Westinghouse; they are all mounted on the receiver-tuner chassis. The vernier dial fine-tunes the main tuning capacitor. The tickler-coil adjustment is part of the regenerative circuit.

Battery-operated antique radios often lacked on/off switches; the batteries had to be disconnected from the terminals. On our Westinghouse, batteries are also conserved by the headphone-jack arrangement. When the detector or first audio jack is used, the following stages are disconnected by the headphone plug.

The Silvertone *Model 1923*

The Silvertone was used mostly in rural areas, and by some urban dwellers whose homes were still unwired. All batteries are concealed in the oversized table-model cabinet. A separate patent notice protects each circuit used in that superhet. Unlike many early radios, an ON/OFF switch disconnects the batteries from the circuit. As we said, the Silvertone receives two short-wave bands in addition to the broadcast band. One knob changes bands without your having to plug in different coils.

Needs and haves

B. R. Pogue, Route 1, Box 786, No. 8, Thatcher, AZ 85552 offers to help readers needing help with antique radios. Enclose an SASE. Antique-radio information and parts can be obtained from E. G. Rountree, Box 269, Norris City, IL 62869. Antique radio tubes and schematics are also available from Byron Ladue, 13 Revere Dr., Rochester, NY 14624. Tubes (many of which are new) can be obtained from Maurer Sales, 29 S. 4th St., Lebanon, PA 17402. Send an SASE.

Bob Fabris, 3626 Morrie Dr., San Jose, CA 95127, is interested in contacting anyone with E. H. Scott Sets. An Atwater Kent Model 49 wiring diagram is needed by Greg Schelin, as the mice ate the insulation. I know what you mean, Greg: They usually don't disconnect the wires after their meals. Just replace them one at a time. Write to Greg at Star RTE Box 80, Culver, MN 55727.

FADA collectors: Jim Collins would like to correspond with you. Write to him at 8622 14 St. NE, Everett WA 98205. Information on an Atwater Kent Model 20 battery eliminator is needed by John Grey, 3348 Wildridge Road NE, Grand Rapids, MI 49505. John also has some antique radio tubes available cheap. A schematic diagram or other information on a U. S. Navy Crew Entertainment Radio, Model RBO2, is needed by George W. Gurner, 4417 Monmouth Castle Road, Virginia Beach, VA 23455.

Supreme Publications, 1926-1947 radio schematics are wanted by H. Penowarur, 1535 No. 8th Ave., St. Cloud, MN 56301. He also has issues of *Radio News* (post-Gernsback), and *Radio Craft* (the forerunner of **R-E**) from the 1930's for sale. Send an SASE for information. William C. Swater would like to contact Zenith collectors or clubs. Write P.O. Box 909, Senatobia, MI 38668. **R-E**

STATE OF SOLID STATE

ROBERT F. SCOTT
SEMICONDUCTOR EDITOR

IC temperature sensors and more

TEMPERATURE SENSORS HAVE COME A long way since the invention of the mercury-bulb thermometer. In the past, electronic devices that indicated changes in temperature were often based on the principle that a device's resistance varies as temperature changes. That variable resistance would cause a change in voltage that could be sampled, scaled, and output in human-readable form. Thermocouples, for example, work according to such principles. But the latest in electronic temperature sensing is based on integrated-circuit technology.

National Semiconductor has introduced two new series of precision IC temperature sensors; each series consists of five different devices with different temperature ranges. In each device, output voltage is linearly proportional to temperature. The LM35 series is used for Celsius readings, and the LM34 series for Fahrenheit readings.

All devices in the series are trimmed and calibrated during manufacturing to provide high accuracy and linearity; hence the circuit designer need not provide either calibration or trimming. The LM35 series features accuracy of ±0.25-degree at room temperature, and ±0.75-degree over the full −55 to +150°C range. The accuracy of the Fahrenheit units is ±0.5-degree at room temperature, and ±1.5-degree over the −50°F to +300°F range. Those devices have one advantage over similar units calibrated in degrees Kelvin. It is unnecessary to subtract or to null out a large constant in order to obtain readings directly in either degrees Celsius or degrees Fahrenheit.

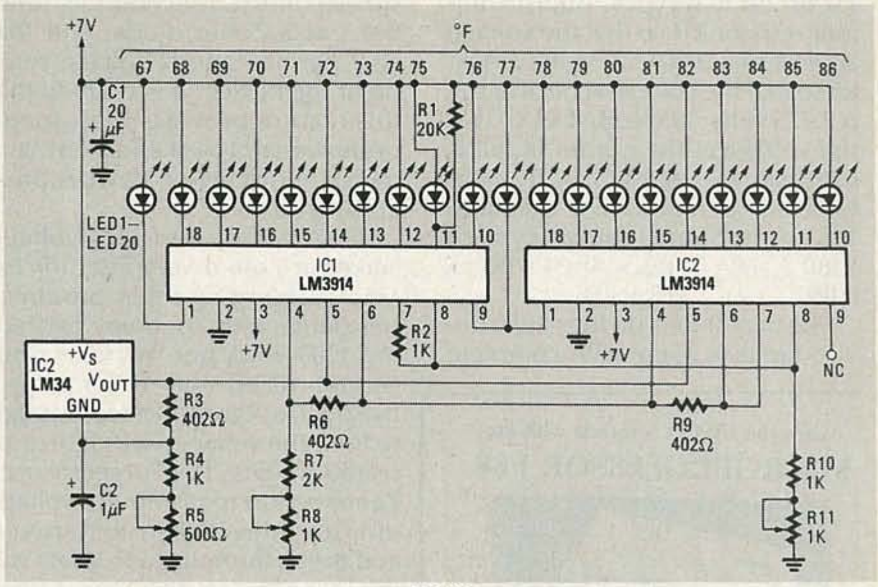


FIG. 2

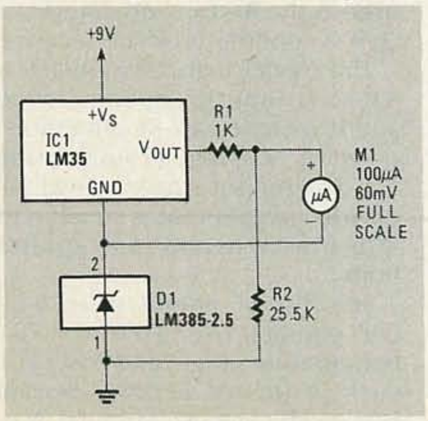


FIG. 1

All devices feature low output impedance, linear output, and precise inherent calibration, all of which make interfacing to readouts or control circuits especially easy. They can be powered by single-ended supplies ranging from +4 to +30 volts, or by split (plus and minus) supplies.

Quiescent current drain is very low. The LM35 series draws 56 µA from a 5- to 30-volt supply at 25°C. The LM34 series draws 75 µA. Self-heating due to thermal resistance is less than 0.1°C or 0.2°F in still air. Devices in the series measure temperatures ranging all the way from −55°C to +150°C (LM35, LM35A), and −50°F to +300°F (LM34, LM34A). Other models are available with more restricted ranges.

Thermal resistance of the LM35 in the TO-46 package is 400°C/W junction to ambient and 24°C/W junction to case. Thermal resistance in the TO-92 package is 180°C/W junction to ambient. The LM34 has a thermal resistance of 292°F/W junction to ambient, and 43°F/W junction to case in a TO-46 metal-can package. Thermal resistance is 324°F/W junction to ambient in the TO-92 plastic package.

All devices in the series produce a linear 10.0 mV/degree (°C or °F) output over the range of +2°C to +150°C for the LM35, and +5°F to +300°F for the LM34. Figure 1 shows the LM35 as an expanded-scale Fahrenheit thermometer with a +50°F to +80°F range.

Figure 2 shows the LM34 used as a bar-graph temperature display that displays temperatures ranging from +67 to +86°F. Two LM3914 bar-display LED drivers control twenty LED's. All fixed resistors are 1% or 2% film types. Adjust trimmer resistor R11 so that the voltage at pin 8 of IC3 is 3.525 volts; adjust R8 so that the voltage at pin 4 of IC2 is 2.725 volts; and adjust R5 so that the voltage at the output of IC1 is 0.085 volts + 40mV/°F × T_A (ambient temperature). For example, for an ambient temperature of +80°F, $V = 0.085 + (0.04 \times 80) = 0.085 + 3.2 = 3.285$ volts.

The data sheets on these two device families come with complete specifications and a dozen or so practical circuit applications. Request copies from **National Semiconductor,** Public Relations, 2900 Semiconductor Drive, Santa Clara, CA 95051.

New transient suppressor

The *Surgector* is a new type of device capable of diverting dangerous transient energy away from sensitive electronic equipment like telephones, computers, and other types of equipment subject to sudden voltage surges.

The monolithic device is a thyristor whose gate region contains a special diffused section that functions as a Zener diode, and that also permits anode-voltage turn-on of the device. It is claimed that this feature provides high-speed protection not available with many transient-protection devices presently used.

Risetimes of transient voltage spikes are often very fast; for example, lightning often produces transients with risetimes exceeding 1000 volts per microsecond. Gas tubes and many other protective devices cannot act fast enough to limit the voltage across the protected circuits. The *Surgector* uses Zener action to clamp the voltage until the integral thyristor turns on and drops the voltage to a safe value. In most cases the peak voltage reaching the protected circuitry does not exceed 130% of normal operating voltage. For example, it is claimed that a lightning surge with a risetime of 1500 volts/μs is clipped at about 100 volts.

Presently, RCA offers four types of Surgector: the SGTO3U13, SGTO6U13, SGT23U13 (2-terminal devices), and the SGT10S10 (a 3-terminal device). The 2-terminal devices are available with voltage ratings of 30, 58, and 226 volts. Those ratings refer to the voltage that can be continuously applied without tripping the device.

When a high-voltage transient arrives, the Zener diode in the gate region of the SCR conducts, and that turns the SCR on. The transient is thereby clamped to the forward drop of the SCR so the protected circuitry cannot be damaged. After the transient has passed, and after normal circuit current has dropped below the holding current of the Surgector, the device turns off, and normal circuit operation resumes. The devices have holding currents above 100 mA, and that insures they will operate in average telecommunication circuits.

The SGT10S10 is unidirectional, and its third terminal allows the user to control the SCR's turn-on voltage. That voltage is normally 100 volts, but, by using external gate-control circuitry, voltages less than 100 can be used to trigger the device.

All devices in the SGT series are housed in modified TO-202 plastic packages, whose small size makes them ideal for telephone handsets and PBX's. However, the SGT devices' low cost and high speed also make them suitable for applications in computers, alarm systems, TV, aircraft electronics, and CATV. In 10,000-piece lots, the SGT03U13, -06U13, -23U13, and -10S10 are $0.58, $0.72, $1.06, and $0.85, respectively.—**RCA Solid State,** Route 202, Somerville, NJ 08876.

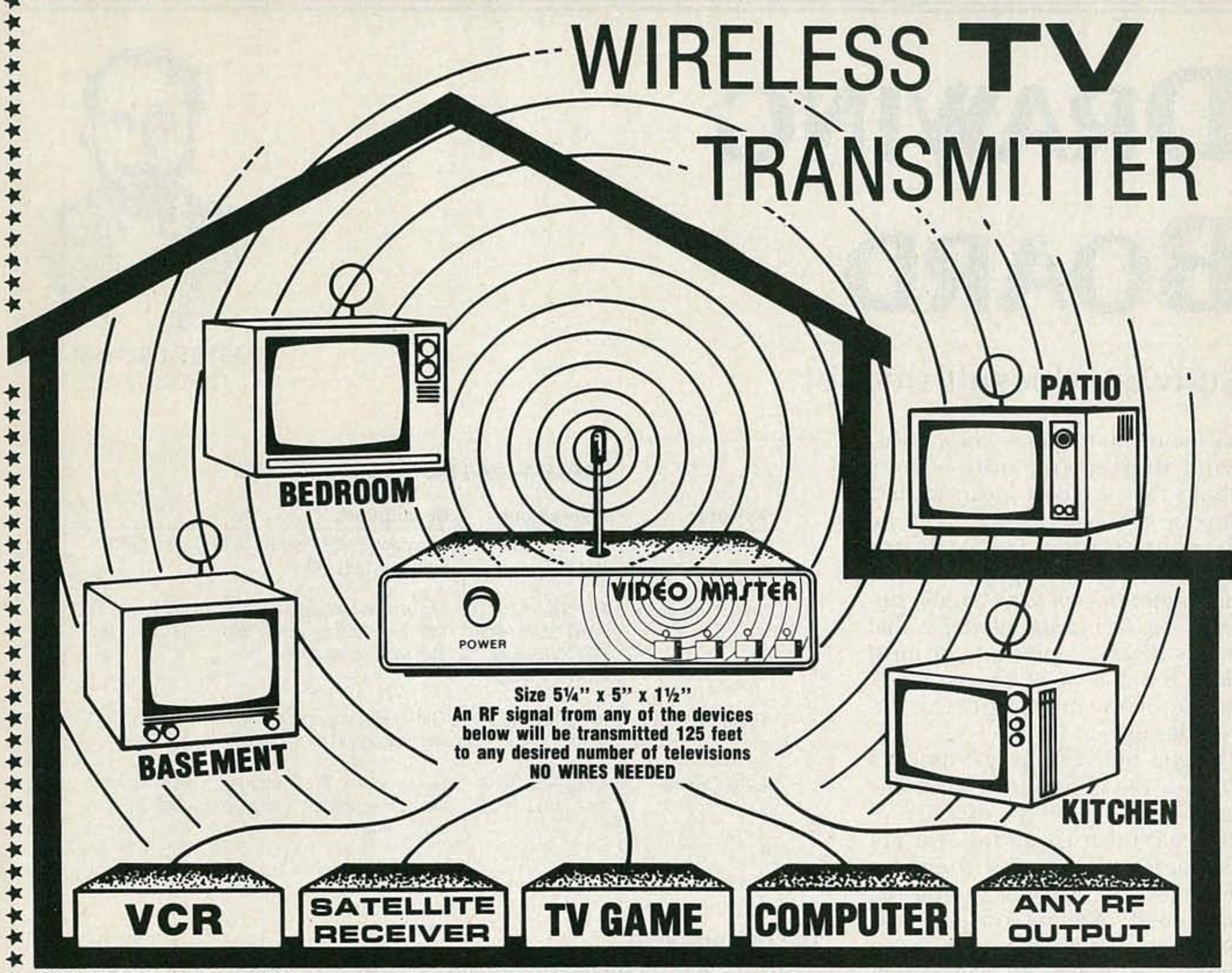
One-IC AM receiver

The ZN416E is the latest addition to Ferranti's line of single-IC AM broadcast-band receivers. Similar to the ZN415E in packaging and pin-out, the new device is a buffered-output version of the TO-92 style ZN414Z. A typical ZN416E delivers 120-mv RMS into a 64-ohm load.

Powered by a single 1.5-volt dry cell, the device may be used in a wide range of applications, including personal receivers, novelty radios, remote telephones, and radio-control circuits. The ZN416E, like others in its family, can be used as the IF-strip and detector of an AM superheterodyne receiver.

The ZN416E features a 150-kHz to 3.0-MHz input-frequency range, and it includes an RF amplifier, a detector, AGC and an audio amplifier. The output stages provide 18-dB voltage gain that is suitable for direct-drive headphone applications.

The ZN416E comes in an 8-pin DIP, operates over a 0°C to +70°C temperature range, and costs $1.12 each in lots of 10,000.—**Ferranti Semiconductors,** 87 Modular Ave., Commack, NY 11725. **R-E**



The video master is a small wireless UHF TV transmitter which transmits channel 3 or 4 RF signal you insert to all the televisions within your home. Input from any of the devices above can be inserted into the video master. The video master will transmit this signal on an unused UHF channel up to 125 feet to as many TV's as you wish to receive.

AND NO WIRES TO HOOK UP!

Use a separate video master on each device and let your TV act as the selector.

Example:

- ★ Video Master #1 On channel 15 connect to your Satellite Receiver
- ★ Video Master #2 On channel 19 connect to your VCR
- ★ Video Master #3 On channel 21 connect to your TV game.

By switching the UHF tuner on your TV, you will receive them all on each TV.

BUY THE VIDEO MASTER TWO WAYS:

#1. KIT FORM

Easy to build and tune, less than 2 hrs., no test equipment needed.
Use your TV to tune the video master kit.
All parts, P.C. Board, Fancy Cabinet, A.C. Power Adapter, UHF Loop Antenna.

Complete **$49.95** Plus Postage

#2. COMPLETELY ASSEMBLED AND TESTED

Complete with A.C. Power Adapter, UHF Loop Antenna
No Tools required for installation

$69.95 Plus Postage

EXTRA UHF LOOP ANTENNAS 95¢
QUANTITY DISCOUNTS — CALL

VISA — Visa & Master Card Accepted — MasterCard
TO ORDER CALL 800-428-3500
Information Call 317-291-7262

ELECTRONIC RAINBOW inc

6254 LaPas Trail • Indianapolis, IN 46268

CIRCLE 283 ON FREE INFORMATION CARD

DRAWING BOARD

ROBERT GROSSBLATT
CIRCUITS EDITOR

Software doesn't smoke!

WE ENDED LAST MONTH ON A SOMEwhat depressing note—sorry about that. I didn't mean to turn anyone off, but I know it can be disconcerting for hardware hackers to come to grips with the fundamentals of Z80 circuit design. The fact of the matter is that the hardware represents *at most* only about 50% of the work required of any microprocessor circuit design.

If you hooked up last month's circuit, the experience probably turned out to be an exercise in unqualified frustration. You got the parts, connected them together—and absolutely nothing happened! The reason is simply that even though microprocessor-based circuits are very powerful, they're also very stupid. They can do anything you want them to do, but they can't do anything at all without very explicit instructions from you.

I'm sure you know I'm talking about software. That is a *big* subject, and there's simply no way we can cover it here in any depth. The best I can do is point out a few fundamentals, and try to steer you in the right direction to get more information.

We've mentioned the *instruction set* here before; it is simply the set of commands recognized by the microprocessor. Each instruction is passed from memory through the INSTRUCTION DECODER, and then carried out by the arithmetic logic unit (or ALU for short). All Z80 circuits must have space to store those commands; in last month's circuit we used an EPROM, although it could have been some other kind of memory.

TABLE 1—Z80 INSTRUCTION TYPES

Function	Instructions	Descriptions
Data Movement	LD EX EXX IN OUT	This family moves data to and from CPU, memory, and I/O.
Data Changing	BIT SET RES ADD SUB AND OR XOR S R CP INC DEC	This is the largest series of instructions. They alter the data by doing arithmetic, bit level, and logical functions.
Program Flow	JP CALL RET	These can change the sequence of instructions in a program.
CPU Control	DI EI IMO IM1 IM2 HALT NOP	These let the Z-80 respond to events that aren't checked by the program being executed.

The hex problem

Since we'll be dealing with the Z80 in low-level machine language (as opposed to BASIC or Pascal, which are high-level languages), there's one thing you'll have to come to grips with right away: dealing with hexadecimal numbers.

Instructions are presented to the Z80 on its eight-bit data bus in binary (that is, as ones and zeros), but straight binary is too difficult to deal with, so designers almost universally use hex. For example, the code for a JUMP instruction (similar to a GOTO in BASIC), is 11000011 to the Z80, but to human beings, it's C3.

If you're serious about using microprocessors, you've got to get to the point where you can look at a hex number and have a good intuitive feel for what it means. I know that's a pain in the neck, but it's easier than constantly converting to and from decimal numbers.

Both data and instructions are specified in hex. The Z80 has 158 basic instructions, but if you count all the different addressing modes, the actual number of instructions is almost three times as many. Since a byte (8 bits) can have only 256 different values, and since there are over 400 different instructions, some instructions must be more than one byte long. In fact, some instructions are four bytes long. Anyway, in order to give you a basic idea of the Z80's instruction set, I've grouped all the instructions in four categories, as shown in Table 1.

The first group of instructions in Table 1, "Data Movement," has the most members. Those instructions include the LOAD series used to move data to and from external memory, the Z80's internal registers, and the I/O (input/output) devices connected to your system. Whenever you use one of these instructions, you have to supply two pieces of information: 1.) The source of the data (i.e.,

which register or memory location), or the data itself. 2.) The destination of the data.

There are 134 different data-movement instructions. Some of that variety is due to the fact that the Z80 has two main sets of registers. The alternate B'C' pair corresponds to the BC pair, D'E' to DE, H'L' to HL, and A'F' to AF. Now, even though it's correct to say that there are 14 registers in the Z80, it's a bit misleading as well. Only one set of those registers is available for use at one time.

The Z80 has two types of instruction that allow access to the alternate registers: EX and EXX. The former exchanges the AF pair and the A'F' pair, and the latter exchanges the other three pairs, (BC, DE, and HL for B'C', D'E', and H'L'), all at once. There are four other EX instructions that swap registers, but they operate only on the main register set.

The IN and OUT instructions are the last of the data-movement instructions. Some of those instructions operate only on a single byte of data, and others make it easy to move whole blocks of data. A simple I/O instruction would be:

```
IN A,n
```

The accumulator is symbolized by *A*, and *n* is a one-byte hex number specifying a particular port address. Since one byte is used to specify that address, the Z80 can address 256 different I/O ports.

When the Z80 executes an I/O instruction, several things happen. First, the port address specified in the I/O instruction is placed on the lower bits of the address bus (A0–A7). Second, the contents of the accumulator are put on the upper half of the address bus (A8–A15). Third, the $\overline{\text{IORQ}}$ line and the $\overline{\text{RD}}$ line go low. Finally, the data is transferred via the data bus to the accumulator. The whole process is quite similar to the way data is transferred to and from RAM (Random Access Memory). An OUT instruction would work in much the same way, but the $\overline{\text{WR}}$, rather than the $\overline{\text{RD}}$, line would go low.

Data changing instructions

The second group of instructions covers many of the things we commonly do with hardware: arithmetic operations (ADD, SUB, CMP), that allow you to add, subtract and compare individual bytes, and logical operations (AND, OR, XOR), and bit operations (BIT, SET, RES, SHF, ROT) that allow you to examine and change individual bits.

If you've programmed in a high-level language like BASIC, the instructions in the third group should look familiar, since there are equivalents in all high-level languages. As mentioned above, the JUMP instruction is similar to BASIC's GOTO; CALL is similar to GOSUB, and RET is similar to RETURN.

The last group of instructions controls the operation of the Z80 itself, rather than directly manipulating or moving data. One very commonly used instruction is NOP, for NO OPERATION. It causes the Z80 simply to bide time for a full clock cycle. Among other things, programmers use NOP's to generate timing loops, and to reserve space in the middle of a program for code that will be added later.

The remaining instructions of that final group are all concerned with *interrupts* in one way or another. The Z80 allows three different types of interrupt, but they all operate in a similar manner. When a low is received on either of the Z80's two interrupt pins, normal program flow stops and, depending on how the Z80 is set up, program flow will continue at a special location in memory.

Unfortunately, to find out more about interrupts, software and other Z80 vitals, you're going to have to do some homework. We need some software to wake up our Z80 circuit, and we'll get into that next month. However, that software won't make much sense if you don't spend some time on your own reading about the Z80's instruction set.

So do some investigating, and don't be afraid to try burning an EPROM and telling our circuit to do something. Learning software design is very similar to learning hardware design—but with one big advantage: It might not work, but it won't smoke or blow up! See you next month. **R-E**

DESIGNER'S NOTEBOOK

A simple CMOS switching circuit

ROBERT GROSSBLATT
CIRCUITS EDITOR

WE RAN A CONTEST, A FEW MONTHS ago, to come up with clever hexadecimal display circuits that would display the digits *Ø through 9* and the letters *A* through *F* on standard 7-segment LED displays, given binary inputs ranging from ØØØØ to 1111. Of course, I received quite a few interesting ideas, but I was surprised to learn that a number of you are interested in using LED display drivers to control devices *other* than LED's!

It seems that people want to use devices like the 4511 to control everything from lightbulbs to relays to high-current motors. I have to admit that I don't really understand why you would want to do that, since the 4511 (and most common display drivers) put peculiar signals on the outputs while the inputs are changing. After all, those IC's were designed to be display drivers, and for display purposes, that's not a problem. But it could be a major problem if you are controlling other devices.

But with the proper interface circuitry, you can have those drivers control anything you want, as long as you don't exceed the IC's current-drive capability. Using a 4511 to drive a device that uses half the available power output of the TVA is possible, given the proper interface. *(For a more extended treatment of this subject, see the article on switching transistor circuit design in next month's issue.—Editor)*

An example

The circuit in Fig. 1 shows how you could use a 4511 (or any other CMOS gate, for that matter) to control low- to medium-power devices. That circuit should look familiar; we've used it, or variations of it, many times in this column. The transistor, which could be a 2N2222, is set up as a switch. When the CMOS output goes high, the transistor will turn on, assuming that R1 allows enough current to flow. Current will then flow through the output device and the transistor's collector-emitter junction.

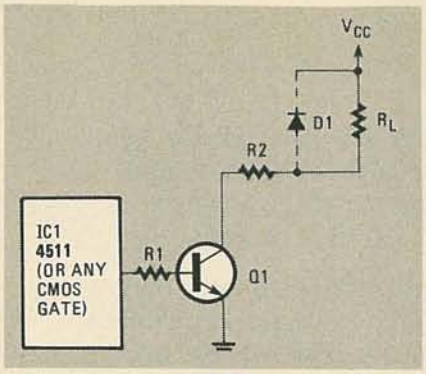


FIG. 1

In that circuit, R_L symbolizes the load you need to control, be it a lightbulb, an LED, a relay, etc. Resistor R1 is there to protect the CMOS output, and R2 is there to limit the current through the transistor. Optional diode D1 should be used if you're driving an inductive load; it will protect the coil from inductive spikes.

Working out the values of the components you need for your application is simple—just follow the design rules below and you shouldn't go wrong.

1) R1 limits the transistor's base drive.

2) R2 limits the transistor's collector current.

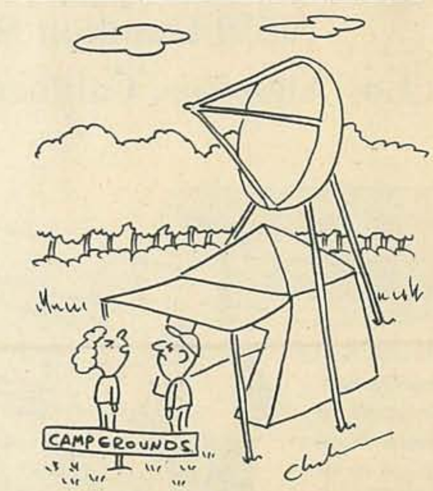
3) Both values can be found from a straightforward application of Ohm's Law. Figure the transistor voltage drop as .6 volts.

4) Make sure that the transistor you choose has high enough ratings to withstand the voltage and current you'll be using.

5) If your circuit doesn't work, the transistor probably doesn't have enough gain. Try another one with higher gain, or else use a Darlington.

6) The diode's PIV rating should be at least twice the value of V_{CC}, and it should be able to handle at least twice the current drawn by the coil.

That kind of circuit is one of the most basic building blocks in electronics. Learning how to work with transistor switches is a good first step if you want to learn how to design your own circuits. So feel free to experiment—the parts are cheap. **R-E**



"People will think that we came here just to watch television."

SERVICE CLINIC

Repairing old TV's

JACK DARR
SERVICE EDITOR

WE'VE TALKED ABOUT REPAIRING OLD radios in past columns; now let's talk about repairing old TV's. The same basic procedure is followed as in fixing modern TV's. Before you start, take a minute to check some of the really obvious trouble spots; doing that could save you a lot of trouble later on. In particular, check the picture tube and the HV (high voltage). If either is bad (for example, if the picture tube has an open heater, or the flyback is burned up), it might be wise to consider whether that TV is really worth fixing. Of course, if the customer says, "Fix it, regardless of the cost," go ahead and do it.

If, in your preliminary examination, you find that the flyback is a charred mess in the bottom of the chassis, contact the customer, tell him that the TV has a serious problem, and explain that a new flyback is going to raise the cost of the repair quite a bit. New flybacks for some old TV's can cost as much as 35 or 40 dollars!

The next step is to look through the chassis for obvious problems like weak tubes, leaky transistors, burnt resistors, open capacitors, etc. If nothing is found, there's a good chance the TV will function correctly.

B+ is first

After getting the go-ahead from your customer, get the B+ up to normal, and then check through the circuit stage by stage to see if anything else is out. Check the sync separator, the video-output circuits, and each portion of the circuit, as shown in Fig. 1; and then check the alignment.

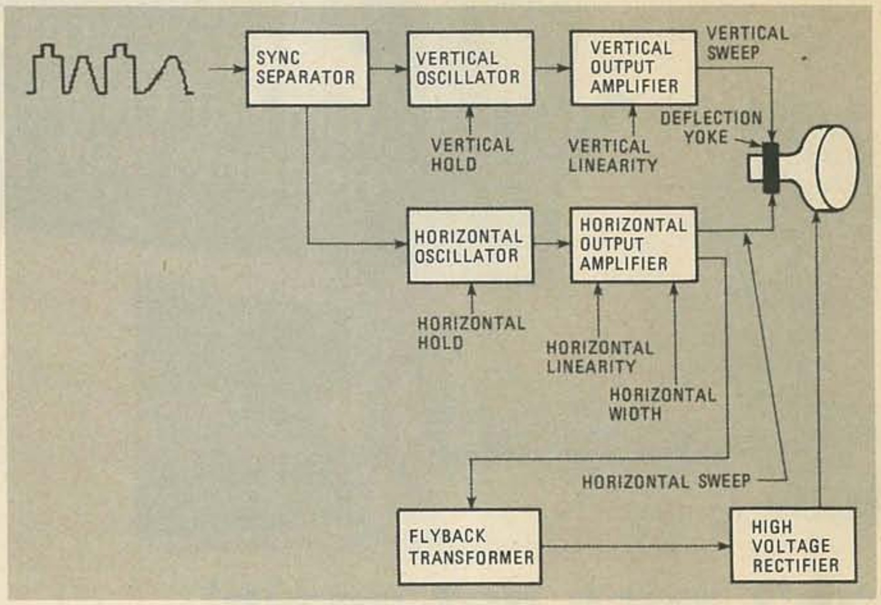


FIG. 1

I'm a great believer in "nonalignment" whenever possible. That is, if the TV works, and if the coils seem not to have been fiddled with—the adjusting slugs are not all the way in or out—there's a good chance that the coils haven't been touched. And if they haven't, then the chances are also good that the alignment is still OK. So, if it ain't broke, don't fix it!

You can check the alignment with a sweep-generator; hook the generator up and get a curve on your scope. If all your markers and traps (sound, picture, etc.) are in the right places, that's even better evidence that the coils haven't been fiddled with. I've put a sweep generator on any number of old TV's, and found a picture-perfect IF curve on them!

Here's another thing to check when working on an older set: Make sure that all of the controls (brightness, horizontal and vertical hold, etc.) are clean and that they work smoothly throughout their useful range of adjustment. Controls in old sets are often functionally OK, but dirty and noisy; and that makes them hard to adjust. If one is dirty, give it a shot of volume-control cleaner spray, and work the control back and forth till the noise goes away. Do that to each control, if necessary.

If the FOCUS control can't make the scanning lines clean and sharp, check for correct focus voltage; about 4,000 to 4500 volts is normal. If the focus voltage *is* too low, the beam won't focus properly. If it is too low, check the focus supply; usually it is separate from the main HV supply, but sometimes it is derived from the HV through a high-value dropping resistor, possibly ten megohms or more. If the focus voltage is too low (or too high), check that dropping resistor. It may have drifted off-value.

All in all, if a TV has survived a few decades with no really serious problems, there's a pretty good chance that it can be successfully restored at not too great an expense. Problems like no B+ are usually simple to diagnose and track down if you're patient. Alignment is often OK, but if the picture is fuzzy, the alignment may be out. Check the tuning-slugs, as mentioned above. Other than that, be on the lookout for suspicious-looking components: burned resistors and the like.

It's usually not too difficult to fix up one of those old soldiers; and if you do, you should wind up with a good working TV. **R-E**

SERVICE QUESTIONS

RED-HOT DAMPER TUBE

An Admiral came in with a blown fuse. I replaced the horizontal output tube, the oscillator and the damper. The set worked for 2 days and now it runs for about 15 minutes, after which the damper tube gets red hot before the fuse blows.—L.H., Keene, NH

A variable transformer would be a big help, here. You could run the chassis at a low AC voltage to keep the damper from glowing while checking out the rest of the circuit. With or without a transformer, wrap your fingers around the flyback. If it's hot, it's defective. The same is true for any component in the output circuit.

VERTICAL BAR IN PICTURE

A Sears model 564-4173 TV set comes on with a 1-inch vertical bar that appears to be an overlapping of the left and right portions of the picture. It gradually narrows and, after 30 minutes, eventually opens into a nearly-full picture. I have no scope. Can you help?—A.H. Atascadero, CA

A scope certainly would help here so that you could take before and after measurements. Nevertheless, it looks like a thermal problem, doesn't it? Once the picture opens up, why not spray components in the horizontal circuit with cooler and look for a breakdown? If you're successful in localizing the problem, you can use the reverse technique—heat the components with a lamp or soldering-iron tip and look for a reaction.

SHRUNKEN VIDEO

I have a Zenith 25DC56 chassis, in which the picture is short by about one inch on each side. I've changed everything in the horizontal circuit and the power supply. Every once in a while I hear the high-voltage crack.—G.E. Bow, KY

My hunch is that the high voltage is too high, hence the arc-over. If so, try replacing the retrace cap (a .0018 μF capacitor from the output collector to ground). I believe what's happening is that the excessive high voltage causes a faster beam through the kine, resulting in a shorter deflection angle, and thus a smaller picture. **R-E**

SECURITY SYSTEM

continued from page 52

vary by rotating R7. The LED's connected to IC4-a should be counting from zero to seven in a binary sequence; the group should change state once for every eight flashes of LED1 if IC2–IC4 are operating properly.

Install a short jumper for sense-loop connector P9 in SO3 and press the TEST switch. The TEST lamp should light up. Press the MASTER RESET switch; DSP1–DSP4 should all read "0," and LED2–LED4 should be off. After releasing the switch, counting will begin. After IC4 has counted to seven, LED5 on the timer board and LMP5 (ARMED) in the control panel should illuminate. Removing the jumper should trigger RY1, and ALARM lamp LMP3 should light. Re-inserting the jumper and pressing ALARM RESET switch S20 should turn off RY1 and LMP3. If everything worked as expected, you're ready to install your real sense loop.

Now test the keyboard circuitry. Set the desired entry code using switches S1-a–S1-h and S2-a–S2-h. Press the MASTER RESET switch and, after the ARMED lamp turns on, punch in your code. LED7 on the display board should light, and so should LED10 in the keyboard panel. Pressing ENTER switch S19 should now cause pin 3 of IC6 to go high, which should clock flip-flop IC7 and turn on RY4.

Incidentally, you may have noticed that the ALARM RESET switch is mounted on the control panel in our prototype. It is likely that you will want to relocate it to a less conspicuous place. One good location would be near the main chassis.

After any problems have been corrected, the sub-assemblies should be sealed up and mounted in their final positions, and the interconnecting cables and sense-loop wiring completed. The alarm should be fully functional now.

Power failure

In the event of a power failure, after power is restored the system will automatically go into the timing cycle and then arm the alarm. If the five-volt power supply fails and the twelve-volt supply remains operational, you would have no way to enter the secured area without tripping the alarm, because, without five volts, the display board would be inoperable, so the proper code could not be punched in. Therefore, you may want to add failsafe keyswitch S23 (shown in Fig. 10); for maximum security, that switch should be located in an out-of-the-way place. If you do not wish to use a keyswitch, an alternative would be to add a battery backup circuit that would take over in the event of a power failure.

Other uses

For automotive or marine use, the timer board might be used by itself as an intrusion alarm. In addition, the digital combination lock could be used as a theft prevention device. By inserting the lock in series with the ignition circuit of an automobile or boat, the vehicle would not start until the correct digital code were punched in. Power could easily be derived from the automobile's (or boat's) electrical system.

If you have any difficulties during either construction or operation of the alarm, feel free to drop the author a line. If you require a reply, be sure to include a self-addressed, stamped envelope, and write to 908 Broadhurst Dr., St. Louis, MO 63011. **R-E**

NEW PRODUCTS

CIRCLE 21 ON FREE INFORMATION CARD

TUNER-PREAMPLIFIER, model *B286,* features a ten-square-inch liquid-crystal panel that displays operational status of 17 different functions, including the call letters, locations, and frequencies of 29 FM and AM stations. It is designed for use with powered speakers—or separate power amplifiers—in a programmable, interactive music system that is remotely controllable, even from other rooms.

The model *B286* is easy to program—either by its front-panel controls or by the model *B205* remote. With the help of two microcompressers and a nonvolatile memory, 34 separate levels can be programmed for each of the 29 FM and AM stations—along with similar programming for source inputs. The music listener can now switch from station to station, or source to source, without annoying volume changes.

The model *286* is priced at $1400.00.—**Studer Revox America, Inc.,** 1425 Elm Hill Pike, Nashville, TN 37210.

TEST-EQUIPMENT LINE, includes two battery testers and five multimeters; here is the data on those seven units.

The model *23-170* multi-purpose battery tester is a large diagonal meter that measures actual voltage and has a "good-weak-replace" scale. There is also a simple mechanical system that allows the user to drop in batteries of different sizes and push a button for accurate readings. The suggested retail price is $12.50.

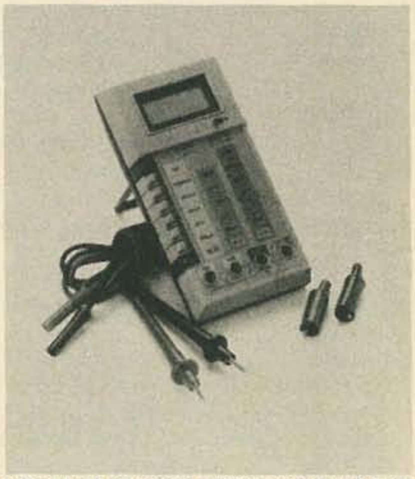
The model *23-175* multiple-range deluxe battery tester is a 3" diagonal analog meter with multiple multi-color scales for easy reading, to tell if the battery is good, marginal, or needs replacement. The suggested retail price is $19.90.

The model *23-200* day-in day-out versatile multi-tester is a 2000 ohm-per-volt multi-tester that measures AC voltage, DC voltage, DC current, decibels, and resistance. There are 16 measurement ranges in all. The suggested retail price of the model *23-200* is $15.95.

The model *23-204* 10,000 ohm-per-volt multi-tester has 19 ranges, an anti-parallax mirror, jeweled movement, and overload protection. The suggested retail price is $23.50.

The model *23-206* high-sensitivity meter features 20,000 ohm-per-volt sensitivity and measures AC voltage, DC voltage, DC current, resistance, and decibels over 23 ranges. The 4" diagonal jeweled meter has anti-parallax mirror, overload protection, and multi-colored scale. The suggested retail price is $32.95.

The model *23-215* pocket-size pushbutton meter is a ten-megohm multimeter with 3-½-digit liquid-crystal display. It features high accuracy, compact size, RF shielding, pushbutton range selection, and a meter-overload protection circuit. The suggested retail price is $79.96.



CIRCLE 22 ON FREE INFORMATION CARD

The model *23-220* 3½"-digit LCD multimeter (shown in photograph) has 10-megohm input sensitivity and professional accuracy of 0.25%. It measures 24 ranges and features an auto-zero function and automatic polarity sensing to prevent overload and minimize potentially damaging voltages. The suggested retail price of the model *23-220* is $119.95.—**Midland International Corporation,** 1690 North Toping Ave., Kansas City, MO 64120. **R-E**

SATELLITE-TV RECEIVER

continued from page 48

to pin 6 of IC8, an NE564 phase-locked loop. That IC is used to lock in the audio subcarrier by varying the voltage on varactor diode D12. The tuning range (5.0 to 8.0 MHz) is set by C72, while front-panel SUB-CARRIER TUNING potentiometer R110 fine-tunes the audio sub-carrier.

Audio de-emphasis is provided by R80 and C55, and Q8 amplifies the signal to drive the RF modulator. A separate audio output is provided at jack J3. Trimmer potentiometers R111 and R112 set the narrow- and wide-reception bandwidths of the PLL, respectively.

As mentioned above, satellite-TV signals for the U.S. are broadcast in two polarities: horizontal and vertical. In order to receive signals of either polarity, we must have some way of rotating the antenna probe. The receiver offers a PULSE output at its rear-panel terminal strip TS1 for that purpose. When POLARITY switch S2 is toggled, the pulse width at the PULSE output changes, and that causes the motor-driven antenna probe (in the feedhorn) to rotate 90 degrees.

The control pulses are generated by IC6, an NE555 timer IC functioning as an astable multivibrator. Its pulses are output on pin 3; R47 protects the IC's output stage in case a short develops in the cable leading to the feedhorn. The SKEW control, R108, varies the pulse width for fine tuning of the received signal.

The pulse width of the output of the 555 circuit can vary from about 0.6 ms to 2.6 ms, which corresponds to a probe movement of about 160 degrees. Ideally, with SKEW control R108 centered, the output pulse width with S2 in its HORIZONTAL position would be 1.9 ms, and it would be 1.0 ms in its VERTICAL position. Then, each time the POLARITY switch is toggled, the probe will rotate 90 degrees. Because polarization may vary slightly from satellite to satellite, the front-panel POLARITY selection switch S2 is supplemented by the front-panel SKEW control (R108) for fine-tuning.

The RF modulator delivers a signal that is compatible with all standard TV's and VCR's to TV Channel 3 or 4. The modulator is crystal controlled, so no fine tuning is required.

Now you should have a pretty good idea of how the satellite receiver works. The next step is to build a unit. Unfortunately, that will have to wait until next time as we are out of room for this month. Meanwhile, if you want to get a head start and gather the parts, a complete parts list has been provided. Most individual parts are available from the kit supplier mentioned. **R-E**

DIGITAL IC'S

continued from page 74

literature, but it is still a popular circuit.

The circuit in Fig. 23 is based on the 4060 CMOS oscillator divider. That IC has an internal oscillator that drives a chain of binary counters. Either R-C or crystal timing of the oscillator is possible. (In the circuit shown, a crystal is used to determine the operating frequency.) Each output is equal to the fundamental frequency divided by a power of two, up to $f/2^{14}$; note, however, that outputs of $f/2$, $f/4$, $f/8$, and $f/2048$ are not available.

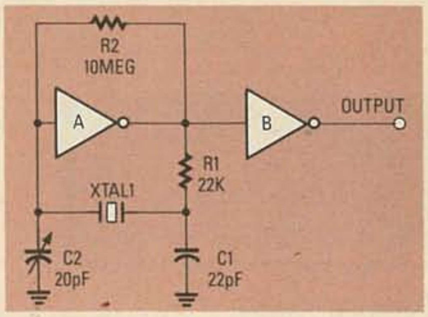


FIG. 22—THIS "CLASSIC" CMOS oscillator first appeared in some of the earliest CMOS applications notes.

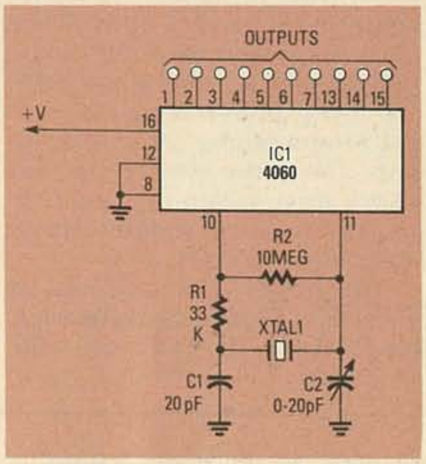


FIG. 23—THE 4060 CMOS oscillator/divider contains an internal oscillator that drives a chain of binary counters.

Op-amp clock circuits

Figure 24 shows how an op-amp can be configured to operate as an astable multivibrator. The negative feedback loop consists of R3 and C1, and it is that network that sets the operating frequency of the circuit, although the voltage-divider bias network, R1-R2, also has a role.

The Zener diodes across the output are connected back-to-back and are used to limit output-voltage swings. In addition, because they prevent saturation of the op-amp output on extreme swings, those diodes also tend to sharpen the squarewave signal. Resistor R4 is used to limit current

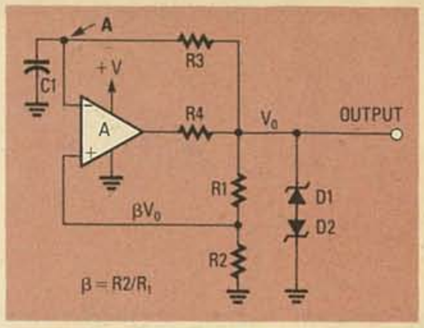


FIG. 24—THE ZENER DIODES are used to limit the output voltage swings.

through the Zeners to a safe value. In most cases the voltage across D1 is equal to the voltage across D2, so the output waveform is symmetrical. Under that condition, the output voltage has a peak-to-peak value of $2(V_{D1} + 0.7)$.

Timing of the output signal is shown in Fig. 25. On both halves of the output squarewave (V_O), capacitor C1 charges through R3. At time t_1, we assume that

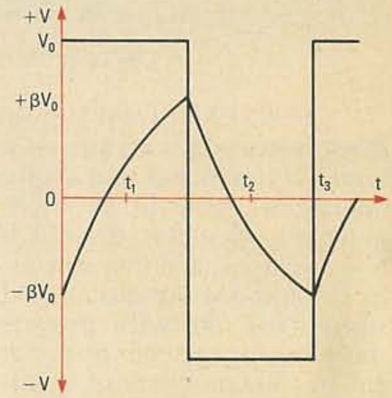


FIG. 25—TIMING DIAGRAM for the circuit of Fig. 24.

the output voltage is positive ($+V_O$), and that voltage V_C (measured at point **A** in Fig. 24) is at $-V_O$, where β is equal to R2/(R1 + R2). Since V_O is positive, and V_C is negative, capacitor C1 will discharge toward zero and then recharge toward $+V_O$ at a rate that is determined by R3, C1 and the output voltage.

The op-amp works as a voltage comparator. As long as V_C is less than βV_O, the output voltage will remain at $+V_O$. But as soon as V_C is equal to, or greater than βV_O, the output snaps to $-V_O$.

The transition of output states occurs at time t_2. Since the output is now negative, and V_C is positive, the capacitor now discharges toward $-\beta V_O$.

The period of the squarewave, T, is $t_3 - t_1$; frequency, of course, is 1/T. For any values of R1 and R2, T is equal to:

$$(2)(R3)(C1)\ln\left(\frac{2R1}{R2} + 1\right)$$

or, if R1 = R2, T = (2.2)(R3)(C1) **R-E**

MARKET CENTER

FOR SALE

RESISTORS ¼W,½W5%C.F. 3 cents. 1%Metal-films, custom wirewounds, capacitors and other components. **JR INDUSTRIES**, 5834-H Swancreek, Toledo, OH 43614.

CABLE and **Subscription TV** secret manual. Build your own **descramblers**, converters. Instructions, schematics for Sine Wave, Inband/Outband Gated Sync, SSAVI—(HBO, Showtime, Cinemax, UHF, etc.) Send $8.95 to **CABLETRONICS**, Box 30502R, Bethesda, MD 20814.

TI-99/4A software/hardware bargains. Hard-to-find items. Huge selection. Fast service. Free catalog. **DYNA**, Box 690, Hicksville, NY 11801.

TUBES, new, unused. Send self-addressed, stamped envelope for list. **FALA ELECTRONICS**, Box 1376-2, Milwaukee, WI 53201.

INDIVIDUAL photofact folders. No. 1 to no. 1400, $3.00 postpaid. **LBT**, 414 Chestnut Lane, East Meadow, NY 11554.

DESCRAMBLERS for downconverters. Bargain. Send $2.00. **RB ELECTRONICS**, P.O. Box 643, Kalamazoo, MI 49005.

ELECTRONICS catalog. Over 4,500 items. Parts & components. Everything needed by the hobbyist or technician. $2.00 postage & handling (States only), refundable with first $15.00 order. **T & M ELECTRONICS**, Dept. R, 472 East Main Street, Patchogue, NY 11772, (516) 289-2520.

WANTED:, Old, new, tubes, speakers, amplifiers, Western Electric, RCA, Telefunken, McIntosh, Marantz, Jan, Quad, Tannoy, Altec, Dynaco, (713) 728-4343. **MAURY**, 11122 Atwell, Houston, TX 77096.

TV tunable notch filters, free brochure, $1.00. **D.K. VIDEO**, Box 63/6025, Margate, FL 33063. (305) 752-9202.

BUGGED? Wiretapped? Find out fast. Countermeasures equipment catalog $1. **CAPRI ELECTRONICS**, Route 1R, Canon, GA 30520

CORDLESS-phone interference? We've got the answer. Have a radar speeding ticket? We can help. Home phone extension in your car? You can have it. 50-page color catalog airmailed $3.00. **DBE**, P.O. Drawer G, Waikiki, HI 96815. MC/VISA orders (808) 395-7458.

COMPUTER adventures. Atari, Apple, Commodore, Spectrum. S.A.S.E. for free catalogue. **COMPUQUEST INFORMATION DESK**, Box-492, St. Croix Falls, WI 54024.

CIRCUIT boards: Your artwork, quick delivery, reasonable. **ATLAS CIRCUITS**, Dept. A, P.O. Box 892, Lincolnton, NC 28092, (704) 735-3943.

TV stereo adapter plans/**PCB** also **UHF gated-pulse** descrambler with simulated stereo output. For additional information—send S.A.S.E. to **SOKOLOWSKI**, Box 150, Elmont, NY 11003.

PICTURE flyer lists quality electronics surplus at low prices. Since 1970. Send for last 3 issues. **STAR-TRONICS**, Box 683, McMinnville, OR 97128.

ASSORTMENT #103— consisting of **TOKO coils** 144LY-120K, 520 HN-3000023, BKAN-K5552AXX (2); **PCB; transistors** 2N3904 (2) BFQ85 (sub); **IC's** 7812, 74123, MC1330A1P; **Diodes** 1N914, 1N5231B. Only $25.00. Coils (only) $8.00/Set. **AC adapter** $6.00. **Free shipping**. MC/VISA/COD. **Toll Free 1-800-821-5226 Ext. 426 (orders). JIM RHODES, INC.**, 1025 Ransome Lane, Kingsport, TN 37660.

ZENITH SSAVI Manual. Original manual used by technicians. Theory of scrambling, schematics parts list, repair for UHF and cable. For speedy delivery send $15.00, cash or money order. **BAY STATE ELECTRONICS**, P.O. Box 263, Accord, MA 02018.

FREE importer accessories catalog, video, audio, others. With business card write, **17 BANNER COURT**, East Brunswick, NJ 08816.

CABLE and satellite equipment: major brands, wholesale prices. Free catalog. **HMR SALES**, 221 East Camelback, Phoenix, AZ 85012. (602) 993-0398.

OLDTIME radio programs on high quality tapes. Comedy! Adventure! Music! Free catalogue. **CARL F. FROELICH**, Heritage Farm, New Freedom, PA 17349.

Wholesale audio, video, telephone accessories, antennas, cartridges. Free catalog. (718) 897-0509. **D & WR** 68-12 110St., Flushing, NY 11375.

CLASSIFIED AD ORDER FORM

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

Radio-Electronics Classified Ads, 200 Park Avenue South, N.Y., N.Y. 10003

PLEASE INDICATE in which category of classified advertising you wish your ad to appear. For special headings, there is a surcharge of **$23.00.**

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

Special Category: $23.00

PLEASE PRINT EACH WORD SEPARATELY, IN BLOCK LETTERS.

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

1	2	3	4	5
6	7	8	9	10
11	12	13	14	15 ($42.75)
16 ($45.60)	17 ($48.45)	18 ($51.30)	19 ($54.15)	20 ($57.00)
21 ($59.85)	22 ($62.70)	23 ($65.55)	24 ($68.40)	25 ($71.25)
26 ($74.10)	27 ($76.95)	28 ($79.80)	29 ($82.65)	30 ($85.50)
31 ($88.35)	32 ($91.10)	33 ($94.05)	34 ($96.90)	35 ($99.75)

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

Card Number ______________________ Expiration Date ______________________

Please Print Name ______________________ / Signature ______________________

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

CLASSIFIED COMMERCIAL RATE: (for firms or individuals offering commercial products or services) $2.85 per word prepaid (no charge for zip code)...**MINIMUM 15 WORDS.** 5% discount for same ad in 6 issues; 10% discount for same ad in 12 issues within one year; if prepaid. **NON-COMMERCIAL RATE:** (for individuals who want to buy or sell a personal item) $2.30 per word, prepaid....no minimum. **ONLY FIRST WORD AND NAME** set in bold caps at no extra charge. Additional bold face (not available as all caps) **50¢ per word additional (20% premium).** Entire ad in boldface, **add 20% premium** to total price. **TINT SCREEN BEHIND ENTIRE AD: add 25% premium** to total price. **TINT SCREEN BEHIND ENTIRE AD PLUS ALL BOLD FACE AD: add 45% premium** to total price. **EXPANDED TYPE AD: $4.30 per word prepaid.** All other items same as for STANDARD COMMERCIAL RATE. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD: add 25% premium** to total price. **TINT SCREEN BEHIND ENTIRE EXPANDED TYPE AD PLUS ALL BOLD FACE AD: add 45% premium** to total price. **DISPLAY ADS:** 1" × 2¼"—$310.00; 2" × 2¼"—$620.00; 3" × 2¼"—$930.00. **General Information:** Frequency rates and prepayment discounts are available. **ALL COPY SUBJECT TO PUBLISHERS APPROVAL. ADVERTISEMENTS USING P.O. BOX ADDRESS WILL NOT BE ACCEPTED UNTIL ADVERTISER SUPPLIES PUBLISHER WITH PERMANENT ADDRESS AND PHONE NUMBER.** Copy to be in our hands on the 12th of the third month preceding the date of the issue. (i.e., August issue copy must be received by May 12th). When normal closing date falls on Saturday, Sunday or Holiday, issue closes on preceding working day.

CB MODIFICATIONS

Increase channels, range, privacy! We specialize in frequency expanders, speech processors, FM converters, PLL & slider tricks, how-to books, plans, kits. Expert mail-in repairs & conversions. 16-page catalog $2.

CBC INTERNATIONAL, P.O. BOX 31500RE, PHOENIX, AZ 85046 (602) 996-8700

TUBES: "oldies", latest. Supplies, components, schematics. Send S.A.S.E. for catalog. **STEINMETZ**, 7519 Maplewood RE, Hammond, IN 46324.

CABLE TV secrets—the outlaw publication the cable companies tried to ban. HBO, Movie Channel, Showtime, descramblers, converters, etc. Suppliers list included. $8.95. **CABLE FACTS,** Box 711-R, Pataskala, OH 43062.

CABLE TV source book—a complete listing of suppliers for hard-to-find converters, descramblers, technical information, schematics and much much more. Full refund if not completely satisfied. Send $4.95 to **CABLE,** Box 12505-R, Columubus, OH 43212.

Microwonderland. Commodore computer's parts! Solid State coolers for 1541/71 drives! KIM-1 computers, accessories! Thousands IC's by mail! Free 64KDRAM sets! Discounts! Catalog—$3.00! **K. BOUFAL—CONSULTING SERVICES,** Fitzwater, Philadelphia, PA 19147. (215) 925-6469.

Cable TV filters for elimination of undesirable signals. (50 dB.notch) channels available: 2 through 8; 14(A) through 22(I). Send $20.00 each, **Money back guarantee**. Quantity disccounts. **CATV,** Box 17621, Plantation, FL. 33318.

Canadians, send for your free semiconductors now. Limited offer, so hurry. Send a self addressed (please print) stamped envelope to **C.E.D.A.C.** 6 Douglas Cres., Hillsburgh, Ont. NOB-1ZO.

Index-Radio Electronics 1980 thru 1985 by category $2.00 per year. Options & diskettes available. **RE-INDEX,** 6472 E. Long Ave., Englewood, CO. 80112.

Check/restore every color, b/w, projection, camera, oscilliscope CRT's. Over 10,000 CRT listings. Guaranteed to fit your tester. Our 3rd year. Chargecards/checks/COD's. CA28-$59.95 ppd 1-800-331-9658. **DANDY ELECTRONICS,** 2323 Gibson, Muskogee, OK 74403.

Software—public domain IBM compatibles. $4.00 volume or rent—over 500 available. $2.00 catalog or $5.00 sample. **DISK SOFTWARE**, Box 41778 Sacramento, CA 95841.

TV-Stereo M.T.S. adapter for any TV-VCR. No receiver disassembly. Line level outputs: includes expander. $52.00, $2.00 shipping. **D. W. FISHER,** Box 334, RFD#5 Penacook, Webster, NH 03303.

Attention looking for surplus test equipment; have voltmeters, signal generators, other types of equipment. **J.B. ELECTRONICS**, 9518 Grand, Franklin Park, IL 60131. (312) 451-1750.

LASERS and nightvision surplus components. Free catalog, **M.J. NEAL COMPANY**, 6672 Mallard Ct., Orient, OH 43146.

FINEST QUALITY SOLDER

SN 60/40 Rosin Core (RA)

One lb. Reels		
16 swg	(.064)	$7.95
18 swg	(.048)	$8.45
19 swg	(.040)	$8.95
20 swg	(.036)	$9.45
21 swg	(.032)	$9.95
½ lb. Reels		
22 swg	(.028)	$5.95
24 swg	(.022)	$7.95

SN 62 (2% Silver) Rosin Core

21 swg (.031) $19.95

FREE Freight On All Orders Over $25
Under $25 add $2.50 per order. Minimum order $10.

FREE Desoldering Wick with each pound of solder

■ Check ■ Money Order ■ VISA ■ MasterCard
N.Y. State residents add appropriate sales tax

SolderCraft™ P.O. Box 668 R Jericho, N.Y. 11753

Call TOLL FREE 800-645-4808
In NYS (516) 334-2660

NEW DIGITAL REVERB FOR ORGANS

ADJUSTABLE DELAYS • MULTIPLE INPUTS
11 BIT ACCURACY • HIGH S/N RATIO
VERSATILE • QUIET • MANY USES
Send for complete information
SONIC CREATIONS INC.
P.O. Box 758, Cortez, Colorado 81321

CABLE-TV converters and descramblers. Low prices, quality merchandise, we ship C.O.D.. Send $2.00 for catalog. **CABLETRONICS UNLIMITED,** P.O. Box 266, South Weymouth, MA 02190.

CB'ERS only: antennas, radios, modulators, voice scramblers, frequency expanders, modifications, goody boxes, professional repairs, much more! **free catalog. PRESIDENT CB SALES.** 101 W. Adams-12, Long Beach, CA 90805. (213) 631-3552.

CONVERTER descrambler schematics, service manuals, cable and satellite; oak cable descrambler. New units, $35.00 each, 10 per carton, varisync units $45.00 each. Call (303)-634-6666. **PONDEROSA COMPANY,** 2408-A East Platte, Colorado Springs, CO 80909.

RESTRICTED technical Informational: electronic surveillance, schematics, locksmithing, covert sciences, hacking, etc. **Huge selection. Free brochure: MENTOR-Z,** 135-53 No. Blvd., Flushing, NY, 11354.

LIGHT chasers, color organs, rope lights. Assembled, kits. **DESIGN SPECIALTY,** Box 1995, Huntington Beach, CA 92647.

TUBES, name brands, new, 80% off list. **KIRBY,** 298 West Carmel Drive, Carmel, IN 46032.

ELECTRONICS catalogs over 6000 items. $2.00 postage. Applied to first $20.00 order. **REDWOOD ELECTRONICS CORP.**, 711 Summer St., Eureka, CA 95501.

MICRO MART

508 Central Ave.
Westfield, N.J. 07090
(201) 654-6008

15 Pin Header & Mating Socket, Vert MT/PC
.156" Centers 5/1.00
Crystal Clock Oscillator .... .50
3,300µF 35V AXIAL-1 1/2" × 7/8" Nich 2/.95
Coils For Radio Elec's Feb. 84 TV Project, Toko #'S T-1, T-2, L-1 (12uH) & L-2 (.071uH) Complete Set Of All 4 Coils 8.50
MC1330—Prime (Moto) 2/1.00
BFQ-85 Transistor 1.50
Disc Caps .001uf 20/1.00
74123-Prime (Nat) 3/1.00
470uf 35V (Radial) 3/1.00
470uf 16V (Axial) 4/1.00
2N3904 .... 10/1.00
2N3906 .... 10/1.00
1N914 .... 40/1.00
1N4148 .... 40/1.00
1N5231B (5.1V.Zener Diode) 5/1.00
Voltage Regulators (Prime TO-220) ... 7805, 7812, 7824, 7905, 7912-Mix or Match-3/1.00
Mica Insulators For TO-220 Pkg. 20/1.00
Voltage Reg's (Unmarked, 60% Prime) May Include Positive/Neg & Adjust 15/1.00
78L08 Voltage Reg (DM106, TO-92) .20/1.00
PN2222A 20/1.00
2N3055 .... .50
2N5308 .... 20/1.00

15 Cent (.15) Per IC TTL

7403	7442	74126
7404	7450	74151
7410	7474	74163
7437	7476	74365
7438	7495	74393
7440	74107	

15 Cent (.15) Per IC 74LSXX

74LS02	74LS32	74LS158
74LS08	74LS74	74LS257
74LS10	74LS86	74LS257
74LS20	74LS153	74LS273

20 Cent (.20) Per IC CMOS
4001B, 4011B, 4050B
MC838 (DTL) 10/1.00
Opto Isolator (H11G2-6PIN DIP) Specs ... .40
2716 Eprom 1.45
2732 Eprom 1.95
2764 Eprom 2.45
27128 EPROM 4.95
256K Dram 150ns Prime Hitachi (Ideal For Mac Upgrades & Expansion Projects) ... 4.95
8243 (I/O Expander IC) W/Specs 2.95
UDN 6118 (Display Driver IC-Specs) ... .85
UDN 6128 .... .95
UCN 4116B-Osc/Freq Div Clock IC-Specs-5/1
UCN 4801 (8 Chan Bi-Mos Latch/Driver)-1.00
LM339 .... .45
LM380 (ULN2280) .... .45
555 Timers (TI) 4/1.00
NE556 (Dual Timer-Moto) .... .50
741J OpAmp (Mini Dip Hi Rel Pkg) ... 4/1.00
LM1310 (Unmarked, Tested Prime) ..... .50

LM1889 .... .95
LM3900 .... .45
AM/FM Radio IC (#2204 W/Specs-Hobby) 15/1.00

IC Sockets

8 PIN/.07	14 PIN/.13	16 PIN/.15
18 PIN/.17	20 PIN/.19	22 PIN/.21
24 PIN/.22	28 PIN/.24	40 PIN/.39

7 Segment Display (.3" Common Cath) ... .15
7 Segment Display (.6" Common Ann) ... .65
Tri State LED's 3/1.00
Jumbo Red LED's-Diffused Lens, Prime (Ti). All 100% Prime-15/$1, 100/$6, 1,000/$57.50
LED Mounting Clips & Rings 15/1.00
Texas Inst/#994A Keyboard-Inc/Data For Pins Made When Each Key Depressed ... 4.95
Dip Switch-12 Position 2/1.00
Dip Switch-8 Position 4/1.00
Keyboard Push Button Tops 30/1.00
Audio Cable 30 Feet/1.00
22AWG Wire 50 Feet/1.00
27AWG Wire 50 Feet/1.00
Mini Lubricator (& Lubricant) 1.00
Molex Pins (7 Pin/Strip) 100/$2, 500/$4, 1K/$6
Clock Module-Crystal Controlled, Green Display/12VDC/Time Set Switches/Data-4.95
Rotary Switch (5 Position, 5A 125V)-3/1.00
Giant Alpha Numeric Display 1-1/2" × 2" 7×5 (35 Total) Red LED Matrix/Specs-4.95
11 LED Bar Graph Display-2-3/4". Rect LED's (Specify Red, Grn, Amb) Specs ... 2.69
Seven Amp (7) Tapped Transformer-Can Be Wired For (7.5V, 9V, 15V, 18V) Reg Shpg ... 8.95
Wall Plug Transformer-24V 525mA 1.50
6.3V 1.2A Transformer 1.20
12V Center Tap Transformer 2.50
8AMP 200V Bridge, Quick Disconnect (GI) .95
1N4007 .... 20/1.00
1N5059 (200V 1 Amp) 15/1.00
1N5060 (400V 1 Amp) 10/1.00
Zener Diodes-20V 1W 30/1.00
Zener Diodes-13V 1W Glass 30/1.00
2560.0KC Crystal .... .50
3.579545 Color Burst Crystal (HC-18) ... .50
1.0 Mhz Crystal 1.95
6.0 Mhz Crystal 1.95
TO-5 Heat Sinks (Bern) 10/1.00
TO-18 Heat Sinks (Bern) 10/1.00
Super Sub-Mini Ceramic Caps (All 100V)
.0015uf 100V (152) 30/1.00
.0022uf 100V (182) 30/1.00
.0027uf 100V (272) 30/1.00
.0033uf 100V (332) 30/1.00
.0039uf 100V (392) 30/1.00
.0056uf 100V (562) 30/1.00
.0082uf 100V (822) 30/1.00
4.7uf 40V Lytic (Radial) 20/1.00
47uf 25V Lytic (Radial) 10/1.00
1000uf 185V Twist Lock 1.00
3200uf 50V (Ideal For Power Supplies)-1.00
5600uf 25V (Comp Grade 3-5/8"×1)-3/1.00
.1uf 50V Monolithics 10/1.00
.22uf 50V Monolithics 20/1.00

Chip Caps-Set of 4, 2 Each 2.7 & 3.3pf-1.00
.33uf 100V Dip Mylar 10/1.00
1,000 PC Resistor Ass't (30 Values) 1/2W-$3
Pots-1 Meg. Linear Taper 5/1.00
Motion Detector Bds (Inc IC-$2) ... 7/10.00
Mot Det (IC Only-ULN2232A) 3/$2-20/10.00
Project Box/Lid For Detector 1.95
Miniature Speaker For Detector .... .65
Extensive Construction Article For Det. $1
TV Knobs 15/1.00
Ammeter (0-15 A.C. Amperes) 4.95
Volt/OHM Meter MVMNT (0-1K OHM, 0-300V) 2.95
6V Miniature Gear Motor .... .50
RF Chokes-1.8uh, 8.2uh, 12uh, 22uh-10/1.00
22/44 Pin Edge Card Connector .... .50
Slide Controls-50K, 100K, 1.2M, 2M, 5M 5/1.00
BNC "T" Connector (UG-274) .... .95
Mixed Connector Ass't 10/1.00
1.5AMP 50V Bridge (GI, TO-5 Pkg) .... .50
25AMP 200V Bridge (Solder Lug Term) ... 1.50
Zenith TV Replacement IC Special $1 Each
221-42, 221-43, 221-45, 221-48, 221-69, 221-79, 221-87, 221-96, 221-104, 221-105, 221-106, 221-140
2SD900 (Horiz Output W/Damper Diode)-2.95
2SC1172B (Toshib-Horiz Output Trans)-1.95
Winegard 4 Bay Bowtie UHF Antenna-19.50
IC Storage (Bug) Box (Holds) 30 IC's-1.75
Precision (Multi-Turn) Trim Pots (Copal), 100 OHM, 500 OHM, 1K, 2K, 5K, 10K, 20K, 50K, 100K, 200K, 500K, 1M-.85 Each-3/$2
Piher PT-10V Hor Mt (Single Turn) Trimmers 100 OHM, 1K, 10K, 25K, 50K, 100K ... 4/$1
Heat Sensitive Switch/150° C. 10/1.00
Mixed Coil Ass't 10/1.00
Buzzers 3/1.00
Chip Resistor (6.8K) 20/1.00
Chip Resistor (470K) 20/1.00
Chip Cap (330pf) 20/1.00
Jumbo Red LED W/Built In Resistor-30/$1
MRF901 (Hobby Grade-60% Good) ... 10/1.00
IC Ass't (Hobby Grade, Some Marked)-30/$1

20 Cent (.20) 74SCXX Series Special

- **Octal Interface Circuits**
- **Equivalent To 74LSXX Series**
- **Low Power ISO-CMOS Technology**
- **Short Propagation Delay**
- **Improved Noise Margins**
- **High Current, Sink/Source Capability**

74SC137-1 Of 8 Inverted Decoder, Latched
74SC138-1 Of 8 Inverted Decoder
74SC139-1 Of 4 Inverted Decoder
74SC237-1 Of 8 Non-Inverted, Latched
74SC238-1 Of 8 Non-Inverted
74SC239-1 Of 4 Non-Inverted
74SC240-Octal Buffer/Line Driver-Inv
74SC241-Octal Buffer/Line Driver-N/I
74SC244-Octal Buffer/Line Driver-N/I
74SC245-Octal Bus Transceiver-Non/I
74SC373-Transoarent Latch-Non/Inv
74SC374-D Type Flip-Flop, Non/Inv
74SC533-Transparent Latch-Inverted
74SC534-D Type Flip-Flop, Inverted
74SC540-Octal Buffer/Line Driver-Inv
74SC541-Octal Buffer/Line Driver-N/I
74SC563-Transparent Latch, Inverted
74SC564-D Type Flip-Flop, Inverted
74SC573-Transparent Latch, Non/Inv
74SC574-D Type Flip-Flop, Non/Inv
Data Book For All Above #'s. 2.50

Cypher IV Micro-Controller Kit- $129.50
- 4 MHz, 8-Bit Microprocessor (NAT 1NS8073)
- Control Basic Interpreter On-Chip
- Auto-Start Operation At Power-On
- Fast 16-Bit Multiply And Divide
- RS-232, Supports CRT & Serial Link
- 24 Bi-Directional I/O Lines (8255A)
- RAM Memory-2K Expandable To 16K
- Eprom Memory-Expandable To 16K
- Built In Eprom Programmer
- Parr (Centronix) Printer Interface
- Optional Real-Time Clock W/Backup

Pay TV Hardware Installation Kit Blow Out As Low As $2.95 + $3.50 Shipping Per Unit
All Kits Contain 5 F Connectors, 300 to 75 OHM Balun, 300 OHM Terminal Block 2 Ft 75 OHM Patch Cord, 2 Ft 300 OHM Twin Lead, Nylon Cable Ties, And UHF Antenna
Model #4124-$2.95 Includes All Of The Above Plus 25 Feet Coaxial Cable And Mounting Hardware For Indoor Wall/Ceiling Installation
Model #4880-$2.95 Includes All Of The Above Plus 25 Feet Coaxial Cable And Attractive Expandable Pole/U-Bolt For Easy Indoor Installation
Model #4845-$3.95 Includes All Of The Above Plus 65 Feet Coaxial Cable And All Necessary U-Bolt Hardware

MODEL 705 Digital Multimeter — **$51.95**

DC Voltage	100µV to 1000V
AC Voltage	100µV to 750V
DC Current	0.1µA to 10A
AC Current	0.1µA to 10A
Hi-Lo Resistance	0.1Ω to 20MΩ
Capacitance	1pF to 20µF
Diode Test	forward voltage testing
Hfe test	transistor testing

UHF-TV PREAMP
(As featured in Radio Electronics March/May articles, 1982)
This inexpensive antenna mounted preamp can add more than 25 dB of gain to your system. Lots of satisfied customers and repeat orders for this high quality kit, which includes all component parts, PC BD, Case, Power Supply and Balun $34.50
Assembled Version $57.50

Terms: MICRO-MART accepts Visa, MC and telephone COD's. Minimum order $10.00. Shipping—U.S. orders, $2.00. Canada and other countries $3.50 (includes ins.). Shipping rate adjusted where applicable. NJ residents add 6% sales tax.

MICRO-MART • 508 CENTRAL AVE., WESTFIELD, NJ 07090 • (201) 654-6008

CIRCLE 273 ON FREE INFORMATION CARD

THE BEST PLACE to BUY, SELL or TRADE NEW and USED EQUIPMENT
NUTS & VOLTS MAGAZINE
BOX 1111-E • PLACENTIA, CA 92670
(714) 632-7721
Join Thousands of Readers Nationwide Every Month
ONE YEAR U.S. SUBSCRIPTIONS
$10.00 - 3rd Class • $15.00 - 1st Class
$35.00 - Lifetime - 3rd Class

IS it true you can buy jeeps for $44.00 through the U.S. Government? Get the facts today! Call (312) 742-1142 ext. 4673.

TECNICA 140/channel cable converter for fully remote sound and video unit only $149.00. **Jerrold** LCC58 converter only $79.00. **Jerrold** DRZ450 converter 90/channel auto tuning only $89.00. All units carry full manufacturer's warranty. Specials while they last. For catalog send $3.00. Thanks. **REDCOAT ELECTRONICS** P.O Box 28504, Jamaica, NY 11128. (718) 459-5088.

LINEAR parts, tubes, transisters—MRF454 $16.00, MRF455 $12.00, MRF477 $11.00, MRF492 $18. Catalog. **RFPC,** Box 700, San Marcos, CA 92069. (619) 744-0728.

LIVE rent-free! Easy & legal. $5 for report. **ROBINSON** POB 76799 Vancouver BC, Canada V5R5S7.

SCHEMATICS: radio receivers 20's/60's. Send brandname, model number, SASE. **EARL SCARAMELLA,** Box 1, Woonsocket, RI 02895-0001.

USED books: Electronics, mathematics, computers, mechanics, physics, etc. $.37 stamp: **SOFTWAVE**, 1515 Sashabaw, Ortonville, MI 48462.

TEST equipment, reconditioned. For sale. $1.25 for catalog. **WALTER'S**, 2697 Nickel, San Pablo, CA 94806.

PLANS AND KITS

CATALOG: Hobby/broadcasting/1750 meters/Ham/CB: transmitters, amplifiers, antennas, scramblers, bugging devices, more! **PANAXIS**, Box 130-F1, Paradise, CA 95969.

CABLE-TV Converters: Jerrold products include "new Jerrold Tri-Mode", SB-3, Hamlin, Oak VN-12, M-35-B, Zenith, and more. UHF Deluxe II kits. (Quantity discounts) 60 day warranty. Repairs of cable converters. For fast service C.O.D. orders accepted. Send S.A.S.E. (60 cents postage), or call for info., (312) 637-4408. HIGGINS ELECTRONICS, 5143 W. Diversey, Chicago, IL 60639. No Illinois orders accepted.

DIGITAL Klock kit plays 1-of-12 melodies each quarter hour. Displays time, date, and other features. Send $2.50 for assembly plans and pricing to **KERBER KLOCK KO.**, 36117 Hillcrest, Eastlake, OH 44094.

PC/XT compatible mother board, fully loaded w/ bios, 256K, 8I/O slots, $199. **NRPC.** (713) 484-9575, 104G S. Friendswood, Friendswood, TX 77546.

BUILD this five digit panel meter and square wave generator including an ohms, capacitance and frequency meter. Detailed instructions $2.50. Refundable plus 50 cents. **BAGNALL ELECTRONICS**, 179 May, Fairfield, CT 06430.

INVENTORS! Aim wants—ideas, inventions, new products, improvements on existing products. We present ideas to manufactures. Confidentiality guaranteed. Call toll free **1-800-225-5800** for information kit.

CATALOG TV descramblers, cable converters, microwave converters, satellite systems, many types, kits or built. $1.00. **MINUTE KITS**, Box 531, West S.Q. Sta., Bronx, NY 10461.

UHF gated-pulse descrambler plans with simulated stereo output. Watch your favorite movies with the realism of stereo. Booklet contains detailed schematics, instructions & theory. $12.00 **DELPHONE INDUSTRIES**, Box 150, Elmont, NY 11003.

CABLE-TV

BONANZA!

ITEM	SINGLE UNIT PRICE	DEALER 10-UNIT PRICE
RCA 36 CHANNEL CONVERTER (CH. 3 OUTPUT ONLY)	29.95	18.00 ea.
PIONEER WIRELESS CONVERTER (OUR BEST BUY)	88.95	72.00 ea.
LCC-58 WIRELESS CONVERTER	92.95	76.00 ea.
JERROLD 450 WIRELESS CONVERTER (CH. 3 OUTPUT ONLY)	105.95	90.00 ea.
SB ADD-ON UNIT	109.95	58.00 ea.
BRAND NEW — TRIMODE UNIT FOR JERROLDS	*Call for specifics*	
MINICODE (N-12)	109.95	58.00 ea.
MINICODE (N-12) VARISYNC	119.95	62.00 ea.
MINICODE VARISYNC W/AUTO ON-OFF	179.95	115.00 ea.
M-35 B (CH. 3 OUTPUT ONLY)	139.95	70.00 ea.
M-35 B W/AUTO ON-OFF (CALL FOR AVAILABILITY)	199.95	125.00 ea.
MLD-1200-3 (CALL IF CH. 2 OUTPUT)	109.95	58.00 ea.
INTERFERENCE FILTERS — CH. 3	24.95	14.00 ea.
JERROLD 400 OR 450 REMOTE CONTROLLER	29.95	18.00 ea.
ZENITH SSAVI CABLE READY (DEALER PRICE BASED ON 5 UNITS)	225.00	185.00 ea.

SPECIFY CHANNEL 2 or 3 OUTPUT ***Other products available — Please Call***

Quantity	Item	Output Channel	Price Each	TOTAL PRICE
			SUBTOTAL	
			Shipping Add $3.00 per unit	
			COD & Credit Cards — Add 5%	
			TOTAL	

California Penal Code #593-D forbids us from shipping any cable descrambling unit to anyone residing in the state of California.

Prices subject to change without notice.

PLEASE PRINT

Name __________

Address __________ City __________

State ______ Zip ______ Phone Number ( ) ______

☐ Cashier's Check ☐ Money Order ☐ COD ☐ Visa ☐ Mastercard

Acct # __________ Exp. Date __________

Signature __________

FOR OUR RECORDS:

DECLARATION OF AUTHORIZED USE — I, the undersigned, do hereby declare under penalty of perjury that all products purchased, now and in the future, will only be used on cable TV systems with proper authorization from local officials or cable company officials in accordance with all applicable federal and state laws.

Dated: ______ Signed: __________

Pacific Cable Company, Inc.

7325½ RESEDA BLVD., DEPT. #10 • RESEDA, CA 91335

(818) 716-5914 • *No Collect Calls* • (818) 716-5140

IMPORTANT: WHEN CALLING FOR INFORMATION
Please have the make and model # of the equipment used in your area. *Thank You*

Quality Microwave TV Antennas

Multi-Channel 1.9 to 2.7 GHz
40dB Gain True Parabolic 20 Inch Dish
Complete System $84.95 (Shipping incl.)
Dealerships, Qty. Pricing, Replacement Parts

Phillips-Tech Electronics
P.O. Box 34772 • Phoenix, AZ 85067
(602) 947-7700 ($3.00 Credit all phone orders!)
LIFETIME WARRANTY MasterCard • Visa • COD's

PROJECTION TV...convert your TV to project 7 foot picture...results comparable to $2,500 projectors...total cost less than $30.00...plans and 3" lens $19.95...illustrated information **free. MACROCOMA-GE,** Washington Crossing, PA 18977. Creditcard orders 24 hours (215) 736-3979.

CRYSTAL radio sets, plans, parts, kits. Catalog $1.00. **MIDCO,** 660 North Dixie Highway, Hollywood, FL 33020.

PAY TV and satellite descrambling all systems schematics. American and Canada. Fanatasy, Anik, etc. 60 pages $12.95. Stungun schematics $5.00. MDS microwave manual including schematics $9.00. Build excellent satellite sysytem under $500. $11.95 kits catalog $2 (refundable). SHOJIKI ELECTRONICS CORP., 1327 Niagra St., Niagara Falls, NY 14302. C.O.D.'s. (716)-282-1001.

TUBES — OVER 2000 TYPES!
DISCOUNT PRICES

Parts, supplies, and literature for tube type radios, inlcuding early and hard-to-find tubes.
Send $1.00 for 24 page wholesale catalog.

ANTIQUE ELECTRONIC SUPPLY
688-B W. First St. • Tempe, AZ 85281 • (602) 894-9503

ELECTRONICS parts. 600 resistors, capacitors, diodes. New, long leads. $6.00 ppd. **STAR-TRONICS,** Box 683, McMinnville, OR 97128.

DESIGN your own custom circuits on your Commodore 64. Just enter specifications and the computer does the rest. Send $5.00. **WEASELGRAPHICS PROGRAM,** Dept RE1, 606 Thomasville, Pocahontas, AR 72455.

LOWEST prices on brand name loudspeaker drivers: Crossovers, parts, and kits. Quality discounts available. Send $1.00 for catalog (refundable with order) to: **KDS ELECTRONICS,** Dept. RE186, P.O. Box 907, Rye, NY 10580.

DESCRAMBLER plans. New design decodes gated sync suppressed signals—newest pilotless method. Circuit boards, most parts from Radio Shack. Detailed theory, drawings, instructions $14.95 plus $2.00 shipping. **DIRIJO CORP.,** Box 212, Lowell, NC 28098.

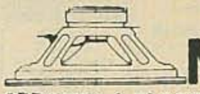
VCR amplifier kit: transmits **VCR** output to any TV in your house, $24.95. Includes PC board and all board mounted parts. CA residents add 6.5%. Catalog $1.00 refundable with order. **CAS ELECTRONICS,** 1559-J Amar Rd. Suite 457, West Covina, CA 91792.

SATELLITE TELEVISION

BUILD your own Satellite-TV receiving system and save! Instruction manuals, schematics, circuit boards, parts kits! Send stamped envelope for complete product listing: XANDI, Box 25647, Dept. 21W, Tempe, AZ 85282.

THE LNA specialists! Brand name, lowest noise, lowest prices! We will not be undersold! Send for prices: **LNA,** 201 E. Southern, Suite 100, Tempe, AZ 85282.

SATELLITE systems $449. Name brands. Quantity discounts. Information $1.00. Catalog $2.00. **STARLINK, INC.,** 2603-16R Artie, Huntsville, AL, 35805.



WRITE FOR
McGEE'S
SPEAKER & ELECTRONICS CATALOG
1001 BARGAINS IN SPEAKERS
toll free 1-800-346-2433 for ordering only.
1901 MCGEE STREET KANSAS CITY, MO. 64108

US$8.00 including disk thousand name brand programs for Apple, IBM-PC. Details US$1.00. **RELIANT,** P.O. Box 33610, Sheungwan, Hongkong.

ENJOY satellite television. Save money with easy, guaranteed, do-it-yourself antenna plans/kits. Complete systems also available from Uniden, Raydx & Winegard. Send $1.00 for catalog or $8.95 for "Consumer Guide to satellite television."**GFI-54,** Box 9108, Missoula, MT 59807.

DESCRAMBLER HBO. Complete satellite system 8', $425. Information, $1.00 postage. **SOTHIS SATELLITE,** Box 7117, Saint John, Canada E2L 4S5.

SATELLITE channels newsletter. Get the most from your dish! Details, sample $2.00. **BOX 31R,** Dighton, MA 02715

DON'T trade in old satellite TV receiver to get remote control. Channel Wizard[R] remotely controls tuning, polarity, and connects from outside satellite receiver. IR version including transmitter, $69.00 assembled, $39.00 kit. Wired version $39.00 assembled; version including transmitter, $69.00 assembled, $24.95 kit. Add $2.00 shipping. Specify PR1 or PR2. Send M.O. or cashier's check to: **ORANGEBURG TECHNOLOGIES, INC.,** 1830 Five Chop Rd., Orangeburg, SC 29115. Send self-addressed stamped envelope for info.

Save hundreds of $. Install your own satellite system. Complete instruction includes installation and tuning $9.95 catalog of satellite systems and accessories. Top brand, low prices. $5.00 **B & T ELECTRONICS** Box 3156 Grand Rapids, MI 49501.

WM. B. ALLEN SUPPLY COMPANY

OPEN SATURDAYS 8 A.M. TO 1 P.M. WITH 24 HOUR ANSWERING TO TAKE YOUR ORDER ANYTIME

TEST EQUIPMENT SPECIALS

SAVE ON HITACHI OSCILLOSCOPES

V-650F
60MHz • Dual Trace
Delayed Sweep

Reg. $1195 **$896** SAVE $299

V-222
20MHz • Dual Trace
6" CRT

Reg. $715 **$500** SAVE $215

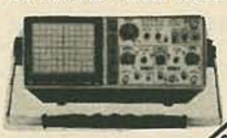
V-1050F
100MHz • Quad Trace
Delayed Sweep

Reg. $1595 **$1196** SAVE $399

V-212
DC-20MHz • Dual Trace

Reg. $615 **$430** SAVE $185

V-422
DC-40MHz • Dual Trace

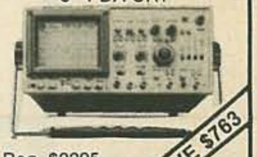


Reg. $925 **$669** SAVE $256

V-1100
100MHz • Quad Trace
CRT Readout • 1mV
6" PDA-CRT

Reg. $2490 **$2260** SAVE $230

V-1070
100MHz • Quad Trace
CRT Readout
6" PDA-CRT



Reg. $2295 **$1532** SAVE $763

V-6041
40MHz/2 Channels • 4000
Words Per Channel

Reg. $5855 **$5311** SAVE $544

WM. B. ALLEN SUPPLY
ALLEN SQUARE
300 BLOCK NORTH RAMPART, NEW ORLEANS, LA 70112
LOUISIANA TOLL FREE 800 462-9520

800 535-9593
COMPLETE INVENTORY OF MULTIMETERS AND SCOPES FROM 18 MANUFACTURERS

CIRCLE 103 ON FREE INFORMATION CARD

CALL 1-800-245-2235 AND YOUR SEARCH IS OVER

SPECIAL 64K DRAM

FULLY FUNCTIONAL WITH SLIGHTLY SHORTER LEADS 200 NS OR FASTER

4164	.45
4416	.90

If you are seeking hard to find part numbers at hard to find low prices.

You are probably already familiar with our low pricing and large inventory of popular ICs, but a big part of our story is what doesn't appear in our ads.

PC boards are the primary source of our IC inventory. As you know our patented process enables us to remove ICs from boards without any degradation of the ICs. We obtain the boards from a wide variety of sources, which enables us to process a wide variety of ICs. Some of the boards we obtain consist of obsolescent technology. This results in a reasonable stock of replacement parts for products that might not be otherwise available.

GROUP PRICED EPROMS

2708, 2716, 2732, 2764, 27128

250NS	3.50
300NS	3.00
350NS	2.75
450NS	2.25
650NS	1.75

GROUP PRICED LOGIC-TTL

74XX, 74LSXX	.25
741XX, 74LS1XX, 74SXX	.35
742XX, 74LS2XX	.50
743XX, 74LS3XX	.50
74S2XX, 74S3XX	.60

GROUP PRICED LOGIC

ECL 10K	1.00
ECL 100K	5.00
CMOS 40XX	.25
CMOS 45XX	.50

ADC-0804	3.50
DAC-0808	**1.50**
ADC-0809	3.50
TL082	.50
AY5-1013	1.50
AY3-1015	**1.50**
TIL117	.50
MC1414	.70
1400-100	2.00
1420-55	2.00
MC1458	.40
MC1472	**.50**
MC1488	**.50**
MC1489	**.50**
FD1793	**5.00**
ULN2003	.50
2006	.70
DG201	.25
ULN2074	2.00
2101-250	.50
2102-450	.50
DG211	1.00
2111-250	1.00
2111-450	1.00
2114-150	**.80**
2114-200	.80
2114-250	.80
2114-300	**.50**
2114-450	.50
2115-70	3.00
2118-120	1.00
2118-150	.75
2118-200	.50
2125-45	3.00
2141-150	.80
2147-45	2.00
2147-55	2.00
2147-70	2.00
2148-55	2.00
2149-49	2.00
X2212	1.00
MPQ2222	.75
25LS2519	.50
25S10	.60
25S18	.60
2532-450	**2.25**
2651	4.00
2661	4.00
26LS31	1.00
26S10	.60
2708-500	**2.00**
2708-550	2.00
27128-200	**5.00**
FSA2719	1.25
27S03	.50
AM2901	3.00
LM2901	.75
AM2903	5.00
AM2905	1.50
Q2T2905	1.50
LM2907	1.25
LM2907(8 pin)	1.25
FPQ2907	.75
AM2910	5.00
AM2911	5.00
LM2917	1.25
AM2940	2.00
UDN2957	.50
AM2965	.75
AM2966	.75
LM301 (8 pin)	.25
TP3040	5.00

CA3054	.50
LM308 (8 pin)	.50
CA3080 (8 pin)	.50
LM310 (8 pin)	1.00
LM311 (8 pin)	.25
LM319	1.25
LM324	.25
D3232	1.00
D3242	4.00
LM3302	1.00
3341	2.00
MC3346	.70
F3357	1.50
LM339	.45
MC3401	.50
MC3403	.50
3441	1.00
3450	1.00
3453	2.00
LM348	.45
3486	1.00
3487	1.50
351	.25
LF353	.50
DS3612	.50
MB3614	.75
3900	.50
3906	1.00
LM393	.35
LM393 (8 pin)	.50
40161	.80
MC4024	2.00
4027-250	.35
4027-300	.35
MC4044	2.00
4044-200	.80
4044-300	.50
40L45-450	.50
TMS4050	.50
TMS4060	.50
CD4104	1.00
4116-120	**1.00**
4116-150	**.75**
4116-200	**.50**
4116-250	**.35**
41256-150	**5.00**
4164-120	1.75
4164-150	.95
4164-200	.85
4164-SPECIAL	**.45**
MB425	2.00
4332-200	2.00
4416-150	1.50
4416-SPECIAL	**.90**
MC4741	.75
IH5010	2.50
IH5011	1.25
CRT-5027	3.00
CRT-5037	5.00

MM5060	2.00
MK5116	.25
TMS5220	5.00
5257-450	.50
LM531 (8 pin)	.75
TMS5501	12.00
NE555 (8 pin)	.35
NE558	.75
LM566	1.00
MSM5832	2.75
MM5837	.50
NE592	.25
6116-100	**2.00**
6116-120	**1.75**
6116-150	**1.25**
6116-200	**.90**
6116-250	**.65**
6264-150	**6.00**
MPQ6502	1.00
6522	3.00
6522A	4.00
6802	2.00
6809	**2.00**
6810	**.75**
6821	**2.00**
6840	2.00
6845	**2.00**
6850	2.00
6852	2.00
68A10	1.25
68A21	2.50
68A45	2.50
68A52	2.50
68B09	3.00
68B21	**3.00**
68B45	3.00
6N138	.50
MB7052	.50
LM710	.40
LM733	.40
LM741 (8 pin)	.30
LM748 (8 pin)	.50
74C00	.50
74F00	.35
74F04	.35
74F08	.35
74F157	.45
74F245	.60
74F32	.35
74F373	.60
74F374	.60
74F374	.60
74F74	.35
74HC138	.45
74HC244	.60
74HC245	.60
74HC373	.60
74HC374	.60
74HCT08	.35
74HCT244	.60

75107	.50
75110	.50
75113	.50
75138	.50
75141	.50
75150	.50
75154	.50
75160	.50
75161	.50
7524	1.00
75322	.50
75365	.50
75427	.50
75450	.50
75451	.50
75452	.50
75453	.50
75454	.50
75461	.50
75462	.50
75497	.50
D765	**4.00**
8017	1.75
8031	5.00
8056	4.00
8080A	.75
8086-2	**5.00**
8123	1.00
8200	2.50
8202A	14.00
8212	**1.00**
8216	1.00
8220	2.00
8224	2.00
8226	2.00
8234	1.50
8237-4	3.00
8237A	3.00
8238	2.50
8243	1.50
8250	**4.00**
8251	**2.00**
8251A	**2.00**
8253	**2.00**
8253-5	**2.00**
8255A	**2.00**
8255A-5	**2.00**
8257	2.00
8257-5	2.00
8259A	**2.00**
8262	1.75
8266	1.75
D8274	9.00
N8274	2.50
8279-5	3.50
8286	4.00
8289	4.00
82S16	1.00
82S62	2.00

MC840	.75
MC8506	10.00
8641	1.00
DS8820	.50
DS8832	.50
DS8833	.50
MB8861	.50
MB8874	.50
AY3-8910	**2.00**
AY3-8912	2.00
8T09	.50
8T14	.50
8T20	.50
8T23	.50
8T24	.50
8T26	.50
8T28	.50
8T37	.50
8T38	.50
FD9216	**5.00**
9312	.80
9314	.60
9321	.75
9328	1.00
9338	1.00
93419	3.00
93422	3.00
93425	3.00
936	2.00
93L22	.50
93L24	.75
93L422	3.00
93S16	.50
93S46	2.00
93S48	.80
9401	5.00
9602	.75
9614	.75
9615	.75
96L02	1.50
96LS02	1.50
TMS9900	3.00
TMS9901	1.50
TMS9904	3.00
TMS9914	3.00
TMS9918	20.00
TMS9980	10.00
Z8001	7.50
Z80ACPU	**2.00**
Z80ACTC	**2.00**
Z80ADMA	**4.50**
Z80APIO	**2.00**
Z80ASIO0	**3.75**
Z80ASIO/2	4.50
Z80BCPU	**3.00**
Z80CPU	**1.00**
Z80CTC	**1.00**
Z80PIO	**1.00**
Z80SIO0	**3.00**

OUR POLICY

Delivery: Orders normally shipped within 2 business days. Add $3 for UPS ground-5# & under. Add $4 for UPS blue (air). 2# & under, for each additional air pound add $1. Arizona residents add 6% sales tax.

Payment: Visa, MC, cashiers check, certified check, money order, personal check accepted. (Allow 10 days for personal checks to clear.) No surcharge on credit card orders. CODs welcome with cash, certified check, cashiers check or money order. Add $3 COD handling charge.

Pricing: Minimum order $20. 30% discount on orders over $500. Prices subject to change without notice. All items limited to stock on hand.
We reserve the right to limit quantities.

KRUEGER Technology, Inc.

2219 South 48th Street • Tempe, AZ 85282

VISA MasterCard

800-245-2235

In Arizona 602-438-1570

HOURS: 7AM-5:00PM (MOUNTAIN TIME) Monday Thru Friday

CIRCLE 257 ON FREE INFORMATION CARD

BUSINESS OPPORTUNITIES

MECHANICALLY inclined individuals desiring ownership of small electronics manufacturing business—without investment. Write: **BUSINESSES,** 92-R, Brighton 11th, Brooklyn, NY 11235.

RECOVER pure gold from old circuit boards, computers, electronic junk. Easy method. Send $5.00 **RECYCLING** Box 11216R, Reno, NV 89510-1216.

PROJECTION TV...make $$$'s assembling projectors...easy...results comparable to $2,500 projectors...your total cost less than $20.00...**plans & 8" lens** & dealers information $17.50...illustrated information **Free...MACROMA-GEX** Washington Crossing, Pennsylvania 18977. Creditcard orders 24 hours (215) 736-2880.

SAVE and earn money repairing home appliances! Our guide has complete details on wiring, instructions, troubleshooting charts. No more time wasted in expensive service shops! $7.00 postpaid. **INFINITE**, Wrightstown-Cookstown Rd., Box 0125, Cookstown, NJ 8511-0125.

YOUR own radio station! AM, FM, TV, Cable. Licensed/unlicensed. **BROADCASTING,** Box 130-F, Paradise, CA 95969.

BIG PROFITS ELECTRONIC ASSEMBLY BUSINESS

Start home, spare time. Investment knowledge or experience unnecessary. BIG DEMAND assembling electronic devices. Sales handled by professionals. Unusual business opportunity.

FREE: Complete illustrated literature
BARTA, RE-O Box 248
Walnut Creek, Calif. 94597

MASTERCARD AND VISA are now accepted for payment of your advertising. Simply complete the form on the first page of the Market Center and we will bill.

Reel TO REEL TAPES

Ampex professional series open reel tape. 1800 or 2400-feet on 7-inch reels, used once. Case of 40, $45.00. 10½ × 3600 feet and cassettes available. Master Card/Visa. **VALTECH ELECTRONICS**, Box 6-RE. Richboro, PA 18954. (215) 322-4866.

EDUCATION & INSTRUCTION

F.C.C. Commercial General Radiotelephone License. Electronics home study. Fast, inexpensive! "Free" details. **COMMAND**, D-176, Box 2223, San Francisco, CA 94126.

$30,000+ technician! You can too. Guaranteed. Send $2.00 P&H for information. **CRT**, 2144 South 1100 East, SLC Utah 84106.

RESISTOR color code, learn on your IBM-PC or MS-DOS compatible computer. Price: $45.00. **PROFESSIONAL TECHNOLOGY SYSTEMS**, P.O. Box 893, Jenson Beach, FL 33457.

ATTENTION ELECTRONIC TECHNICIANS

Highly Effective Home Study BSEE Degree Program for Experienced Electronic Technicians. Our New Advanced Placement Program grants Credit for previous Schooling & Professional Experience. Advance Rapidly! Our 40th Year!

FREE DESCRIPTIVE LITERATURE!

Cook's Institute of Electronics Engineering
P.O. BOX 20345, JACKSON, MS 39209

WANTED

RADIO tubes: 2A3, 45's, 50's, 211, 845. Western Electric tubes, amps, drivers, horns, speakers. **DAVID**, P.O. Box 832, Monterey Park, CA 91754. Tel: (818) 576-2642.

DESIGNERS wanted to design electronic kits. Send resume to **ATRONIC Limited,** Box 79306, Mongkok HongKong.

INVENTORS!

CAN you profit from your idea? Call **AMERICAN INVENTORS CCORPORATION** for free information. Over a decade of service. 1-800-338-5056. In Massachusetts call (413) 568-3753.

PRINTED-CIRCUIT BOARDS

PRINTED-circuit boards. **Quick** prototypes, production, design, reflow solder. Send print or description for quote to **KIT CIRCUITS**, Box 235, Clawson, MI 48017.

CABLE-TV

DEALERS wanted: Channel 2, 3, and 4 notch filters. Money back guarantee. Send $15.00 for sample and quantity price list. Specify channel(s). **GARY KURTZ**, P.O. Box 291394, Davie, FL 33329.

EPROM PROGRAMMING

HOBBYISTS: Pretested EPROMs sold with your programming installed. Program listing provided. Fast service. Write or call: **ROMULUS MICROCONTROL**, Box 8669, Rockville, MD 20856; (301) 540-8863.

DO IT YOURSELF TV REPAIR

NEW...repair any TV ...easy. Anyone can do it. Write, **RESEARCH**, Rt 3, Box 601BR, Colville, WA 99114.

ROBOTS

ROBOT catalog. $2.00 refundable. Complete line of personal, educational robots, kits, toys books, plans and peripherals. **THE ROBOT STORE**, 906 Bancroft Way, Berkeley, CA 94710.

ALL SALES SUBJECT TO THE TERMS OF OUR 90 DAY LIMITED WARRANTY. FREE COPY UPON REQUEST.

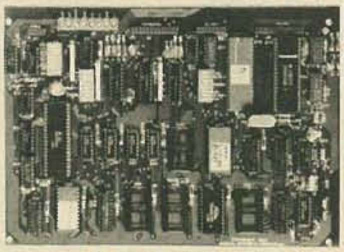
SOLAR CELL SPECIAL: 4 In. Diameter Rated .45 VDC At 1.2 Amps Or Better. Brand New Units, Cosmetic Seconds, But Perfect Electrically. $3.99 6/$20.

THE NEW ZRT-80

CRT TERMINAL BOARD!

A LOW COST Z-80 BASED SINGLE BOARD THAT ONLY NEEDS AN ASCII KEYBOARD, POWER SUPPLY, AND VIDEO MONITOR TO MAKE A COMPLETE CRT TERMINAL. USE AS A COMPUTER CONSOLE, OR WITH A MODEM FOR USE WITH ANY OF THE PHONE-LINE COMPUTER SERVICES.

FEATURES:
- Uses a Z80A and 6845 CRT Controller for powerful video capabilities.
- RS232 at 16 BAUD Rates from 75 to 19,200.
- 24 x 80 standard format (60 Hz).
- Optional formats from 24 x 80 (50 Hz) to 64 lines x 96 characters (60 Hz).
- Higher density formats require up to 3 additional 2K x 8 6116 RAMS.
- Uses N.S. INS 8250 BAUD Rate Gen. and USART combo IC.
- 3 Terminal Emulation Modes which are Dip Switch selectable. These include the LSI-ADM3A, the Heath H-19, and the Beehive.
- Composite or Split Video.
- Any polarity of video or sync.
- Inverse Video Capability.
- Small Size: 6.5 x 9 inches.
- Upper & lower case with descenders.
- 7 x 9 Character Matrix.
- Requires Par. ASCII keyboard.



$89.95 #ZRT-80
(COMPLETE KIT, 2K VIDEO RAM)

FOR 8 IN. SOURCE DISK (CP/M COMPATIBLE) ADD $10

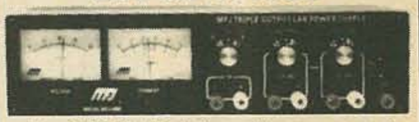
BLANK PCB WITH 2716 CHAR. ROM. 2732 MON. ROM
$49.95
SOURCE DISKETTE - ADD $10
SET OF 2 CRYSTALS - ADD $7.50

Digital Research Computers
(OF TEXAS)
P.O. BOX 381450 • DUNCANVILLE TX 75138 • (214) 225-2309

Call or write for a free catalog on Z-80 or 6809 Single Board Computers, SS-50 Boards, and other S-100 products.

TERMS: Add $3.00 postage. We pay balance. Orders under $15 add 75¢ handling. No C.O.D. We accept Visa and MasterCard. Texas Res. add 5-1/8% Tax. Foreign orders (except Canada) add 20% P & H. Orders over $50 add 85¢ for insurance.

Now! A triple output lab power supply for $149.95.



For $149.95, this lab quality power supply gives you 3 completely isolated outputs: two variable 1.5-20 VDC at 0.5 amp and a fixed 5 VDC at 1 amp — the same as the $300 units.

The MFJ-4002 is American made and designed for heavy use.

You'll get plenty of voltage and current for your analog and digital circuits. It's ideal for education, circuit design, product development, testing, quality control and production.

You can connect the outputs in series or parallel for higher voltage or current. It's short circuit protected, has excellent line regulation (typically 0.01%/V) and load regulation (typically 0.1%). **Two large 3 inch precision meters,** monitor voltage and current simultaneously and are lighted for easy reading. It's ruggedly built with heavy guage aluminum so you'll get many years of trouble free service. 12 x 3 x 6 inches. 110 VAC with 3 wire safety plug.

800-647-1800

Order from MFJ and try it. If not satisfied, return within 30 days for refund (less shipping).
One year unconditional guarantee.
Order today. Call TOLL FREE 800-647-1800. Charge VISA, MC or mail check, money order.

MFJ MFJ Enterprises, Inc.
921 Louisville Road
Starkville, MS 39759

CIRCLE 105 ON FREE INFORMATION CARD

One tree can make 3,000,000 matches.

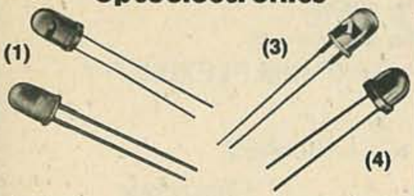
One match can burn 3,000,000 trees.

A Public Service of This Magazine & The Advertising Council

Radio Shack Parts Place

OVER 1000 ITEMS IN STOCK AT EVERYDAY LOW PRICES!

Optoelectronics



(1) TIL906-1 High-Output Infrared LED. Requires only 20 milliamps at 1.3 VDC, yet emits as much energy as three regular IR LEDs. #276-143 .... **1.49**

(2) TIL414 Infrared Photo Transistor. High-speed NPN type is suitable for fiber optic experiments, model train switching, more. 50 mW. #276-145 .... **89¢**

(3) XC-5491 Tri-Color LED. Glows red on DC, green on reverse DC and yellow on AC. Rated 25 mA at 2.2 VDC. #276-035 .... **1.29**

(4) CQX21 Blinking LED. Combines a MOS integrated circuit driver and a red LED. Ideal for displays, electronic jewelry, badges, models and much more. Can drive several LEDs in series. Requires 20 mA at 5 VDC. #276-036 ..... **1.59**

"Finishing Touches" For Projects

(5)

(6) (7)

(5) Deluxe Two-Tone Enclosures. Easy-to-work metal with eggshell white bottom and black top. Complete with hardware and rubber feet.

Size	Cat. No.	Each
1 15/16 × 8 1/4 × 6 1/8"	270-272	5.99
3 1/16 × 8 1/4 × 6 1/8"	270-274	7.99

(6) PC Board-Mount Piezo Buzzer. Loud, yet draws only 12 mA at 12 VDC. #273-065 ... **2.49**

(7) Precision Panel Voltmeter. 0 to 15 volts DC. Ideal for monitoring vehicle electrical system or power supply voltage. 2 3/4 × 2 1/4 × 1 1/4". Mounts in 1 7/8" round hole. #270-1754 .... **7.95**

New "Hot-Line" Service For Semiconductors

Radio Shack Can Replace Almost Any IC or Semiconductor

More Than 200,000 Substitutions Available!

■ **No Minimum Order** ■ **No Postage Charge**

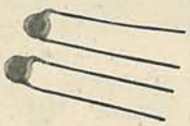
If the IC or semiconductor you need is not part of our regular stock, our store manager will check our new in-store substitution guide and special-order a replacement from our warehouse. Your order will be sent ASAP to your Radio Shack store. We also offer this service on selected tubes, crystals, phono cartridges and styli.

CMOS Digital ICs

All Include Pin-Out And Specs

Type	Cat. No.	Each
4001	276-2401	.99
4011	276-2411	.99
4013	276-2413	1.19
4017	276-2417	1.49
4049	276-2449	1.19
4066	276-2466	1.19

Ceramic Disc Capacitors



Low As 39¢ Pkg. of 2

50 WVDC Minimum

pF	Cat. No.	Pkg. of 2	µF	Cat. No.	Pkg. of 2
4.7	272-120	.39	.001	272-126	.49
47	272-121	.39	.005	272-130	.49
100	272-123	.39	.01	272-131	.59
220	272-124	.49	.05	272-134	.59
470	272-125	.49	.1	272-135	.59

Electronics Textbook

7.95

Basic Electronics Technology. The "hows" and "whys" of modern electronics presented in plain language. Learn how semiconductors work as amplifiers, oscillators, in power supplies, radio/TV, computers. Illustrated. 464 pages. #62-1394

PC Board Etching Kit

Two 4 1/2 × 3" copper-clad boards, resist-ink pen and solvent, etchant, layout strips and circles, tank, 1/16" drill bit, instructions. #276-1576, 9.95

DC Hobby Motor

Special Purchase! 1.19

Reversible, perfect for robotics experiments and model-making. 3 to 19 VDC. 23,000 RPM at no load. Approximately 2 1/2 long with 3/32" diameter shaft. Leads for easy hookup. #273-207

Illuminated Switches

(8) 120 VAC SPST Push-On/Push-Off. Rated 10 amps, 100-125 VAC. 7/16" mtg. hole. #275-671 .... **3.49**

(9) 12 VDC SPST Toggle Switch. Rated 3 amps, 12 VDC use only. 7/16" mtg. hole. #275-706 .... **1.99**

(8)

(9)

Add Voice Output to Your Microcomputer

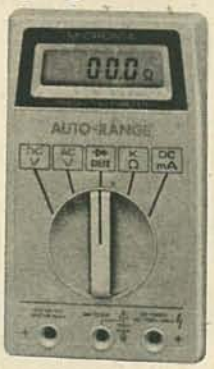
Heart of a Rewarding Project

SPO256-AL2 Speech Synthesizer IC. This large-scale MOS device simplifies the construction of a complete speech synthesis system. Built-in 16K ROM contains a synthesis program with 59 discrete speech sounds and five pauses. Requires clock crystal and low-cost support components, not included, all available through your Radio Shack store. 28-pin DIP with detailed data and circuit examples. #276-1784 .... **12.95**

CTS256-AL2 Text-to-Speech IC. Makes it easy to add voice output to virtually any computer or terminal. Converts standard ASCII characters into control data for the IC above. 40-pin DIP with data and circuit examples. #276-1786 .... **16.95**

Autoranging DVM

Only **34.95**



Breakthrough Low Price!

Select the function and it does the rest! "Diode check" mode for testing semiconductors. Measures to 1000 volts DC, 500 volts AC (accurate from 45 Hz to 10 kHz), DC current to 200 mA. Resistance to 2 megohms in 5 ranges. 4 7/8 × 2 13/16 × 1 1/4". With test leads, spare fuse, instructions. Battery extra. #22-188

TV RF Modulator

Special Purchase! 4.95

Selectable channel 3/4 output. 5-pin DIN plug accepts video, audio and 12 VDC power inputs. On/off switch with built-in TV antenna/modulator switching. #277-1015

Keyboard Bargain

Special Purchase!

Only **5.95**

High-quality full-stroke unencoded keyboard with standard "QUERTY" layout plus word processing functions—total of 75 keys. Mounted on 4 7/8 × 14 1/4" metal-backed base. 21-conductor flat-cable output. Specs not available. #277-1020

Over 1000 items in stock: Binding posts, Books, Breadboards, Buzzers, Capacitors, Chokes, Clips, Connectors, Fuses, Hardware, ICs, Jacks, Knobs, Lamps, Multitesters, PC Boards, Plugs, Rectifiers, Relays, Resistors, Switches, Tools, Transformers, Transistors, Wire, Zener Diodes, and more!

Radio Shack®
A DIVISION OF TANDY CORPORATION

Prices apply at participating Radio Shack stores and dealers

CIRCLE 78 ON FREE INFORMATION CARD

4164 200ns 49¢ 41256 150ns $2.95

STATIC RAMS

2101	256x4	(450ns)	1.95
5101	256x4	(450ns)(CMOS)	3.95
2102L-4	1024x1	(450ns)(LP)	.99
2102L-2	1024x1	(250ns)(LP)	1.45
2112	256x4	(450ns)	2.99
2114	1024x4	(450ns)	.99
2114L-4	1024x4	(450ns)(LP)	1.09
2114L-2	1024x4	(200ns)(LP)	1.49
2114L-15	1024x4	(150ns)(LP)	1.95
TMS4044-4	4096x1	(450ns)	1.95
TMM2016-150	2048x8	(150ns)	1.49
TMM2016-100	2048x8	(100ns)	1.95
HM6116-4	2048x8	(200ns)(CMOS)	1.39
HM6116-3	2048x8	(150ns)(CMOS)	1.49
HM6116LP-4	2048x8	(200ns)(CMOS)(LP)	1.49
HM6116LP-3	2048x8	(150ns)(CMOS)(LP)	1.59
HM6116LP-2	2048x8	(120ns)(CMOS)(LP)	2.95
HM6264P-15	8192x8	(150ns)(CMOS)	3.89
HM6264LP-15	8192x8	(150ns)(CMOS)(LP)	3.95
HM6264LP-12	8192x8	(120ns)(CMOS)(LP)	4.49

LP=Low power

DYNAMIC RAMS

4116-250	16384x1	(250ns)	.49
4116-200	16384x1	(200ns)	.69
4116-150	16384x1	(150ns)	.89
4116-120	16384x1	(120ns)	1.49
MK4332	32768x1	(200ns)	6.95
4164-200	65536x1	(200ns)(5V)	.49
4164-150	65536x1	(150ns)(5V)	.69
4164-120	65536x1	(120ns)(5V)	1.95
MCM6665	65536x1	(200ns)(5V)	1.95
TMS4164	65536x1	(150ns)(5V)	1.95
4164-REFRESH	65536x1	(150ns)(5V)(REFRESH)	2.95
TMS4416	16384x4	(150ns)(5V)	4.95
41128-150	131072x1	(150ns)(5V)	5.95
41256-200	262144x1	(200ns)(5V)	2.95
41256-150	262144x1	(150ns)(5V)	2.95

5V=Single 5 Volt Supply REFRESH=Pin 1 Refresh

★★★★HIGH-TECH★★★★

NEC V20 μPD70108 $20.95

REPLACES 8088 TO SPEED UP IBM PC 10-40%

- HIGH-SPEED ADDRESS CALCULATION IN HARDWARE
- PIN COMPATIBLE WITH 8088
- SUPERSET OF 8086/8088 INSTRUCTION SET
- LOW POWER CMOS

★★★★SPOTLIGHT★★★★

ORDER TOLL FREE
800-538-5000
800-662-6279 (CA)

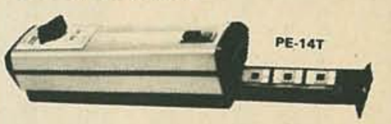
MasterCard VISA

EPROMS

2708	1024x8	(450ns)	3.95
2716-6	2048x8	(650ns)	2.29
2716	2048x8	(450ns)(5V)	1.95
2716-1	2048x8	(350ns)(5V)	2.49
TMS2532	4096x8	(450ns)(5V)	3.95
2732	4096x8	(450ns)(5V)	2.29
2732A	4096x8	(250ns)(5V)(21V PGM)	2.69
2732A-2	4096x8	(200ns)(5V)(21V PGM)	3.95
27C64	8192x8	(250ns)(5V)(CMOS)	5.95
2764	8192x8	(450ns)(5V)	1.95
2764-250	8192x8	(250ns)(5V)	2.49
2764-200	8192x8	(200ns)(5V)	3.49
TMS2564	8192x8	(450ns)(5V)	8.95
MCM68766	8192x8	(350ns)(5V)(24 PIN)	17.95
27128	16384x8	(250ns)(5V)	2.79
27C256	32768x8	(250ns)(5V)(CMOS)	12.95
27256	32768x8	(250ns)(5V)	7.49

5V=Single 5 Volt Supply 21V PGM=Program at 21 Volts

SPECTRONICS CORPORATION EPROM ERASERS



Model	Timer	Capacity Chip	Intensity (uW/Cm²)	Unit Price
PE-14	NO	9	8,000	$83.00
PE-14T	YES	9	8,000	$119.00
PE-24T	YES	12	9,600	$175.00

8000

8035	1.49
8039	1.95
8080	2.95
8085	2.49
8087-2	139.95
8087	109.00
8088	6.95
8088-2	9.95
8155	2.49
8155-2	3.95
8748	7.95
8755	19.95
80286	129.95
80287	185.00

8200

8203	29.95
8205	3.29
8212	1.49
8216	1.49
8224	2.25
8237	4.95
8237-5	5.49
8250	6.95
8251	1.69
8251A	1.89
8253	1.89
8253-5	1.95
8255	1.69
8255-5	1.89
8259	1.95
8259-5	2.29
8272	4.95
8279	2.49
8279-5	2.95
8282	3.95
8284	2.95
8286	3.95
8288	4.95

Z-80

Z80-CPU 2.5 MHz	1.79
4.0 MHz	
Z80A-CPU	1.89
Z80A-CTC	1.95
Z80A-DART	5.95
Z80A-DMA	5.95
Z80A-PIO	1.95
Z80A-SIO/0	5.95
Z80A-SIO/1	5.95
Z80A-SIO/2	5.95
6.0 MHz	
Z80B-CPU	4.95
Z80B-CTC	8.95
Z80B-PIO	8.95
Z80B-DART	14.95
Z80B-SIO/0	12.95
Z80B-SIO/2	12.95
Z8671 ZILOG	19.95

6500

1.0 MHz	
6502	2.79
65C02 (CMOS)	12.95
6507	9.95
6520	1.95
6522	4.95
6526	26.95
6532	6.95
6545	6.95
6551	5.95
6561	19.95
6581	34.95
2.0 MHz	
6502A	2.95
6520A	2.95
6522A	5.95
6532A	11.95
6545A	7.95
6551A	6.95
3.0 MHz	
6502B	6.95

6800

1.0 MHz	
6800	1.95
6802	4.95
6803	9.95
6809	5.95
6809E	5.95
6810	1.95
6820	2.95
6821	1.95
6840	6.95
6843	19.95
6844	12.95
6845	4.95
6847	11.95
6850	1.95
6883	22.95
2.0 MHz	
68B00	4.95
68B02	5.95
68B09E	7.95
68B09	7.95
68B21	4.95
68B45	8.95
68B50	3.95
68B54	7.95

CLOCK CIRCUITS

MM5369	1.95
MM5369-EST	1.95
MM58167	12.95
MM58174	11.95
MSM5832	2.95

CRT CONTROLLERS

6845	4.95
68B45	8.95
6847	11.95
HD46505SP	6.95
MC1372	2.95
8275	26.95
7220	19.95
CRT5027	12.95
CRT5037	9.95
TMS9918A	19.95

DISK CONTROLLERS

1771	4.95
1791	9.95
1793	9.95
1795	12.95
1797	12.95
2791	19.95
2793	19.95
2797	29.95
6843	19.95
8272	4.95
UPD765	4.95
MB8876	12.95
MB8877	12.95
1691	6.95
2143	6.95

BIT RATE GENERATORS

MC14411	9.95
BR1941	4.95
4702	9.95
COM8116	8.95
MM5307	4.95

UARTS

AY5-1013	3.95
AY3-1015	4.95
TR1602	3.95
2651	4.95
IM6402	6.95
IM6403	9.95
INS8250	6.95

SOUND CHIPS

76477	3.95
76489	8.95
SSI-263	39.95
AY3-8910	12.95
AY3-8912	12.95
SP1000	39.00

CRYSTALS

32.768 KHz	.95
1.0 MHz	2.95
1.8432	2.95
2.0	1.95
2.097152	1.95
2.4576	1.95
3.2768	1.95
3.579545	1.95
4.0	1.95
4.032	1.95
5.0	1.95
5.0688	1.95
6.0	1.95
6.144	1.95
6.5536	1.95
8.0	1.95
10.0	1.95
10.738635	1.95
12.0	1.95
14.31818	1.95
15.0	1.95
16.0	1.95
17.430	1.95
18.0	1.95
18.432	1.95
20.0	1.95
22.1184	1.95
24.0	1.95
32.0	1.95

CRYSTAL OSCILLATORS

1.0MHz	5.95
1.8432	5.95
2.0	5.95
2.4576	5.95
2.5	4.95
4.0	4.95
5.0688	4.95
6.0	4.95
6.144	4.95
8.0	4.95
10.0	4.95
12.0	4.95
12.480	4.95
15.0	4.95
16.0	4.95
18.432	4.95
20.0	4.95
24.0	4.95

MISC.

TMS99531	9.95
TMS99532	19.95
ULN2003	.79
3242	7.95
3341	4.95
MC3470	1.95
MC3480	8.95
MC3487	2.95
11C90	13.95
2513-001 UP	6.95
AY5-2376	11.95
AY5-3600 PRO	11.95

74LS00

74LS00	.16	74LS165	.65
74LS01	.18	74LS166	.95
74LS02	.17	74LS169	.95
74LS03	.18	74LS173	.49
74LS04	.16	74LS174	.39
74LS05	.18	74LS175	.39
74LS08	.18	74LS191	.49
74LS09	.18	74LS192	.69
74LS10	.16	74LS193	.69
74LS11	.22	74LS194	.69
74LS12	.22	74LS195	.69
74LS13	.26	74LS196	.59
74LS14	.39	74LS197	.59
74LS15	.26	74LS221	.59
74LS20	.17	74LS240	.69
74LS21	.22	74LS241	.69
74LS22	.22	74LS242	.69
74LS27	.23	74LS243	.69
74LS28	.26	74LS244	.69
74LS30	.17	74LS245	.79
74LS32	.18	74LS251	.49
74LS33	.28	74LS253	.49
74LS37	.26	74LS256	1.79
74LS38	.26	74LS257	.39
74LS42	.39	74LS258	.49
74LS47	.59	74LS259	1.29
74LS48	.69	74LS260	.49
74LS51	.17	74LS266	.39
74LS73	.29	74LS273	.79
74LS74	.24	74LS279	.39
74LS75	.29	74LS280	1.98
74LS76	.29	74LS283	.59
74LS83	.49	74LS290	.89
74LS85	.49	74LS293	.89
74LS86	.22	74LS299	1.49
74LS90	.39	74LS322	3.95
74LS92	.49	74LS323	2.49
74LS93	.39	74LS364	1.95
74LS95	.49	74LS365	.39
74LS107	.34	74LS367	.39
74LS109	.36	74LS368	.39
74LS112	.29	74LS373	.79
74LS122	.45	74LS374	.79
74LS123	.49	74LS375	.95
74LS124	2.75	74LS377	.79
74LS125	.39	74LS378	1.18
74LS126	.39	74LS390	1.19
74LS132	.39	74LS393	.79
74LS133	.49	74LS541	1.49
74LS136	.39	74LS624	1.95
74LS138	.39	74LS640	.99
74LS139	.39	74LS645	.99
74LS145	.99	74LS669	1.29
74LS147	.99	74LS670	.89
74LS148	.99	74LS682	3.20
74LS151	.39	74LS683	3.20
74LS153	.39	74LS684	3.20
74LS154	1.49	74LS688	2.40
74LS155	.59	74LS783	22.95
74LS156	.49	81LS95	1.49
74LS157	.35	81LS96	1.49
74LS158	.29	81LS97	1.49
74LS160	.29	81LS98	1.49
74LS161	.39	25LS2521	2.80
74LS162	.49	25LS2569	2.80
74LS163	.39	26LS31	1.95
74LS164	.49	26LS32	1.95

HIGH SPEED CMOS

A new family of high speed CMOS logic featuring the speed of low power Schottky (8ns typical gate propagation delay), combined with the advantages of CMOS: very low power consumption, superior noise immunity, and improved output drive.

74HC00

74HC: Operate at CMOS logic levels and are ideal for new, all-CMOS designs.

74HC00	.59	74HC148	1.19
74HC02	.59	74HC151	.89
74HC04	.59	74HC154	2.49
74HC08	.59	74HC157	.89
74HC10	.59	74HC158	.95
74HC14	.79	74HC163	1.15
74HC20	.59	74HC175	.99
74HC27	.59	74HC240	1.89
74HC30	.59	74HC244	1.89
74HC32	.69	74HC245	1.89
74HC51	.59	74HC257	.85
74HC74	.75	74HC259	1.39
74HC85	1.35	74HC273	1.89
74HC86	.69	74HC299	4.99
74HC93	1.19	74HC368	.99
74HC107	.79	74HC373	2.29
74HC109	.79	74HC374	2.29
74HC112	.79	74HC390	1.39
74HC125	1.19	74HC393	1.39
74HC132	1.19	74HC4017	1.99
74HC133	.69	74HC4020	1.39
74HC138	.99	74HC4049	.89
74HC139	.99	74HC4050	.89

74HCT00

74HCT: Direct, drop-in replacements for LS TTL and can be intermixed with 74LS in the same circuit.

74HCT00	.69	74HCT166	3.05
74HCT02	.69	74HCT174	1.09
74HCT04	.69	74HCT193	1.39
74HCT08	.69	74HCT194	1.19
74HCT10	.69	74HCT240	2.19
74HCT11	.69	74HCT241	2.19
74HCT27	.69	74HCT244	2.19
74HCT30	.69	74HCT245	2.19
74HCT32	.79	74HCT257	.99
74HCT74	.85	74HCT259	1.59
74HCT75	.95	74HCT273	2.09
74HCT138	1.15	74HCT367	1.09
74HCT139	1.15	74HCT373	2.49
74HCT154	2.99	74HCT374	2.49
74HCT157	.99	74HCT393	1.59
74HCT158	.99	74HCT4017	2.19
74HCT161	1.29	74HCT4040	1.59
74HCT164	1.39	74HCT4060	1.49

74F00

74F00	.69	74F74	.79	74F251	1.6
74F02	.69	74F86	.99	74F253	1.6
74F04	.79	74F138	1.69	74F257	1.
74F08	.69	74F139	1.69	74F280	1.
74F10	.69	74F157	1.69	74F283	3.
74F32	.69	74F240	3.29	74F373	4.
74F64	.89	74F244	3.29	74F374	4.

VISIT OUR RETAIL STORE LOCATED AT 1256 SOUTH BASCOM AVENUE IN SAN JOSE

HOURS: M-W-F, 9-5 TU-TH, 9-9 SAT,

PLEASE USE YOUR CUSTOMER NUMBER WHEN ORDER

JDR Microdevices

1224 S. Bascom Avenue, San Jose, CA 95128

800-538-5000 • 800-662-6279 (CA) • (408) 995-5430

FAX (408) 275-8415 • Telex 171-110

TERMS: Minimum order $10.00. For shipping and handling include $2.50 fo Ground and $3.50 for UPS Air. Orders over 1 lb. and foreign orders may additional shipping charges - please contact our sales department for the amou residents must include applicable sales tax. All merchandise is warranted for unless otherwise stated. Prices are subject to change without notice. We responsible for typographical errors. We reserve the right to limit quantities substitute manufacturer. All merchandise subject to prior sale.

CIRCLE 113 ON FREE INFORMATION CARD

PARTIAL LISTING ONLY — CALL FOR A FREE CATALOG

CMOS

4001	.19	14419	4.95
4011	.19	14433	14.95
4012	.25	4503	.49
4013	.35	4511	.69
4015	.29	4516	.79
4016	.29	4518	.85
4017	.49	4522	.79
4018	.69	4526	.79
4020	.59	4527	1.95
4021	.69	4528	.79
4024	.49	4529	2.95
4025	.25	4532	1.95
4027	.39	4538	.95
4028	.65	4541	1.29
4035	.69	4553	5.79
4040	.69	4585	.75
4041	.75	4702	12.95
4042	.59	74C00	.29
4043	.85	74C14	.59
4044	.69	74C74	.59
4045	1.98	74C83	1.95
4046	.69	74C85	1.49
4047	.69	74C95	.99
4049	.29	74C150	5.75
4050	.29	74C151	2.25
4051	.69	74C161	.99
4052	.69	74C163	.99
4053	.69	74C164	1.39
4056	2.19	74C192	1.49
4060	.69	74C193	1.49
4066	.29	74C221	1.75
4069	.19	74C240	1.89
4076	.59	74C244	1.89
4077	.29	74C374	1.99
4081	.22	74C905	10.95
4085	.79	74C911	8.95
4086	.89	74C917	8.95
4093	.49	74C922	4.49
4094	2.49	74C923	4.95
14411	9.95	74C926	7.95
14412	6.95	80C97	.95

7400/9000

7400	.19	74147	2.49
7402	.19	74148	1.20
7404	.19	74150	1.35
7406	.29	74151	.55
7407	.29	74153	.55
7408	.24	74154	1.49
7410	.19	74155	.75
7411	.25	74157	.55
7414	.49	74159	1.65
7416	.25	74161	.69
7417	.25	74163	.69
7420	.19	74164	.85
7423	.29	74165	.85
7430	.19	74166	1.00
7432	.29	74175	.89
7438	.29	74177	.75
7442	.49	74178	1.15
7445	.69	74181	2.25
7447	.89	74182	.75
7470	.35	74184	2.00
7473	.34	74191	1.15
7474	.33	74192	.79
7475	.45	74194	.85
7476	.35	74196	.79
7483	.50	74197	.75
7485	.59	74199	1.35
7486	.35	74221	1.35
7489	2.15	74246	1.35
7490	.39	74247	1.25
7492	.50	74248	1.85
7493	.35	74249	1.95
7495	.55	74251	.75
7497	2.75	74265	1.35
74100	2.29	74273	1.95
74121	.29	74278	3.11
74123	.49	74367	.65
74125	.45	74368	.65
74141	.65	9368	3.95
74143	5.95	9602	1.50
74144	2.95	9637	2.95
74145	.60	96S02	1.95

74S00

74S00	.29	74S163	1.29
74S02	.29	74S168	3.95
74S03	.29	74S174	.79
74S04	.29	74S175	.79
74S05	.29	74S188	1.95
74S08	.35	74S189	1.95
74S10	.29	74S195	1.49
74S15	.35	74S196	1.49
74S30	.29	74S197	1.49
74S32	.35	74S226	3.99
74S37	.69	74S240	1.49
74S38	.69	74S241	1.49
74S74	.49	74S244	1.49
74S85	.95	74S257	.79
74S86	.35	74S253	.79
74S112	.50	74S258	.95
74S124	2.75	74S280	1.95
74S138	.79	74S287	1.69
74S140	.55	74S288	1.69
74S151	.79	74S299	2.95
74S153	.79	74S373	1.69
74S157	.79	74S374	1.69
74S158	.95	74S471	4.95
74S161	1.29	74S571	2.95

DATA ACQ / INTERFACE

DATA ACQ		INTERFACE	
ADC0800	15.55	8T26	1.29
ADC0804	3.49	8T28	1.29
ADC0809	4.49	8T95	.89
ADC0816	14.95	8T96	.89
ADC0817	9.95	8T97	.59
ADC0831	8.95	8T98	.89
DAC0800	4.49	DM8131	2.95
DAC0806	1.95	DP8304	2.29
DAC0808	2.95	DS8833	2.25
DAC1020	8.25	DS8835	1.99
DAC1022	5.95	DS8836	.99
MC1408L8	2.95	DS8837	1.65

VOLTAGE REGULATORS

TO-220 CASE

7805T	.49	7905T	.59
7808T	.49	7908T	.59
7812T	.49	7912T	.59
7815T	.49	7915T	.59

TO-3 CASE

7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49

TO-92 CASE

78L05	.49	79L05	.69
78L12	.49	79L12	.69

OTHER VOLTAGE REGS

LM323K	5V 3A	TO-3	4.79
LM338K	Adj. 5A	TO-3	3.95
78H05K	5V 5A	TO-3	7.95
78H12K	12V 5A	TO-3	8.95
78P05K	5V 10A	TO-3	14.95

IC SOCKETS

	1-99	100
8 PIN ST	.13	.11
14 PIN ST	.15	.12
16 PIN ST	.17	.13
18 PIN ST	.20	.18
20 PIN ST	.29	.27
22 PIN ST	.30	.27
24 PIN ST	.30	.27
28 PIN ST	.40	.32
40 PIN ST	.49	.39
64 PIN ST	4.25	CALL
ST=SOLDERTAIL		
8 PIN WW	.59	.49
14 PIN WW	.69	.52
16 PIN WW	.69	.58
18 PIN WW	.99	.90
20 PIN WW	1.09	.98
22 PIN WW	1.39	1.28
24 PIN WW	1.49	1.35
28 PIN WW	1.69	1.49
40 PIN WW	1.99	1.80
WW=WIREWRAP		
16 PIN ZIF	4.95	CALL
24 PIN ZIF	5.95	CALL
28 PIN ZIF	6.95	CALL
40 PIN ZIF	9.95	CALL

ZIF=TEXTOOL
(ZERO INSERTION FORCE)

LINEAR

TL066	.99	LM733	.98
TL071	.69	LM741	.29
TL072	1.09	LM747	.69
TL074	1.95	LM748	.59
TL081	.59	MC1330	1.69
TL082	.99	MC1350	1.19
TL084	1.49	MC1372	6.95
LM301	.34	LM1414	1.59
LM309K	1.25	LM1458	.49
LM311	.59	LM1488	.49
LM311H	.89	LM1489	.49
LM317K	3.49	LM1496	.85
LM317T	.95	LM1812	8.25
LM318	1.49	LM1889	1.95
LM319	1.25	ULN2003	.79
LM320	see 7900	XR2206	3.75
LM322	1.65	XR2211	2.95
LM323K	4.79	XR2240	1.95
LM324	.49	MPQ2907	1.95
LM331	3.95	LM2917	1.95
LM334	1.19	CA3046	.89
LM335	1.40	CA3081	.99
LM336	1.75	CA3082	.99
LM337K	3.95	CA3086	.80
LM338K	3.95	CA3089	1.95
LM339	.59	CA3130E	.99
LM340	see 7800	CA3146	1.29
LM350T	4.60	CA3160	1.19
LF353	.59	MC3470	1.95
LF356	.99	MC3480	8.95
LF357	.99	MC3487	2.95
LM358	.59	LM3900	.49
LM380	.89	LM3909	.98
LM383	1.95	LM3911	2.25
LM386	.89	LM3914	2.39
LM393	.45	MC4024	3.49
LM394H	4.60	MC4044	3.99
TL494	4.20	RC4136	1.25
TL497	3.25	RC4558	.69
NE555	.29	LM13600	1.49
NE556	.49	75107	1.49
NE558	1.29	75110	1.95
NE564	1.95	75150	1.95
LM565	.95	75154	1.95
LM566	1.49	75188	1.25
LM567	.79	75189	1.25
NE570	2.95	75451	.39
NE590	2.50	75452	.39
NE592	.98	75453	.39
LM710	.75	75477	1.29
LM723	.49	75492	.79

H=TO-5 CAN, K=TO-3, T=TO-220

EDGECARD CONNECTORS

100	PIN	ST	S-100	.125	3.95
100	PIN	WW	S-100	.125	4.95
62	PIN	ST	IBM PC	.100	1.95
50	PIN	ST	APPLE	.100	2.95
44	PIN	ST	STD	.156	1.95
44	PIN	WW	STD	.156	4.95

36 PIN CENTRONICS

MALE

IDCEN36	RIBBON CABLE	6.95
CEN36	SOLDER CUP	4.95
CEN36PC	RT ANGLE PC MOUNT	4.95

FEMALE

IDCEN36/F	RIBBON CABLE	7.95

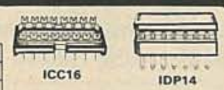
INTERSIL

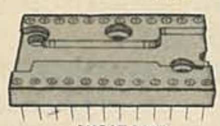
ICL7106	9.95
ICL7107	12.95
ICL7660	2.95
ICL8038	4.95
ICM7207A	5.95
ICM7208	15.95

DIP CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 8	14	16	18	20	22	24	28	40
HIGH RELIABILITY TOOLED ST IC SOCKETS	AUGATxxST	.62	.79	.89	1.09	1.29	1.39	1.49	1.69	2.49
HIGH RELIABILITY TOOLED WW IC SOCKETS	AUGATxxWW	1.30	1.80	2.10	2.40	2.50	2.90	3.15	3.70	5.40
COMPONENT CARRIES (DIP HEADERS)	ICCxx	.49	.59	.69	.99	.99	.99	.99	1.09	1.49
RIBBON CABLE DIP PLUGS (IDC)	IDPxx	---	.95	.95	---	---	---	1.75	---	2.95

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE BELOW


ICC16 IDP14


AUGAT 24ST

DIODES/OPTO/TRANSISTORS

1N751	.25	4N26	.69
1N759	.25	4N27	.69
1N4148	25/1.00	4N28	.69
1N4004	10/1.00	4N33	.89
1N5402	.25	4N37	1.19
KBP04	.55	MCT-2	.59
KBU8A	.95	MCT-6	1.29
MDA990-2	.35	TIL-111	.99
N2222	.25	2N3906	.10
PN2222	.10	2N4401	.25
2N2905	.50	2N4402	.25
2N2907	.25	2N4403	.25
2N3055	.79	2N6045	1.75
2N3904	.10	TIP31	.49

D-SUBMINIATURE

DESCRIPTION		ORDER BY	CONTACTS 9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.82	.90	1.25	1.25	1.80	3.48
	FEMALE	DBxxS	.95	1.15	1.50	1.50	2.35	4.32
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	1.20	1.49	---	1.95	2.65	---
	FEMALE	DBxxSR	1.25	1.55	---	2.00	2.79	---
WIRE WRAP	MALE	DBxxPWW	1.69	2.56	---	3.89	5.60	---
	FEMALE	DBxxSWW	2.76	4.27	---	6.84	9.95	---
IDC RIBBON CABLE	MALE	IDBxxP	2.70	2.95	---	3.98	5.70	---
	FEMALE	IDBxxS	2.92	3.20	---	4.33	6.76	---
HOODS	METAL	MHOODxx	1.25	1.25	1.30	1.30	---	---
	GREY	HOODxx	.65	.65	---	.65	.75	.95

ORDERING INSTRUCTIONS: INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED.

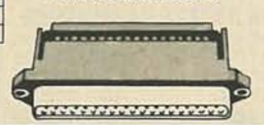
EXAMPLE: A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR.

MOUNTING HARDWARE $1.00


MTG HDWR


HOOD25


DB37S


IDB37S

LED DISPLAYS

FND-357(359)	COM CATHODE	.362"	1.25
FND-500(503)	COM CATHODE	.5"	1.49
FND-507(510)	COM CATHODE	.5"	1.49
MAN-72	COM ANODE	.3"	.99
MAN-74	COM CATHODE	.3"	.99
MAN-8940	COM CATHODE	.8"	1.99
TIL-313	COM CATHODE	.3"	.45
HP5082-7760	COM CATHODE	.43"	1.29
TIL-311	4x7 HEX W/LOGIC	.270"	9.95
HP5082-7340	4x7 HEX W/LOGIC	.290"	7.95

DIFFUSED LEDS

		1-99	100-UP
JUMBO RED	T1¾	.10	.09
JUMBO GREEN	T1¾	.14	.12
JUMBO YELLOW	T1¾	.14	.12
MOUNTING HDW	T1¾	.10	.09
MINI RED	T1	.10	.09

SWITCHES

SPST	MINI-TOGGLE ON-ON	1.25
DPDT	MINI-TOGGLE ON-ON	1.50
DPDT	MINI-TOGGLE ON-OFF-ON	1.75
SPST	MINI-PUSHBUTTON N.O.	.39
SPST	MINI-PUSHBUTTON N.C.	.39
SPST	TOGGLE ON-OFF	.49
BCD OUTPUT 10 POSITION 6 PIN DIP		1.95

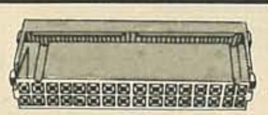
DIP SWITCHES

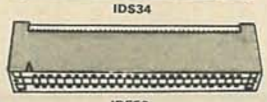
4 POSITION	.85	7 POSITION	.95
5 POSITION	.90	8 POSITION	.95
6 POSITION	.90	10 POSITION	1.29

IDC CONNECTORS

DESCRIPTION	ORDER BY	CONTACTS 10	20	26	34	40	50
SOLDER HEADER	IDHxxS	.82	1.29	1.68	2.20	2.58	3.24
RIGHT ANGLE SOLDER HEADER	IDHxxSR	.85	1.35	1.76	2.31	2.72	3.39
WW HEADER	IDHxxW	1.86	2.98	3.84	4.50	5.28	6.63
RIGHT ANGLE WW HEADER	IDHxxWR	2.05	3.28	4.22	4.45	4.80	7.30
RIBBON HEADER SOCKET	IDSxx	.79	.99	1.39	1.59	1.99	2.25
RIBBON HEADER	IDMxx	---	5.50	6.25	7.00	7.50	8.50
RIBBON EDGE CARD	IDExx	1.75	2.25	2.65	2.75	3.80	3.95

FOR ORDERING INSTRUCTIONS SEE D-SUBMINIATURE ABOVE


IDS34


IDE50

RIBBON CABLE

CONTACTS	SINGLE COLOR 1'	SINGLE COLOR 10'	COLOR CODED 1'	COLOR CODED 10'
10	.18	1.60	.30	2.75
16	.28	2.50	.48	4.40
20	.36	3.20	.60	5.50
25	.45	4.00	.75	6.85
26	.46	4.10	.78	7.15
34	.61	5.40	1.07	9.35
40	.72	6.40	1.20	11.00
50	.89	7.50	1.50	13.25

HARD TO FIND "SNAPABLE" HEADERS

CAN BE SNAPPED APART TO MAKE ANY SIZE HEADER, ALL WITH .1" CENTERS

1x40	STRAIGHT LEAD	.99
1x40	RIGHT ANGLE	1.49
2x40	STRAIGHT LEAD	2.49
2x40	RIGHT ANGLE	2.99

SHORTING BLOCKS

GOLD CONTACTS SPACED AT .1" CENTERS

5/$1.00

Let me tell you how much I appreciate your Sales & Customer Service staffs. My recent order was filled in a most courteous & prompt manner & I will deal with you in the future to the exclusion of other similar firms who obviously don't need customers bothering them. Thank you,

F.K.
Chapel Hill, NC.

CALL FOR VOLUME QUOTES

CIRCLE 253 ON FREE INFORMATION CARD

ORDER TOLL FREE **800-538-5000** **800-662-6279 (CA)**

BARGAIN HUNTERS CORNER

IBM COMPATIBLE MONOCHROME DISPLAY ADAPTOR

- 720 x 350 PIXEL SCREEN (80 CHARACTERS x 25 LINES)
- CHARACTER ATTRIBUTES: BLINK, UNDERLINE, REVERSE, VIDEO & INTENSIFIED
- STANDARD TTL OUTPUT
- MADE IN USA BY INTERSIL SYSTEMS
- 90 DAY WARRANTY
- INCLUDES 5 PAGE MANUAL

$49.95

NOTE: THE ABOVE CARD DOES NOT INCLUDE A PARALLEL PRINTER PORT. DON'T LET THIS PRICE SCARE YOU AS WE PURCHASED THESE FROM AN EXCESS INVENTORY LOT, WE CAN SELL THEM AT AN UNHEARD-OF-PRICE!

PURCHASE THE ABOVE
MONOCHROME DISPLAY ADAPTOR
AND THE
SAMWOO MONOCHROME MONITOR
FOR ONLY **$139.95**

ADDITIONAL SAVINGS

SPECIALS END 12/31/85

PAGE WIRE WRAP WIRE

PRECUT ASSORTMENT
IN ASSORTED COLORS $27.50
100ea: 5.5", 6.0", 6.5", 7.0"
250ea: 2.5", 4.5", 5.0"
500ea: 3.0", 3.5", 4.0"

SPOOLS

100 feet	$4.30	250 feet	$7.25
500 feet	$13.25	1000 feet	$21.95

Please specify color: Blue, Black, Yellow or Red

EMI FILTER $4.95

- MANUFACTURED BY CORCOM
- LOW COST
- FITS LC-HP BELOW
- 6 AMP 120/240 VOLT

6 FOOT LINE CORDS

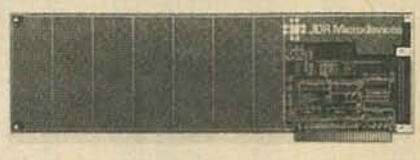
LC-2	2 CONDUCTOR	.39
LC-3	2 CONDUCTOR	.99
LC-HP	3 CONDUCTOR W/STD FEMALE SOCKET	1.49

MUFFIN FANS

3.15" SQ.	ROTRON	14.95
3.63" SQ.	ETRI	14.95
3.18" SQ.	MASUSHITA	16.95

WIRE WRAP PROTOTYPE CARDS

FR-4 EPOXY GLASS LAMINATE
WITH GOLD-PLATED EDGE-CARD FINGERS



IBM-PR2

IBM

BOTH CARDS HAVE SILK SCREENED LEGENDS AND INCLUDES MOUNTING BRACKET

IBM-PR1	WITH +5V AND GROUND PLANE	$27.95
IBM-PR2	AS ABOVE WITH DECODING LAYOUT	$29.95

S-100

P100-1	BARE - NO FOIL PADS	$15.15
P100-2	HORIZONTAL BUS	$21.80
P100-3	VERTICAL BUS	$21.80
P100-4	SINGLE FOIL PADS PER HOLE	$22.75

APPLE

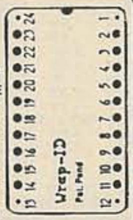
P500-1	BARE - NO FOIL PADS	$15.15
P500-3	HORIZONTAL BUS	$22.75
P500-4	SINGLE FOIL PADS PER HOLE	$21.80
7060-45	FOR APPLE IIe AUX SLOT	$30.00

SOCKET-WRAP I.D.™

- SLIPS OVER WIRE WRAP PINS
- IDENTIFIES PIN NUMBERS ON WRAP SIDE OF BOARD
- CAN WRITE ON PLASTIC; SUCH AS IC #

PINS	PART#	PCK. OF	PRICE
8	IDWRAP 08	10	1.95
14	IDWRAP 14	10	1.95
16	IDWRAP 16	10	1.95
18	IDWRAP 18	5	1.95
20	IDWRAP 20	5	1.95
22	IDWRAP 22	5	1.95
24	IDWRAP 24	5	1.95
28	IDWRAP 28	5	1.95
40	IDWRAP 40	5	1.95

PLEASE ORDER BY NUMBER OF PACKAGES (PCK. OF)



ID WRAP 24

FRAME STYLE TRANSFORMERS

12.6V AC CT	2 AMP	5.95
12.6V AC CT	4 AMP	7.95
12.6V AC CT	8 AMP	10.95
25.2V AC CT	2 AMP	7.95

25 PIN D-SUB GENDER CHANGERS

$7.95

SWITCHING POWER SUPPLIES

PS-IBM $99.95
- FOR IBM PC-XT COMPATIBLE
- 130 WATTS
- +5V @ 15A, +12V @ 4.2A, -5V @ .5A, -12V @ .5A
- ONE YEAR WARRANTY

PS-130 $99.95
- 130 WATTS
- SWITCH ON REAR
- FOR USE IN OTHER IBM TYPE MACHINES
- 90 DAY WARRANTY

PS-A $49.95
- USE TO POWER APPLE TYPE SYSTEMS
- +5V @ 4A, +12V @ 2.5A, -5V @ .5A, -12V @ .5A
- APPLE POWER CONNECTOR

PS-3 $39.95
- AS USED IN APPLE III
- +5V @ 4A, +12V @ 2.5A, -5V @ .25A, -12V @ .30A,
- 15.5" x 4.5" x 2.0", .884 LBS.

PS-ASTEC $19.95
- CAN POWER TWO 5¼" FDDS
- +5V @ 2.5A, +12V @ 2A, -12V @ .1A
- +5V @ 5A IF +12V IS NOT USED
- 6.3" x 4.0" x 1.9", 1 LB.

PS-TDK $29.95
- +5V @ 4A, +12V @ 2A
- +12V @ 2.8A, -12V @ .30A
- 6.2" x 7.4" x 1.7", 1.6 LBS.

PS-IBM

PS-130

PS-A

PS-ASTEC

CAPACITORS

TANTALUM

1.0μf	15V	.35	.47μf	35V	.45
6.8	15V	.70	1.0	35V	.45
10	15V	.80	2.2	35V	.65
22	15V	1.35	4.7	35V	.85
.22	35V	.40	10	35V	1.00

DISC

10pf	50V	.05	680	50V	.05
22	50V	.05	.001μf	50V	.05
27	50V	.05	.0022	50V	.05
33	50V	.05	.005	50V	.05
47	50V	.05	.01	50V	.07
68	50V	.05	.02	50V	.07
100	50V	.05	.05	50V	.07
220	50V	.05	.1	12V	.10
560	50V	.05	.1	50V	.12

MONOLITHIC

.01μf	50V	.14	.1μf	50V	.18
.047μf	50V	.15	.47μf	50V	.25

ELECTROLYTIC

RADIAL			AXIAL		
1μf	25V	.14	1μf	50V	.14
2.2	35V	.15	10	50V	.16
4.7	50V	.15	22	16V	.14
10	50V	.15	47	50V	.20
47	35V	.18	100	35V	.25
100	16V	.18	220	25V	.30
220	35V	.20	470	50V	.50
470	25V	.30	1000	16V	.60
2200	16V	.70	2200	16V	.70
4700	25V	1.45	4700	16V	1.25

COMPUTER GRADE 44,000μf 30V 3.95

DATARASE EPROM ERASER $34.95

- ERASES TWO EPROMS IN 10 MINUTES
- COMPACT-NO DRAWER
- THIN METAL SHUTTER PREVENTS UV LIGHT FROM ESCAPING

¼ WATT RESISTORS

5% CARBON FILM ALL STANDARD VALUES
FROM 1 OHM TO 10 MEG. OHM

10 PCS same value	.05		100 PCS same value	.02
50 PCS same value	.025		1000 PCS same value	.015

RESISTOR NETWORKS

SIP	10 PIN	9 RESISTOR	.69
SIP	8 PIN	7 RESISTOR	.59
DIP	16 PIN	8 RESISTOR	1.09
DIP	16 PIN	15 RESISTOR	1.09
DIP	14 PIN	7 RESISTOR	.99
DIP	14 PIN	13 RESISTOR	.99

SPECIALS ON BYPASS CAPACITORS

.01 μf CERAMIC DISC	100/$5.00
.01 μf MONOLITHIC	100/$10.00
.1 μf CERAMIC DISC	100/$6.50
.1 μf MONOLITHIC	100/$12.50

NEW BOOKS BY STEVE CIARCIA

BIULD YOUR OWN Z80 COMPUTER	$19.95
CIRCUIT CELLAR VOL 1	$17.95
CIRCUIT CELLAR VOL 2	$18.95
CIRCUIT CELLAR VOL 3	$18.95
CIRCUIT CELLAR VOL 4	$18.95

MICROCOMPUTER HARDWARE HANDBOOK

FROM ELCOMP $14.95

OVER 800 PAGES OF DATA SHEETS ON THE MOST COMMONLY USED ICs. INCLUDES TTL, CMOS, 74LS00, MEMORY, CPUs, MPU SUPPORT. AND MUCH MORE!

WISH SOLDERLESS BREADBOARDS

PART NUMBER	DIMENSIONS	DISTRIBUTION STRIP(S)	TIE POINTS	TERMINAL STRIP(S)	TIE POINTS	BINDING POSTS	PRICE
WBU-D	.38 x 6.50"	1	100	---	---	---	2.95
WBU-T	1.38 x 6.50"	---	---	1	630	---	6.95
WBU-204-3	3.94 x 8.45"	1	100	2	1260	2	17.95
WBU-204	5.13 x 8.45"	4	400	2	1260	3	24.95
WBU-206	6.88 x 9.06"	5	500	3	1890	4	29.95
WBU-208	8.25 x 9.45"	7	700	4	2520	4	39.95

LITHIUM BATTERY

AS USED IN CLOCK CIRCUITS

3 VOLT BATTERY	$3.95
BATTERY HOLDER	$1.49

IC MASTER $79.95

THE INDUSTRY STANDARD

VISIT OUR RETAIL STORE LOCATED AT 1256 SOUTH BASCOM AVENUE IN SAN JOSE

JDR Microdevices
1224 S. Bascom Avenue, San Jose, CA 95128
800-538-5000 • 800-662-6279 (CA) • (408) 995-5430
FAX (408) 275-8415 • Telex 171-110

HOURS: M-W-F, 9-5 TU-TH, 9-9 SAT, 10-3

PLEASE USE YOUR CUSTOMER NUMBER WHEN ORDERING

TERMS: Minimum order $10.00. For shipping and handling include $2.50 for UPS Ground and $3.50 for UPS Air. Orders over 1 lb. and foreign orders may require additional shipping charges - please contact our sales department for the amount. CA. residents must include applicable sales tax. All merchandise is warranted for 90 days unless otherwise stated. Prices are subject to change without notice. We are not responsible for typographical errors. We reserve the right to limit quantities and to substitute manufacturer. All merchandise subject to prior sale.

ALL MERCHANDISE 100% GUARANTEED

PARTIAL LISTING ONLY — CALL FOR A FREE CATALOG

B&L PRINTER BUFFERS

- FREES COMPUTER FOR OTHER TASKS WHILE PRINTING LONG DOCUMENTS.
- STANDALONE DESIGN - WORKS WITH ANY COMPUTER OR PRINTER.
- ALL MODELS FEATURE PRINT PAUSE, MEMORY CHECK AND GRAPHICS CAPABILITY.

SP120P PARALLEL $139.95
- 64K UPGRADABLE TO 256K
- LED INDICATOR SHOWS VOLUME OF DATA IN BUFFER

SP120S RS232 SERIAL $159.95
- 64K UPGRADABLE TO 256K
- SIX SELECTABLE BAUD RATES FROM 600B — 19,200B

SP110 PARALLEL $249.95
- 64K UPGRADABLE TO 512K
- SPOOLS OUTPUT OF UP TO THREE COMPUTERS
- LED BARGRAPH DISPLAYS AMOUNT OF DATA IN BUFFER
- RESET FUNCTION CLEARS DATA IN BUFFER
- REPEAT FUNCTION CAN PRODUCE MULTIPLE COPIES OF A DOCUMENT


SP120


SP110

B&L 3-WAY SWITCH BOXES

- SERIAL OR PARALLEL
- CONNECTS 3 PRINTERS TO 1 COMPUTER OR 3 COMPUTERS TO 1 PRINTER
- ALL LINES SWITCHED
- HIGH QUALITY ROTARY SWITCH MOUNTED ON PCB
- GOLD CONTACTS
- STURDY METAL ENCLOSURE

SWITCH-3P	CENTRONICS PARALLEL	99.95
SWITCH-3S	RS232 SERIAL	99.95

FLOPPY DISK DRIVES


TEAC FD-55B

TEAC

FD-55B	½ HEIGHT DS/DD	$89.95
FD-55F	½ HEIGHT DS/QUAD	$99.95

SHUGART

SA460	5¼" (80 TRACK) DS/QUAD	$199.95

TANDON

TM100-2	5¼" (FOR IBM) DS/DD	$99.95

MPI

MPI-B52	5¼" (FOR IBM) DS/DD	$89.95

SIEMENS 8" DISK DRIVES

FD100-8	SS/DD SA801R EQUIV.	$119.00
FD200-8	DS/DD SA851R EQUIV.	$159.00
JFORMAT-2 SOFTWARE		$49.95

SUPPORT FOR QUAD DENSITY DRIVES FROM TALL TREE SYSTEMS


TANDON TM100-2

IBM PRINTER CABLE

- DB25 TO CENTRONICS
- SHIELDED CABLE

$9.95

JOYSTICKS

$7.95

$4.95

DISK DRIVE CABINETS

5¼" DRIVE ENCLOSURES

CAB-APPLE	APPLE TYPE DRIVE CABINET WITHOUT POWER SUPPLY	$24.95
CAB-1FH5	FULL HEIGHT 5¼" BEIGE DRIVE CABINET WITH POWER SUPPLY	$69.95
CAB-2SV5	DUAL SLIMLINE 5¼" CABINET WITH POWER SUPPLY - VERTICAL MOUNT	$49.95

8 INCH DRIVE ENCLOSURES BY JMR

CAB-2SV8	DUAL SLIMLINE 8" DRIVE CABINET WITH POWER SUPPLY - VERTICAL MOUNT	$209.95
CAB-2FH8	DUAL FULL HEIGHT 8" DRIVE CABINET WITH POWER SUPPLY - HORIZONTAL	$219.95


CAB-1FH5


CAB-2SV5


CAB-2FH8

NASHUA DISKETTE SPECIALS

5¼" SOFT SECTOR DS/DD WITH HUB RINGS

$9.90	89¢ea	79¢ea
BOX OF 10	BULK QTY 50	BULK QTY 250

NASHUA DISKETTES WERE JUDGED TO HAVE THE HIGHEST POLISH AND RECORDED AMPLITUDE OF ANY DISKETTES TESTED. SEE "COMPARING FLOPPY DISKS", BYTE 9-84.

DISKETTE FILE

$8.95

HOLDS 70 5¼" DISKETTES

DISKETTES

NASHUA 5¼"

N-MD2D	DS/DD SOFT SECTOR	$9.90
N-MD2F	DS/QUAD SOFT SECTOR	$34.95
N-MD2H	DS/HIGH DENSITY FOR AT	$49.95

NASHUA 8"

N-FD1	SS/DD SOFT SECTOR	$27.95
N-FD2D	DS/DD SOFT SECTOR	$34.95

NASHUA 3.5"

N-3.5SS	3.5" SS/DD FOR MACINTOSH	$32.95

VERBATIM 5¼"

V-MD1D	SS/DD SOFT SECTOR	$23.95
V-MD2D	DS/DD SOFT SECTOR	$29.95
V-MD110D	SS/DD 10 SECTOR HARD	$23.95

IBM STYLE COMPUTER CASE

ATTRACTIVE STEEL CASE, WITH HINGED LID, FITS POPULAR PC/XT COMPATIBLE MOTHER-BOARDS.

- SWITCH CUT-OUT ON SIDE FOR PC/XT STYLE POWER SUPPLY
- CUT-OUT FOR 8 EXPANSION SLOTS
- ALL HARDWARE INCLUDED

ONLY $59.95

IBM COMPATIBLE KEYBOARDS

DKM-2000 $79.95
- FULLY IBM COMPATIBLE
- 83 KEY WITH CAPACITANCE TYPE SWITCHES
- LED STATUS INDICATORS FOR CAPS, NUMBER LOCK
- AUDIBLE CLICK

KB-5151 $99.95
- ENHANCED IBM COMPATIBLE
- SEPARATE CURSOR AND NUMERIC KEYPADS
- CAPS LOCK & NUMBER LOCK INDICATORS
- IMPROVED KEYBOARD LAYOUT

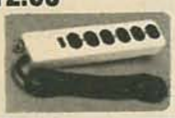
EXTENDER CARDS

IBM-PC	$45.00
IBM-AT	$68.00
APPLE II	$45.00
APPLE IIe	$45.00
MULTIBUS	$86.00

POWER STRIPS

- UL APPROVED
- 15A CIRCUIT BREAKER

$12.95



KEYBOARD-AP

- REPLACEMENT FOR APPLE II KEYBOARD
- CAPS LOCK KEY
- AUTO-REPEAT
- ONE KEY ENTRY OF BASIC OR CP/M COMMANDS

$49.95

CASE WITH KEYBOARD

FOR APPLE MOTHER-BOARD — MODEL KB-1000

- USER DEFINED FUNCTION KEYS
- NUMERIC KEYPAD WITH CURSOR CONTROL
- CAPS LOCK
- AUTO-REPEAT

ONLY $79.95

HIGH QUALITY TEST EQUIPMENT FROM JDR INSTRUMENTS

20 MHz DUAL TRACE OSCILLOSCOPE

MODEL 2000

$389

- BAND WIDTH - DC: TO20 MHz (-3db) AC: 10 Hz TO 20MHZ (-3db)
- SWEEP TIME - .2 μSEC TO .5 SEC/DIV ON 20 RANGES
- COMPLETE MANUAL AND HIGH QUALITY HOOK-ON PROBES INCLUDED
- INPUT IMPEDANCE: 1 MEG OHM
- TV VIDEO SYNC FILTER
- X-Y AND Z AXIS OPERATION
- 110/220 VOLT OPERATION
- COMPONENT TESTER
- LP CONSUMPTION - 19 WATTS
- BUILT-IN CALIBRATOR
- AUTOMATIC OR TRIGGERED TIMEBASE

35 MHz DUAL TRACE OSCILLOSCOPE

MODEL 3500

$549

- BAND WIDTH - DC: TO 35MHz (-3db) AC: 10 Hz TO 35MHZ (-3db)
- SWEEP TIME - .1 μSEC TO .5 SEC/DIV ON 21 RANGES
- DELAYED TRIGGER - 100 mSEC TO 1 μSEC WITH INTENSIFIED AND DELAYED MODES
- COMPLETE MANUAL AND 1X-10X COMPENSATED HOOK-ON PROBES INCLUDED
- VARIABLE HOLD OFF FOR VIEWING COMPLEX WAVES
- TV VIDEO SYNC FILTER
- TRIGGERING OF CH-A, CH-B, ALTERNATING, LINE OR EXTERNAL
- X-Y AND Z AXIS OPERATION

DIGITAL MULTIMETER PEN MODEL DPM-1000

$49.95

AUTO RANGING, POLARITY AND DECIMAL!

- LARGE 3.5" DISPLAY
- DATA HOLD SWITCH FREEZES READING
- FAST, AUDIBLE CONTINUITY TEST
- LOW BATTERY INDICATOR
- OVERLOAD PROTECTION
- ONLY 1⅛ x 6¼ x ¾"
- DC VOLTS 1mV-500V
- AC VOLTS 1mV-500V
- .1 OHM - 2 MEG OHM
- WEIGHS ONLY 2.3 OUNCES
- LOW PARTS COUNT-CUSTOM 80 PIN LSI INSURES RELIABILITY
- INCLUDES MANUAL, BATTERIES, HARD CASE, AND ALLIGATOR CLIP

CALL FOR VOLUME QUOTES

CIRCLE 255 ON FREE INFORMATION CARD

Jameco ELECTRONICS — NEW LOW, LOW PRICES!!!

CALL FOR QUANTITY DISCOUNTS

7400

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
SN7400N	14	.19	SN7474N	14	.35	SN74159N	24	1.49
SN7401N	14	.19	SN7475N	16	.39	SN74160N	16	.79
SN7402N	14	.19	SN7476N	16	.35	SN74161N	16	.59
SN7403N	14	.19	SN7480N	14	.59	SN74162N	16	.85
SN7404N	14	.25	SN7482N	14	.95	SN74163N	16	.59
SN7405N	14	.19	SN7483N	16	.49	SN74164N	14	.69
SN7406N	14	.29	SN7485N	16	.59	SN74165N	16	.69
SN7407N	14	.29	SN7486N	14	.35	SN74166N	16	.69
SN7408N	14	.25	SN7489N	16	1.95	SN74167N	16	2.95
SN7409N	14	.29	SN7490N	14	.39	SN74170N	16	1.59
SN7410N	14	.19	SN7491N	14	.59	SN74172N	24	4.95
SN7411N	14	.25	SN7492N	14	.49	SN74173N	16	.75
SN7412N	14	.35	SN7493N	14	.35	SN74174N	16	.59
SN7413N	14	.35	SN7494N	14	.69	SN74175N	16	.59
SN7414N	14	.45	SN7495N	14	.49	SN74176N	14	.69
SN7416N	14	.25	SN7496N	16	.65	SN74177N	14	.69
SN7417N	14	.35	SN7497N	16	2.69	SN74179N	16	1.49
SN7420N	14	.19	SN74100N	24	1.75	SN74180N	14	.69
SN7421N	14	.35	SN74105N	14	.99	SN74181N	24	1.95
SN7422N	14	.49	SN74107N	14	.39	SN74182N	16	.75
SN7423N	16	.49	SN74109N	16	.39	SN74184N	16	1.95
SN7425N	14	.38	SN74116N	24	1.49	SN74185N	16	1.95
SN7426N	14	.29	SN74121N	14	.29	SN74189N	16	1.95
SN7427N	14	.29	SN74122N	14	.45	SN74190N	16	.89
SN7428N	14	.45	SN74123N	16	.45	SN74191N	16	.89
SN7430N	14	.19	SN74125N	14	.45	SN74192N	16	.69
SN7432N	14	.29	SN74126N	14	.45	SN74193N	16	.69
SN7433N	14	.45	SN74128N	14	.49	SN74194N	16	.79
SN7437N	14	.29	SN74132N	14	.49	SN74195N	16	.79
SN7438N	14	.29	SN74136N	14	.69	SN74196N	14	.99
SN7439N	14	.29	SN74141N	16	.69	SN74197N	14	.69
SN7440N	14	.15	SN74142N	16	2.95	SN74198N	24	1.35
SN7441N	16	.89	SN74143N	24	3.95	SN74199N	24	1.35
SN7442N	16	.45	SN74144N	24	2.95	SN74221N	16	.89
SN7443N	16	.79	SN74145N	16	.65	SN74251N	16	.89
SN7444N	16	.79	SN74147N	16	1.69	SN74273N	20	1.95
SN7445N	16	.69	SN74148N	16	.89	SN74276N	20	2.49
SN7446N	16	.79	SN74150N	24	1.29	SN74279N	16	.79
SN7447N	16	.79	SN74151N	16	.29	SN74283N	16	1.39
SN7448N	16	.79	SN74152N	14	.49	SN74284N	16	2.95
SN7454N	14	.19	SN74153N	16	.39	SN74285N	16	2.95
SN7459N	14	.59	SN74154N	24	1.25	SN74365N	16	.59
SN7460N	14	.25	SN74155N	16	.49	SN74366N	16	.59
SN7470N	14	.39	SN74156N	16	.65	SN74367N	16	.59
SN7472N	14	.39	SN74157N	16	.49	SN74368N	16	.59
SN7473N	14	.35	SN74158N	16	1.39	SN74390N	16	1.49
						SN74393N	14	1.49

74LS

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
74LS00	14	.19	74LS133	16	.49	74LS253	16	.49
74LS01	14	.19	74LS136	14	.39	74LS257	16	.39
74LS02	14	.19	74LS138	16	.39	74LS258	16	.49
74LS03	14	.19	74LS139	16	.39	74LS259	16	1.19
74LS04	14	.25	74LS145	16	.89	74LS260	14	.49
74LS05	14	.25	74LS147	16	.99	74LS261	16	1.49
74LS06	14	.99	74LS148	16	.99	74LS266	14	.49
74LS07	14	.99	74LS151	16	.39	74LS273	20	.79
74LS08	14	.19	74LS153	16	.39	74LS279	16	.39
74LS09	14	.19	74LS154	24	1.49	74LS280	14	1.19
74LS10	14	.19	74LS155	16	.49	74LS283	16	.59
74LS11	14	.19	74LS156	16	.49	74LS289	16	3.95
74LS12	14	.19	74LS157	16	.35	74LS299	20	1.49
74LS14	14	.39	74LS158	16	.35	74LS322	20	2.95
74LS15	14	.29	74LS160	16	.69	74LS323	20	2.49
74LS20	14	.19	74LS161	16	.39	74LS347	16	.79
74LS21	14	.25	74LS162	16	.69	74LS353	16	1.19
74LS26	14	.25	74LS163	16	.49	74LS364	20	1.95
74LS27	14	.25	74LS164	14	.49	74LS365	16	.39
74LS28	14	.29	74LS165	16	.79	74LS366	16	.39
74LS30	14	.19	74LS166	16	.89	74LS367	16	.39
74LS32	14	.25	74LS168	16	.99	74LS368	16	.39
74LS33	14	.39	74LS169	16	.99	74LS373	20	.79
74LS37	14	.29	74LS170	16	1.49	74LS374	20	.79
74LS38	14	.29	74LS173	16	.49	74LS375	16	.69
74LS42	16	.39	74LS174	16	.39	74LS377	20	.79
74LS47	16	.89	74LS175	16	.39	74LS386	14	.45
74LS48	16	.89	74LS181	24	1.49	74LS390	16	1.09
74LS51	14	.25	74LS189	16	3.95	74LS393	14	.79
74LS54	14	.19	74LS190	16	.49	74LS399	16	1.09
74LS73	14	.35	74LS191	16	.49	74LS490	16	1.49
74LS74	14	.25	74LS192	16	.69	74LS533	20	1.95
74LS75	16	.29	74LS193	16	.69	74LS534	20	1.95
74LS76	16	.29	74LS194	16	.59	74LS540	20	1.09
74LS85	16	.49	74LS195	16	.59	74LS541	20	1.09
74LS86	14	.25	74LS196	14	.89	74LS590	16	5.95
74LS90	14	.39	74LS197	14	.89	74LS624	14	1.95
74LS92	14	.49	74LS221	16	.59	74LS629	16	2.49
74LS93	14	.39	74LS240	20	.69	74LS640	20	.99
74LS95	16	.49	74LS241	20	.69	74LS641	20	1.29
74LS107	14	.35	74LS242	14	1.09	74LS644	20	1.29
74LS109	16	.35	74LS243	14	.69	74LS645	20	.99
74LS112	16	.29	74LS244	20	.69	74LS670	16	.99
74LS122	14	.45	74LS245	20	.79	74LS688	20	1.95
74LS123	16	.49	74LS247	16	.99	81LS95	20	1.49
74LS125	14	.39	74LS251	16	.49	81LS96	20	1.49
74LS126	14	.39				81LS97	20	1.49
74LS132	14	.39				81LS98	20	1.49

74S/PROMS*

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
74S00	14	.29	74S112	16	.49	74S189	16	1.95
74S02	14	.29	74S124	16	2.75	74S194	16	1.49
74S04	14	.35	74S132	14	1.49	74S195	16	1.49
74S05	14	.35	74S133	16	.45	74S196	16	1.49
74S08	14	.35	74S135	16	.89	74S240	20	1.49
74S09	14	.39	74S136	14	1.39	74S241	20	1.49
74S10	14	.29	74S138	16	.79	74S242	14	2.69
74S11	14	.35	74S139	16	.79	74S244	20	1.49
74S15	14	.35	74S140	14	.55	74S251	16	.79
74S20	14	.35	74S151	16	.79	74S253	16	.79
74S22	14	.35	74S153	16	.79	74S257	16	.79
74S30	14	.35	74S157	16	.79	74S258	16	.99
74S32	14	.35	74S158	16	.89	74S273	20	2.39
74S37	14	.69	74S160	16	4.95	74S280	14	1.89
74S38	14	.69	74S169	16	3.95	74S287*	16	1.69
74S64	14	.39	74S174	16	.79	74S288*	16	1.69
74S65	14	.39	74S175	16	.79	74S299	20	3.95
74S74	14	.49	74S188*	16	1.75	74S373	20	1.69
74S85	16	1.49				74S374	20	1.69
74S86	14	.35				74S472*	20	3.49

74ALS

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
74ALS00	14	.35	74ALS32	14	.39	74ALS174	16	.89
74ALS02	14	.35	74ALS74	14	.55	74ALS175	16	.89
74ALS04	14	.39	74ALS109	16	.55	74ALS240	20	1.79
74ALS05	14	.35	74ALS112	16	.79	74ALS244	20	1.79
74ALS08	14	.35	74ALS138	16	.89	74ALS245	20	2.49
74ALS10	14	.35				74ALS373	20	1.95
74ALS27	14	.39				74ALS374	20	1.95
74ALS30	14	.35				74ALS573	20	1.95

74F

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
74F00	14	.59	74F138	16	1.19	74F241	20	2.49
74F02	14	.59	74F139	16	1.29	74F244	20	2.49
74F04	14	.65	74F157	16	1.29	74F251	16	1.49
74F08	14	.59	74F158	16	1.29	74F253	16	1.79
74F10	14	.59	74F193	16	4.95	74F257	16	1.39
74F32	14	.65	74F240	20	2.49	74F373	20	2.95
74F74	14	.69				74F374	20	2.95
74F86	14	.69				74F379	16	2.19
74F109	16	.89						

CD—CMOS

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
CD4000	14	.19	CD4043	16	.69	CD40103	16	2.95
CD4001	14	.19	CD4044	16	.69	CD4503	16	.49
CD4002	14	.25	CD4046	16	.69	CD4508	24	1.45
CD4006	16	.69	CD4047	14	.89	CD4510	16	.69
CD4007	14	.25	CD4048	16	.59	CD4511	16	.69
CD4008	16	.89	CD4049	16	.29	CD4512	16	.69
CD4009	16	.39	CD4050	16	.29	CD4514	24	.99
CD4010	16	.39	CD4051	16	.65	CD4515	24	1.39
CD4011	14	.19	CD4052	16	.65	CD4516	16	.79
CD4012	14	.25	CD4053	16	.65	CD4518	16	.79
CD4013	14	.35	CD4056	16	2.19	CD4519	16	.39
CD4014	16	.69	CD4059	24	3.49	CD4520	16	.79
CD4015	16	.25	CD4060	16	.89	CD4522	16	.79
CD4016	14	.29	CD4066	14	.29	CD4526	16	.79
CD4017	16	.49	CD4068	14	.29	CD4528	16	.79
CD4018	16	.69	CD4069	14	.25	CD4529	16	1.49
CD4019	16	.35	CD4070	14	.29	CD4531	16	.89
CD4020	16	.59	CD4071	14	.25	CD4538	16	.89
CD4021	16	.69	CD4072	14	.25	CD4541	14	.89
CD4022	16	.69	CD4073	14	.25	CD4543	16	.99
CD4023	14	.25	CD4075	14	.25	CD4553	16	4.95
CD4024	14	.49	CD4076	16	.89	CD4555	16	.89
CD4025	14	.25	CD4077	14	.29	CD4556	16	.89
CD4026	16	1.49	CD4078	14	.29	CD4560	16	3.95
CD4027	16	.39	CD4081	14	.25	CD4566	16	1.95
CD4028	16	.65	CD4082	14	.25	CD4583	16	1.19
CD4029	16	.65	CD4093	14	.39	CD4584	14	.59
CD4030	14	.39	CD4094	16	1.49	CD4585	16	.75
CD4034	24	1.39	CD4098	16	1.49	CD4723	16	1.19
CD4035	16	.85	CD4099	16	1.39	CD4724	16	1.19
CD4040	16	.65				MC14411	24	9.95
CD4041	14	.75				MC14490P	16	4.49
CD4042	16	.59				MC14572	16	.89

SPECIAL!! SPECIAL!! SPECIAL!!

MOTOROLA

MC68701 — Microcomputer with EPROM

The MC68701 is an 8-bit single chip microcomputer unit (MCU) which significantly enhances the capabilities of the MC6800 family of parts. On-chip resources include 2048 bytes of EPROM, 128 bytes of RAM, Serial Communications Interface (SCI), parallel I/O, and a three function Programmable Timer.

MC68701. . . . . $24.95

CUSTOM COMMODORE CHIPS for VIC-20, C-64 and C-128 Personal Computers

Part No.	Description	Price	Part No.	Description	Price	Part No.	Description	Price
*6510	CPU	$19.95	*6526	CIA	$25.95	*6581	SID	$32.95
*6525	TPI	$20.95	*6560	VIC-I	$29.95	82S100PLA	PLA	$37.95
			*6567	VIC-II	$44.95			

*SPECS. AVAILABLE @ $1.50 EA. NOTE: 82S100 = U17 (C-64)

MICROPROCESSOR COMPONENTS

MICROPROCESSOR CHIPS

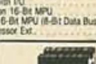
Part No.	Pins	Function	Price
D765AC	40	Floppy Disk Controller	4.95
CDP1802CE	40	CPU 2.5MHz	9.95
2661-3	28	Enhanced Prog. Comm. Interface	6.95
3242	28	Add. Multiplexer & Refresh Counter	6.95
Z80, Z80A, Z80B, SERIES			
Z80	40	CPU (MK3880N) (780C) 2.5MHz	1.75
Z80-CTC	28	Counter Timer Circuit	1.79
Z80-DART	40	Dual Asynchronous Rec./Trans.	4.95
Z80-DMA	40	Direct Memory Access Circuit	4.95
Z80-P10	40	Parallel I/O Interface Controller	1.79
Z80-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	4.95
Z80-S10/1	40	Serial I/O (Lacks DTRB)	4.95
Z80-S10/2	40	Serial I/O (Lacks SYNCB)	4.95
Z80-S10/9	40	Serial I/O	4.95
Z80A	40	CPU (MK3880N-4) (780C-1) 4MHz	1.85
Z80A-CTC	28	Counter Timer Circuit	1.89
Z80A-DART	40	Dual Asynchronous Rec./Trans.	5.25
Z80A-DMA	40	Direct Memory Access Circuit	5.95
Z80A-P10	40	Parallel I/O Interface Controller	1.95
Z80A-S10/0	40	Serial I/O (TxCB and RxCB Bonded)	5.25
Z80A-S10/1	40	Serial I/O (Lacks DTRB)	5.25
Z80A-S10/2	40	Serial I/O (Lacks SYNCB)	5.25
Z80A-S10/9	40	Serial I/O	5.25
Z80B	40	CPU (MK3880N-6) 6MHz	3.95
Z80B-CTC	28	Counter Timer Circuit	3.95
Z80B-DART	40	Dual Asynchronous Rec./Trans.	6.95
Z80B-P10	40	Parallel I/O Interface Controller	4.95
Z80B-S10/0	40	Ser. I/O (TxCB & RxCB Bond.) (MK3884-6)	12.95
Z80B-S10/1	40	Serial I/O (Lacks DTRB)	12.85
Z80B-S10/2	40	Serial I/O (Lacks SYNCB)	12.79
6500/6800/68000 SERIES			
6502	40	MPU with Clock (1MHz)	2.75
6502A	40	MPU with Clock (2MHz)	2.95
6502B	40	MPU with Clock (3MHz)	6.95
6520	40	Peripheral Inter. Adapter	2.95
6522	40	Versatile Inter. Adapter	4.95
6545	40	CRT Controller (CRTC)	4.95
6551	28	Async. Comm. Interface Adapt.	6.95
6800	40	MPU	1.95
6802	40	MPU with Clock and RAM	4.95
6809	40	CPU — 8-Bit (On-Chip Oscillator)	5.7?
6809E	40	CPU — 8-Bit (External Clocking)	5.95
68B09E	40	CPU — 8-Bit (Ext. Clocking) 2MHz	7.25
6810	24	128x8 Static RAM	1.95
68B10	24	128x8 Static RAM (2MHz)	3.49
6821	40	Peripheral Inter. Adapt. (MC6820)	1.95
68B21	40	Peripheral Interface Adapter (2MHz)	3.95
6840	28	Programmable Timer	6.75
6843	40	Programmable Floppy Disk Controller	19.95
6845	40	CRT Controller (CRTC)	4.95
68B45	40	CRT Controller (CRTC) 2MHz	6.95
6850	24	Asynchronous Comm. Adapter	1.95
6852	24	Synchronous Serial Data Adapter	4.75
6860	24	0-600bps Digital MODEM	7.95
68000L8	64	MPU 16-Bit (8MHz)	9.95
68488P	40	General Purpose Int. Adapter	14.95
68661	28	Enhanced Prog. Comm. Interface (2661)	8.95
68701	40	Microcomputer with EPROM	24.95
8000/80000 SERIES			
8031	40	Control Oriented CPU w/RAM & I/O	6.95
8035	40	MPU — 8-Bit	1.95
8039	40	CPU — Sgl. Chip 8-Bit (128bts. RAM)	2.75
8060	40	CPU — 8-Bit NMOS	14.95
8073N	40	CPU w/Basic Micro Interpreter	29.95
8080A	40	CPU	3.95
8085A	40	CPU	2.75
8085A-2	40	CPU-8-Bit N-Channel (5MHz)	4.95
8086-2	40	CPU 16-bit 8MHz	8.95
8087	40	Arithmetic Processor (5MHz)	129.95
8087-2	40	Arithmetic Processor	139.95
8088	40	CPU 8/16-Bit	7.95
8116	18	Dual Baud Rate Generator	8.95
8155	40	HMOS RAM I/O Port-Timer	2.75
8156	40	RAM with I/O Port and Timer	2.75
8202	40	Dynamic RAM Controller	9.95
8203	40	64K Dynamic RAM Controller	29.95
8205	16	Hi Speed 1 out of 8 Binary Decoder	3.29
8212	24	8-Bit Input/Output (74S412)	1.95
8224	16	Clock Generator/Driver	2.25
8228	28	Sys. Cont./Bus Driver (74S428)	3.49
8237-5	40	High Perf. Prog. DMA Cont. (5MHz)	6.95
8238	28	System Controller (74S438)	4.29
8243	24	I/O Expander for 48 Series	2.49
8250A	40	Async. Comm. Element	6.95
8250B	40	ACE (IBM PC or XT Software Compatible)	5.95
8251	28	Prog. Comm. I/O (USART)	1.95
8251A	28	Prog. Comm. Interface (USART)	2.25
8253-5	24	Programmable Interval Timer	2.25
8254	24	Programmable Interval Timer	9.95
8255	40	Prog. Peripheral I/O (PPI)	1.95
8255A-5	40	Prog. Peripheral I/O (PPI) 5MHz	2.25
8257-5	40	Prog. DMA Controller	2.49
8259	28	Prog. Interrupt Control	2.25
8259-5	28	Prog. Interrupt Controller	2.49
8272	40	Sgle/Dble Density Floppy Disk Cont.	4.95
8274	40	Multi-Protocol Serial Cont. (7201)	14.95
8275	40	Prog. CRT Controller	14.95
8279	40	Prog. Keyboard/Display Interface	2.49
8279-5	40	Prog. Keyboard/Display Interface	2.95
8282	20	Octal Latch	3.95
8284	18	Clock Generator/Driver	2.95
8286	20	Octal Bus Transceiver	3.95
8287	20	Octal Bus. Transceiver (Inverted)	3.95
8288	20	Bus Controller	4.95
8289	20	Bus Arbiter	14.95
8741	40	8-Bit Univ. Peripheral Interface	8.95
8748	40	HMOS EPROM MPU	7.95
8749	40	MPU 8-Bit (EPROM Version of 8049)	9.95
8751	40	CPU w/4Kx8 EPROM & 128x8 RAM	29.95
8755	40	16K EPROM with I/O	14.95
80186	68	High Integration 16-Bit MPU	49.95
80188	68	High Integra. 16-Bit MPU (8-Bit Data Bus)	49.95
80287	40	Numeric Processor Ext.	229.95

DYNAMIC RAMS

Part No.	Pins	Function		Price
1103	18	1024x1	(300ns)	.89
4027	16	4096x1	(250ns)	.89
4116N-15	16	16,384x1	(150ns)	.45
4116N-20	16	16,384x1	(200ns)	.39
4128		131,072x1	(200ns)	4.95
4164N-150	16	65,536x1	(150ns)	.89
4164N-200	16	65,536x1	(200ns)	.79
TMS4416-12	18	16,384x4	(120ns)	4.95
MM5261	16	1024x1	(300ns)	.25
MM5262	22	2048x1	(365ns)	.25
MM5270	18	4096x1	(200ns)	1.95
MM5280	22	4096x1	(200ns) 2107	1.95
MM5298-3	16	8192x1	(200ns)	.19
8118	16	16,384x1	(120ns) +5V Only Req.	1.95
41256-150	16	262,144x1	(150ns)	3.29
41256-200	16	262,144x1	(200ns)	3.19
50464-15	18	65,536x4	(150ns) (41254) (41464)	7.95
STATIC RAMS				
TMM2016-12	24	2048x8	(120ns)	1.69
2101	22	256x4	(450ns) 8101	1.95
2102	16	1024x1	(350ns)	.89
2102-2L	16	1024x1	(250ns) L.P. (91L02)	1.49
2111	18	256x4	(450ns) 8111	2.49
2112	16	256x4	(450ns) MOS	2.49
2114N	18	1024x4	(450ns)	.99
2114N-L	18	1024x4	(450ns) L.P.	1.09
2114N-2	18	1024x4	(200ns)	1.05
2114N-2L	18	1024x4	(200ns) L.P.	1.49
21C14	18	1024x4	(200ns) CMOS	.49
2116N-25L	24	2048x8	(250ns) L.P. NMOS	3.49
2125A	16	1024x1	(45ns) High Speed	2.95
2147HN	18	4096x1	(70ns)	3.95
2148HN	18	1024x4	(70ns)	4.29
2149	18	1024x4	(45ns)	4.95
27LS00	16	256x1	(80ns) L.P.	2.95
TMS40L47-45	20	1024x4	(450ns)	.99
5101	22	256x4	(450ns) CMOS	3.95
MM5257	18	4096x1	(450ns) 4044	2.95
HM6116P-3	24	2048x8	(150ns) CMOS	1.79
HM6116LP-3	24	2048x8	(150ns) L.P. CMOS	1.85
HM6116P-4	24	2048x8	(200ns) CMOS	1.69
HM6116LP-4	24	2048x8	(200ns) L.P. CMOS	1.75
HM6264P-12	28	8192x8	(120ns) CMOS	4.69
HM6264LP-12	28	8192x8	(120ns) L.P. CMOS	4.79
HM6264P-15	28	8192x8	(150ns) CMOS	4.49
HM6264LP-15	28	8192x8	(150ns) L.P. CMOS	4.59
6514	18	1024x4	(350ns) CMOS (UPD444C)	4.49
74S189	16	16x4	(35ns)	1.95
74S289	16	16x4	(35ns) 3101	2.95
PROMS/EPROMS				
1702A	24	256x8	(1μs)	3.95
TMS2516	24	2048x8	(450ns)	3.49
TMS2532	24	4096x8	(450ns) NMC2532	3.95
TMS2564	28	8192x8	(450ns)	8.95
2708	24	1024x8	(450ns)	3.95
TMS2716	24	2048x8	(450ns) 3 voltage	6.49
2716	24	2048x8	(450ns)	2.49
27C16	24	2048x8	CMOS	9.95
2716-1	24	2048x8	(350ns)	2.95
2732	24	4096x8	(450ns)	2.49
2732A-20	24	4096x8	(200ns) 21V	3.95
2732A-25	24	4096x8	(250ns) 21V	2.95
2732A-45	24	4096x8	(450ns) 21V	2.75
27C32	24	4096x8	CMOS	10.95
2758	24	1024x8	(450ns) Single +5V	3.95
2764-20	28	8192x8	(200ns) 21V	3.95
2764-25	28	8192x8	(250ns) 21V	2.95
2764A-25	28	8192x8	(250ns) 12.5V	2.95
2764-45	28	8192x8	(450ns) 21V	2.19
27C64	28	8192x8	CMOS 21V	6.95
27128-25	28	16,384x8	(250ns) 128K 21V	2.95
27128A-25	28	16,384x8	(250ns) 128K 12.5V	4.95
27256-25	28	32,768x8	(250ns) 256K (14V)	7.95
27C256-25	28	32,768x8	(250ns) 256K (CMOS)	13.95
68764	24	8192x8	(450ns) 25V	15.95
68766	24	8192x8	(350ns) 25V	16.95
74S188	16	32x8	PROM O.C. (6330-1)	1.75
74S287	16	256x4	PROM T.S. (6301-1)	1.69
74S288	16	32x8	PROM T.S. (6331-1)	1.69
74S387	16	256x4	PROM O.C. (6300-1)	1.69
74S471	20	256x8	PROM T.S. (6309-1)	4.95
74S472	20	512x8	PROM T.S. (6349-1)	3.49
74S473	20	512x8	PROM O.C. (6348)	2.95
74S474	24	512x8	PROM T.S. (DM87S296N)	3.49
74S475	24	512x8	PROM O.C. (6340)	3.49
74S476	18	1024x4	PROM T.S.	4.95
74S570	16	512x4	PROM O.C. (6305)	2.95
74S571	16	512x4	PROM T.S. (6306)	2.95
74S572	18	1024x4	PROM O.C. (6352)	3.49
74S573	18	1024x4	PROM T.S. (82S137)	2.95
82S23	16	32x8	PROM O.C. (27S18)	2.49
82S115	24	512x8	PROM T.S. (27S15)	9.95
82S123	16	32x8	PROM T.S. (27S19)	2.95
82S126	16	256x4	PROM O.C. (27S20)	2.95
82S129	16	256x4	PROM T.S. (27S21)	2.95
82S130	16	512x4	PROM O.C. (27S12)	3.95
82S185	18	2048x4	PROM T.S. (TBP24S81)	9.95
82S191	24	2048x8	(80ns)	14.95
DM87S181N	24	1024x8	PROM T.S. (82S181)	9.95
DATA ACQUISITION				
ADC0800	18	8-Bit A/D Converter (±1 LSB)		14.49
ADC0801	20	8-Bit A/D Converter (1/4LSB)		14.95
ADC0803	20	8-Bit A/D Converter (±1/2LSB)		5.95
ADC0804	20	8-Bit A/D Converter (1LSB)		3.49
ADC0808	28	8-Bit A/D Conv. w/8-Channel Analog		8.95
ADC0809	28	8-Bit A/D Converter (8-Ch. Multi.)		3.95
ADC0816	40	8-Bit A/D Conv. w/16-Channel Analog		14.95
ADC0817	40	8-Bit A/D Converter (16-Ch. Multi.)		8.95
ADC0832	8	8-Bit Ser. I/O A/D Conv. (2,4, or 8-Ch. Mult.)		4.95
DAC0800	16	8-Bit D/A Converter (±1 LSB)		3.95
DAC0806	16	8-Bit D/A Converter (0.78% Lin.)		1.95
DAC0807	16	8-Bit D/A Converter (MC1408-7)		1.49
DAC0808	16	8-Bit D/A Converter (MC1408-8)		1.95
DAC0830	20	8-Bit Up D/A Conv. (.05% Lin.)		5.95
DAC0831	20	8-Bit Up D/A Conv. (.10% Lin.)		4.49
DAC1000	24	10-Bit D/A Conv. Micro. Comp. (0.05%)		4.95
DAC1008	20	8-Bit D/A Conv. Micro. Comp. (0.20%)		7.95
DAC1022	16	10-Bit D/A Conv. (0.20% lin.)		5.95
DAC1222	18	12-Bit D/A Conv. (0.20% Lin.)		6.95
DAC1230	20	12-Bit Up D/A Conv. (.012% Lin.)		14.95
DAC1231	20	12-Bit Up D/A Conv. (.024% Lin.)		13.95
AY-3-1015D	40	25K Baud UART		4.95
AY-5-1013A	40	30K Baud UART (TR1602)		3.95

Low Profile (Tin) Sockets

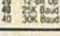
Part No.	1-9	10-99	100-up
8 pin LP	.13	.12	.11
14 pin LP	.15	.13	.11
16 pin LP	.17	.15	.13
18 pin LP	.25	.23	.21
20 pin LP	.28	.26	.23
22 pin LP	.30	.28	.26
24 pin LP	.31	.30	.29
28 pin LP	.39	.37	.35
40 pin LP	.49	.46	.43



Soldertail (Gold) Standard

Part No.	1-9	10-99	100-up
8 pin SG	.39	.35	.29
14 pin SG	.49	.45	.39
16 pin SG	.55	.49	.45
18 pin SG	.65	.59	.51
20 pin SG	.75	.65	.59
22 pin SG	.79	.69	.65
24 pin SG	.79	.69	.65
28 pin SG	.95	.85	.75
36 pin SG	1.25	1.15	.99
40 pin SG	1.39	1.25	1.15

Wire Wrap Sockets (Gold) Level #3



Part No.	1-9	10-99	100-up
8 pin WW	.55	.49	.45
10 pin WW	.65	.59	.55
14 pin WW	.69	.65	.59
16 pin WW	.75	.69	.65
18 pin WW	.85	.79	.75
20 pin WW	.95	.89	.85
22 pin WW	.99	.95	.89
24 pin WW	1.19	1.09	.99
28 pin WW	1.39	1.29	1.19
36 pin WW	1.49	1.39	1.29
40 pin WW	1.79	1.69	1.59

Header Plugs (Gold)

Part No.	1-9	10-99	100-up
14 pin HP	.55	.49	.45
16 pin HP	.59	.55	.49
24 pin HP	.99	.89	.79

Header Covers

Part No.	1-9	10-99	100-up
14 pin HC	.15	.13	.12
16 pin HC	.19	.17	.15
24 pin HC	.29	.27	.25

$20 Minimum Order — U.S. Funds Only. CA Residents: Add 6% or 6½% Sales Tax. Spec Sheets — 30¢ each. Shipping: Add 5% plus $1.50 Insurance. Send $1 Postage for FREE 1986 Jameco Catalog. Prices Subject to Change.

Send stamped, self-addressed envelope to receive a Quarterly Sales Flyer — FREE!

MasterCard — Jameco ELECTRONICS (Mail Order Electronics · Worldwide) — VISA

1355 SHOREWAY ROAD, BELMONT, CA 94002

1/86 *PHONE ORDERS WELCOME — (415) 592-8097 — Telex: 176043*

EEPROM

Part No.	Pins	Function	Price
2816A	24	2048x8 16K E²PROM 350ns. . .	$8.95

Features: • On-board Address/Data Latches • Auto-Timed Byte Write (on chip timer) • 5V Erase/Write/Read • Optional High Voltage Erase/Program (9V-15V) • Power Up/Down Write Protection • Auto Erase before Write. The 2816A is an ideal nonvolatile memory providing in-system alterability with the same ease and with the same features as 2Kx8 Static RAMs.

Digitalker™

DT1050 — Applications: Teaching aids, appliances, clocks, automotive, telecommunications, language translations, etc. The DT1050 is a standard DIGITALKER kit encoded with 137 separate and useful words, 2 tones, and 5 different silence durations. The words and tones have been assigned discrete addresses, making it possible to output single words or words concatenated into phrases or even sentences. The "voice" output of the DT1050 is a highly intelligible male voice. The DT1050 consists of a Speech Processor Chip, MM54104 (40-pin) and two (2) Speech ROMs MM52164SSR1 and MM52164SSR2 (24-pin) along with a Master Word list and a recommended schematic diagram on the application sheet.

DT1050 Digitalker™. . . . . $24.95 ea.
MM54104 Processor Chip. . . . . $12.95 ea.

DT1057 — Expands the DT1050 vocabulary from 137 to over 260 words, incl. 2 ROMs and specs.
Part No. DT1057. . . . . $11.95 ea.

INTERSIL

Part No.	Pins	Function	Price
FE0202D	40	4 Digit LCD Display for 7211IPL & 7211MIPL	12.95
FE0203D	40	3½ Digit LCD Display for 7106 & 7116	12.95
7045IPI	28	CMOS Precision Timer	11.95
7045EV/Kit	28	Stopwatch Chip, XTL (Evaluation Kit)	16.95
7106CPL	40	3½ Digit A/D (LCD Drive)	8.95
7106EV/Kit	40	IC, Circuit Board, Display (Evaluation Kit)	46.95
7107CPL	40	3½ Digit A/D (LED Drive)	8.95
7107EV/Kit	40	IC, Circuit Board, Display (Evaluation Kit)	46.95
7116CPL	40	3½ Digit A/D LCD Dis. HLD	8.95
7201IUS		Low Battery Volt. Indicator	2.29
7205IPG	24	CMOS LED Stopwatch/Timer	14.95
7205EV/Kit	24	Stopwatch Chip, XTL (Evaluation Kit)	16.95
7206CJPE	16	Tone Generator	4.95
7206CEV/Kit	16	Tone Generator Chip, XTL (Evaluation Kit)	7.95
7207AIPD	14	Oscillator Controller	5.95
7207AEV/Kit	14	Freq. Counter Chip, XTL (Evaluation Kit)	8.49
7211IPL	40	4 Digit LCD Display Decoder/Driver (TTL compatible)	7.95
7211MIPL	40	4 Digit LCD Display Decoder/Driver (Microproc. compat.)	8.49
7215IPG	24	4 Func. CMOS Stopwatch CKT	16.95
7215EV/Kit	24	4 Func. Stopwatch Chip, XTL (Evaluation Kit)	19.49
7216AIJI	28	8 Digit Univ. Counter C.A.	31.49
7216DIPI	28	8 Digit Freq. Counter C.C.	21.49
7217IJI	28	4 Digit LED Up/Down Counter C.A.	10.95
7217AIPI	28	4 Digit LED Up/Down Counter C.C.	8.95
7224IPL	40	LCD 4½ Digit Up Counter DR.	10.95
7226AEV/Kit	40	5 Function Counter Chip, XTL (Evaluation Kit)	99.95

30009 1985 Intersil Data Book (1075 pgs.) **$9.95**

74HC HIGH SPEED CMOS

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
74HC00	14	.35	74HC139	16	.79	74HC245	20	1.59
74HC02	14	.39	74HC147	16	.99	74HC251	16	.79
74HC03	14	.39	74HC151	16	.79	74HC253	16	.79
74HC04	14	.39	74HC153	16	.79	74HC257	16	.79
74HCU04	14	.39	74HC154	24	1.95	74HC259	16	1.19
74HC08	14	.39	74HC157	16	.79	74HC266	14	.69
74HC10	14	.39	74HC158	16	.79	74HC273	20	1.79
74HC11	14	.39	74HC160	16	.89	74HC280	14	2.95
74HC14	14	.59	74HC161	16	.89	74HC299	20	3.19
74HC20	14	.39	74HC162	16	.89	74HC366	16	1.49
74HC27	14	.39	74HC163	16	.89	74HC367	16	1.49
74HC30	14	.39	74HC164	14	.99	74HC373	20	1.49
74HC32	14	.45	74HC165	16	1.49	74HC374	20	1.49
74HC42	16	.75	74HC166	16	1.95	74HC390	16	1.19
74HC51	14	.39	74HC173	16	.89	74HC393	14	1.19
74HC58	14	.39	74HC174	16	.89	74HC533	20	1.95
74HC73	14	.45	74HC175	16	.89	74HC534	20	1.95
74HC74	14	.45	74HC190	16	1.19	74HC595	16	1.95
74HC75	16	.69	74HC191	16	1.19	74HC688	20	1.95
74HC76	16	.69	74HC192	16	.99	74HC4024	14	1.19
74HC85	16	1.19	74HC193	16	.99	74HC4040	16	1.19
74HC86	14	.59	74HC194	16	.89	74HC4049	16	.79
74HC107	14	.49	74HC195	16	.89	74HC4050	16	.79
74HC109	16	.49	74HC221	16	1.95	74HC4060	16	1.19
74HC112	16	.49	74HC237	16	1.19	74HC4075	14	.49
74HC123	16	1.19	74HC240	20	1.39	74HC4078	14	.49
74HC125	14	.99	74HC241	20	1.39	74HC4511	16	1.95
74HC132	14	.79	74HC242	14	1.39	74HC4514	24	2.95
74HC137	16	1.19	74HC243	14	1.39	74HC4538	16	1.95
74HC138	16	.79	74HC244	20	1.49	74HC4543	16	2.95

74HCU04 is unbuffered.

74C—C/MOS

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
74C00	14	.29	74C151	16	1.95	74C373	20	1.95
74C02	14	.29	74C154	24	2.95	74C374	20	1.95
74C04	14	.25	74C157	16	1.75	74C901	14	.49
74C08	14	.35	74C160	16	.89	74C902	14	.49
74C10	14	.29	74C161	16	.89	74C903	14	.49
74C14	14	.49	74C162	16	.89	74C906	14	.49
74C20	14	.29	74C163	16	.89	74C907	14	.59
74C30	14	.29	74C164	14	.99	74C911	28	7.95
74C32	14	.35	74C165	16	.99	74C912	28	7.95
74C42	16	.89	74C173	16	.89	74C915	18	1.19
74C48	16	1.19	74C174	16	.89	74C917	28	7.95
74C73	14	.49	74C175	16	.89	74C920	22	9.95
74C74	14	.49	74C192	16	.99	74C921	18	9.95
74C85	16	1.19	74C193	16	.99	74C922	18	3.95
74C86	14	.29	74C195	16	.99	74C923	20	3.95
74C89	16	3.95	74C221	16	1.19	74C925	16	4.95
74C90	14	.89	74C240	20	1.59	74C926	18	4.95
74C93	14	.89	74C244	20	1.59	74C930	18	9.95
74C95	14	.99				80C95	16	.69
74C107	14	.55				80C97	16	.69

LINEAR

Part No.	Pins	Price	Part No.	Pins	Price	Part No.	Pins	Price
DS0026CN	8	1.69	LM350K		3.95	LM748N	8	.59
TL064CN	14	1.95	LF351N	8	.49	UA760HC		1.29
TL071CP	8	.59	LF353N	8	.59	LM1456V	8	1.95
TL072CP	8	.79	LF355N	8	.89	LM1458CN	8	.49
TL074CN	14	.79	LF356N	8	.89	LM1488N	14	.69
TL081CP	8	.49	LM358N	8	.49	LM1489N	14	.69
TL082CP	8	.69	LM359N	14	1.59	LM1496N	14	.99
TL084CN	14	1.09	LM370N	14	4.95	LM1605CK		9.95
LM109K		4.95	LM373N	14	4.95	LM1871N	18	1.95
LM301CN	8	.35	LM377N	14	1.95	LM1872N	18	2.49
LM302H		.69	LM380CN	8	1.09	LM1877N-9	14	2.49
LM304H		.99	LM380N	14	.89	LM1889N	18	1.59
LM305H		.99	LM381N	14	1.29	LM1896N	14	1.59
LM307CN	8	.45	LM382N	14	1.29	LM2002T		1.95
LM308CN	8	.59	LM384N	14	1.69	ULN2003A	16	.99
LM309K		1.25	LM386N-3	8	.89	XR2206	16	3.95
LM310CN	8	1.29	LM387N	8	.99	XR2207	14	2.49
LM311CN	8	.45	LM389N	18	.99	XR2208	16	1.79
LM312H		1.49	LM391N-80	16	1.29	XR2211	14	2.95
LM317T		.99	LM392N	8	.59	LM2877P		1.95
LM317K		2.95	LM393N	8	.45	LM2878P		2.19
LM318CN	8	1.19	LF398N	8	2.39	LM2901N	14	.59
LM319N	14	1.19	LM399H		3.95	LM2902N	14	.59
LM320K-5		1.35	LF412CN	8	1.49	LM2907N	14	1.95
LM320K-12		1.35	TL494CN	16	1.95	LM2917N	8	1.55
LM320K-15		1.35	TL496CP	8	1.59	LM2935T		1.49
LM320K-24		1.35	TL497ACN	14	2.19	LM3900N	14	.59
LM320T-5		.59	NE531V	8	1.79	LM3905CN	8	1.19
LM320T-12		.59	NE540H (C540H)		2.95	LM3909N	8	.89
LM320T-15		.59	NE544N	14	1.49	LM3911N	8	1.19
LM320T-24		.59	NE550A	14	.69	LM3914N	18	1.95
LM322N	14	1.49	NE555V	8	.29	LM3915N	18	1.95
LM323K		4.49	XR-L555	8	.69	LM3916N	18	1.95
LM324N	14	.39	LM556N	14	.59	RC4136N	14	.89
LM329DZ		.55	NE558N	16	1.19	RC4151NB	8	.99
LM331M	8	3.49	NE564N	16	1.95	RC4193NB	8	2.95
LM334Z		1.19	LM565N	14	.99	LM4250CN	8	1.19
LM335Z		1.29	LM566CN	8	1.39	NE5532	8	.99
LM336Z		1.09	LM567V	8	.89	NE5534	8	.89
LM337MP		1.15	NE570N	16	2.49	78L05A		.35
LM337T		1.49	NE571N	16	1.95	78L12A		.35
LM338K		3.95	NE592N	14	.89	79L05A		.59
LM339N	14	.49	LM703CN	8	1.19	79M05AH		.69
LM340K-5		1.35	LM710N	14	.69	ICL8038	14	3.95
LM340K-12		1.35	LM711N	14	.69	LM13080N	8	1.19
LM340K-15		1.35	LM723N	14	.45	LM13600N	16	1.19
LM340K-24		1.35	LM733N	14	.69	75477	8	1.19
LM340T-5		.49	LM739N	14	2.95	76002	14	1.25
LM340T-12		.49	LM741CN	8	.29	76477	28	3.95
LM340T-15		.49	LM747N	14	.59			
LM340T-24		.49						
LF347N	14	.99						
LM348N	14	.69						

30003 1982 Nat. Linear Data Book (1952 pgs.) . . **$14.95**

CIRCLE 114 ON FREE INFORMATION CARD

SARATOGA ELECTRONICS

ORDER TOLL FREE

800-621-0854 ext.245

SPECIAL

MULTI USER COMPUTER CASE

* * * * * * * * * * * * * * *

Ready For Your Best PCB Designs and Application

Includes:

- *130 Watt Linear Power Supply (115/230V)
- *Power Connectors for Floppy or Hard Drives
- *16 Multi User Ports W/Attached PCB
- *Two Cooling Fans (2½")
- *External Fuse & EMI Type Filter
- *5' Power Cords

$69.95 ea/or 2 for $120-

Limited Quantities
Order Part # 816/40

DISK DRIVES

TEAC 55B Disk Drive (½HT) $79.95

APPLE II (½HT) Disk Drive $84.95

INVENTORY CLEARANCE

2716-450ns	1.75
2764-250ns	2.25
4164-150ns	.75
41256-150ns	2.45
8088	4.00
74LS374	.59
4585	.25
74HC193	1.00
74LS244	.59
LM350K	2.00
Power Cords	1.49

12380 Saratoga-Sunnyvale Road
Saratoga CA 95070
(408) 446-4949
Fax: (408) 253-8572

MasterCard VISA

CIRCLE 260 ON FREE INFORMATION CARD

AMAZING DEVICES

PHASORS

PERSONAL DEFENSE AND PROPERTY PROTECTION UTILIZE SPACE AGE TECHNOLOGY.
CAUTION THESE DEVICES CAN BE HAZARDOUS AND MAY SOON BE ILLEGAL.

POCKET PAIN FIELD GENERATOR — IPG50
Assembled.......$64.50
IPG5.......Plans.......$8.00 **IPG5K**.....Kit/Plans.....$44.50

PHASOR PAIN FIELD CROWD CONTROLLER — PPF10
Assembled.......$250.00
PPF1.......Plans.......$15.00 **PPF1K**....Kit/Plans....$175.00

BLASTER - Provides a plasma discharge capable of puncturing a can. *Produces a 100,000 WATT PULSE.*
BLS10..........ASSEMBLED..........$89.50
BLS1..PLANS..$10.00 **BLS1K**..KTI/PLANS..$69.50

PLASMA STUN GUN - Very intimidating and affective 5 to 10 feet 100,000 VOLTS
ITM10..........ASSEMBLED..........$99.50
ITM1..PLANS..$10.00 **ITM1K**..KIT/PLANS..$69.50

LASERS

RUBY LASER RAY GUN — Intense visible red beam burns and welds hardest of metals. **MAY BE HAZARDOUS.**
RUB3 ***All Parts Available for Completing Device*** $20.00

CARBON DIOXIDE BURNING, CUTTING LASER — Produces a continuous beam of high energy. **MAY BE HAZARDOUS.**
LC5..***All Parts Available for Completing Device***..$20.00

VISIBLE LASER LIGHT GUN — produces intense red beam for sighting, spotting, etc. Hand held complete.
LGU3..Plans..$10.00 ***(Kit & Assembled Units Available)***

IR PULSED LASER RIFLE — Produces 15-30 watt infra-red pulses at 200-2000 per sec.
LRG3..........***All Parts & Diodes Available***..........$10.00

BEGINNERS LOW POWER VISIBLE LASER — Choice of red, yellow, green — provides an excellent source of monochromatic light.
LHC2.......Plans.......$5.00 **LHC2K**.......Kit.......$34.50

SECURITY

SNOOPER PHONE — Allows user to call his premises and listen in without phone ever ringing.
SNP20..........Assembled..........$89.50
SNP2.......Plans.......$9.00 **SNP2K**.....Plans/Kit.....$59.50

LONG RANGE WIRELESS MIKE — Miniature device clearly transmits well over one mile. Super sensitive, powerful.
MFT1.......Plans.......$7.00 **MFT1K**.....Plans/Kit.....$49.50

WIRELESS TELEPHONE TRANSMITTER — Transmits both sides of phone conversation over one mile, shuts off automatically.
VWPM5......Plans......$8.00 **VWPM5K**...Plans/Kit...$39.50

PWM5—LONG RANGE SUPER EAR WITH WIRELESS ATTACHMENT
PWM5...Plans...$10.00 **PWM5K**..Kit..$139.50
PWM50.......Assembled and Tested.......$169.50

Our phone is open for orders anytime. Technicians are available 9-11 a.m., Mon-Thurs for those needing assistance or information. Send $1.00 for catalog of hundreds more similar devices. Send check, cash, MO, Visa, MC, COD to: **INFORMATION UNLIMITED**
DEPT **R8**, P.O. Box 716, Amherst, N. H. 03031 Tel: 603-673-4730

CIRCLE 72 ON FREE INFORMATION CARD

SALE!

SMASHING VALUES!

- **TEXAS INSTRUMENT 99/4A VIDEO MODULATORS. (TI No. MDPVA-3410). MG038**..........$1.39
- **25AH NICAD BATTERIES (used-clean). MG039**..........$3.95
- **CHANNEL 3 (63.5MHz)-60db NOTCH FILTER. MG040**..........$8.95
- **4" DIA. 1 AMP/.45V SOLAR CELLS. MG041**..........$1.99
- **F59 CABLE TV PLUGS. MG042**..........9¢
- **AA NICAD SUPER DEAL. NEW. MG043**..........79¢
- **ADAM CASSETTE DIGITAL DATA DRIVE. NEW! MG044**..........$3.95
- **ADAM DISC DRIVE LINEAR POWER SUPPLY. NEW! MG045**..........$5.95
- **ADAM KEYBOARD (cabineted with cord). NEW! MG046**..........$7.95
- **HITACHI VCR CLOCK/PROGRAMMER ASSEMBLIES. MG047**..........$1.95
- **HITACHI VCR UHF/VHF COMPLETE VARACTOR FRONT END. MG048**.... $14.95
- **CABLE TV DESCRAMBLING TECHNIQUES. OUTSTANDING 56 PAGE BOOK. TA439**..........$12.95

FREE! *Our latest bargain packed flyers- thousands of surplus specials, unusual items & hard to find parts! Circle the reader information card now.*

ETCO ELECTRONICS
NORTH COUNTRY SHOPPING CENTER
PLATTSBURGH, NY 12901

Check with order please. VISA & Mastercard OK. (Sorry no C.O.D.'s). Add 15% for UPS & handling. (Excess refunded) NY State Residents add sales tax. Our telephone order desk never closes.

CALL 1-518-561-8700

CIRCLE 270 ON FREE INFORMATION CARD

STUN GUN

Free holster with purchase.

VISA MasterCard

EQUALIZER

- The ultimate non-lethal defense weapon.
- In five seconds can immobilize your attacker, even through heavy clothing.
- Discharges over forty thousand volts of electricity from a nine volt nickel-cadmium battery.
- $49.95, Mass 5% sales tax, $3.00 shipping and handling.

1-800-225-5800
FOR ORDERS ONLY
617-871-5611
FOR INFORMATION

Cameo Enterprises, Inc.
P.O. Box 63, Accord, MA 02018

CIRCLE 269 ON FREE INFORMATION CARD

You Are Not ALONE!

If you think that being in business makes you INDEPENDENT, think again!
Consumerists and government agencies are your silent — but greedy — partners; AND THEIR SHARE COMES FIRST; even if you don't make a profit.

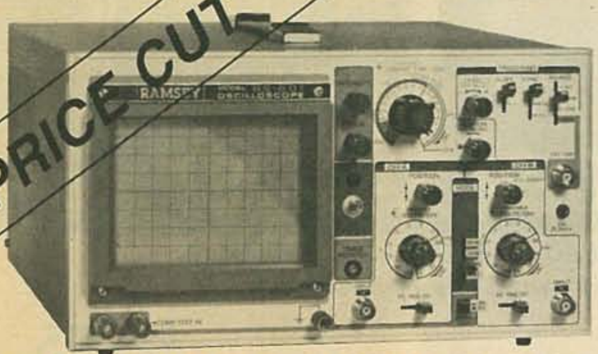
WELL, YOU DON'T HAVE TO FACE THEM BY YOURSELF

JOIN NESDA
AND YOUR LOCAL & STATE ASSOCIATIONS

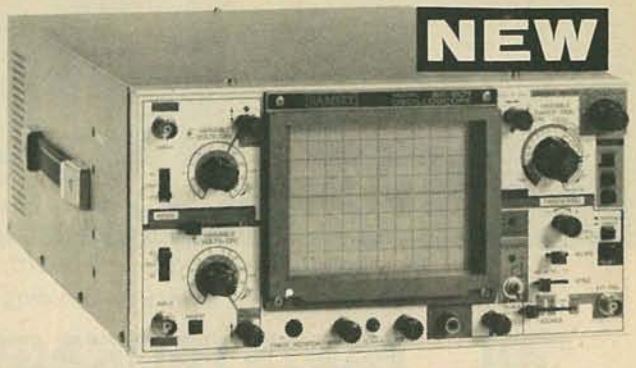
Send for more information to:
NESDA, 2708 W. Berry St.
Fort Worth, Texas 76109

RAMSEY THE FIRST NAME IN ELECTRONIC TEST GEAR

PRICE CUT



NEW



20 MHz DUAL TRACE OSCILLOSCOPE

Unsurpassed quality at an unbeatable price, the Ramsey oscilloscope compares to others costing hundreds more. Features include a component testing circuit for resistor, capacitor, digital circuit and diode testing. • TV video sync filter • wide bandwidth & high sensitivity • internal graticule • front panel trace rotator • Z axis • high sensitivity x-y mode • regulated power supply • built-in calibrator • rock solid triggering

*USA—Add $10.00 per unit for postage, overseas orders add 15% of total order for insured surface mail.

~~$399.95~~* high quality hook on probes included

$369.95

45 MHz DUAL SWEEP OSCILLOSCOPE

The Ramsey 625 is a dual time base, delayed sweep unit that includes a built-in signal delay line to permit clear viewing during very short rise times of high frequency waveforms. Other features include; variable trigger holdoff • 20 calibrated sweep time ranges from 0.5 s/div to 0.2 µS/div. • fully adjustable sweep time • X5 sweep magnification • five trigger sources; CH1, CH2, LINE EXTernal and INTernal (V mode) • front panel x-y operation, Z axis input • sum difference of CH1. and CH2 waveforms displayed as single trace • sweep gate and sweep output • auto focus • single sweep

*Same as unit to left.

~~$799.95~~* high quality hook on probes included

$669.95

RAMSEY D-1100 VOM MULTITESTER

Compact and reliable, designed to service a wide variety of equipment. Features include • mirror back scale • double-jeweled precision moving coil • double overload protection • an ideal low cost unit for the beginner or as a spare back-up unit.

~~$19.95~~ test leads and battery included

$12.95

NEW RAMSEY 1200 VOM MULTITESTER

Check transistors, diodes and LEDs with this professional quality meter. Other features include; decibel scale • 20K volt metering system • 3½" mirrored scale • polarity switch • 20 measuring ranges • safety probes • high impact plastic case

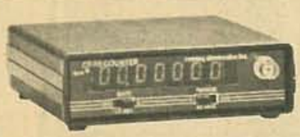
~~$24.95~~ test leads and battery included

$19.95

RAMSEY D-3100 DIGITAL MULTIMETER

Reliable, accurate digital measurements at an amazingly low cost • in-line color coded push buttons, speeds range selection • abs plastic tilt stand • recessed input jacks • overload protection on all ranges • 3½ digit LCD display with auto zero, auto polarity & low BAT. indicator

$49.95 test leads and battery included



CT-70 7 DIGIT 525 MHz COUNTER

Lab quality at a breakthrough price. Features • 3 frequency ranges each with pre amp • dual selectable gate times • gate activity indicator • 50mV @ 150 MHz typical sensitivity • wide frequency range • 1 ppm accuracy

$119.95 wired includes AC adapter

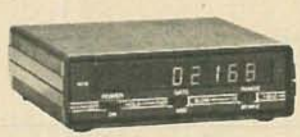
CT-70 kit $99.95
BP-4 nicad pack 8.95

CT-90 9 DIGIT 600 MHz COUNTER

The most versatile for less than $300. Features 3 selectable gate times • 9 digits • gate indicator • display hold • 25mV @ 150 MHz typical sensitivity • 10 MHz timebase for WWV calibration • 1 ppm accuracy

$149.95 wired includes AC adapter

CT-90 kit $129.95
OV-1 0.1 PPM oven timebase 59.95
BP-4 nicad pack 8.95



CT-125 9 DIGIT 1.2 GHz COUNTER

A 9 digit counter that will outperform units costing hundreds more. • gate indicator • 24mV @ 150 MHz typical sensitivity • 9 digit display • 1 ppm accuracy • display hold • dual inputs with preamps

$169.95 wired includes AC adapter

BP-4 nicad pack 8.95

CT-50 8 DIGIT 600 MHz COUNTER

A versatile lab bench counter with optional receive frequency adapter, which turns the CT-50 into a digital readout for most any receiver • 25 mV @ 150 MHz typical sensitivity • 8 digit display • 1 ppm accuracy

$169.95 wired

CT-50 kit $139.95
RA-1 receiver adapter kit 14.95

DM-700 DIGITAL MULTIMETER

Professional quality at a hobbyist price. Features include 26 different ranges and 5 functions • 3½ digit, ½ inch LED display • automatic decimal placement • automatic polarity

$119.95 wired includes AC adapter

DM-700 kit $99.95
MP-1 probe set 4.95

PS-2 AUDIO MULTIPLIER

The PS-2 is handy for high resolution audio resolution measurements, multiplies UP in frequency • great for PL tone measurements • multiplies by 10 or 100 • 0.01 Hz resolution & built-in signal preamp/conditioner

$49.95 wired

PS-2 kit $39.95

PR-2 COUNTER PREAMP

The PR-2 is ideal for measuring weak signals from 10 to 1,000 MHz • flat 25 db gain • BNC connectors • great for shifting RF • ideal receiver/TV preamp

$44.95 wired includes AC adapter

PR-2 kit $34.95

PS-1B 600 MHz PRESCALER

Extends the range of your present counter to 600 MHz • 2 stage preamp • divide by 10 circuitry • sensitivity: 25mV @ 150 MHz • BNC connectors • drives any counter

$59.95 wired includes AC adapter

PS-1B kit $49.95

ACCESSORIES FOR RAMSEY COUNTERS

Telescopic whip antenna—BNC plug	$ 8.95
High impedance probe, light loading	16.95
Low pass probe, audio use	16.95
Direct probe, general purpose use	13.95
Tilt bail, for CT-70, 90, 125	3.95

VISA MasterCard

PHONE ORDERS CALL
716-586-3950
TELEX 466735 RAMSEY CI

TERMS: • satisfaction guaranteed • examine for 10 days; if not pleased, return in original form for refund • add 6% for shipping and insurance to a maximum of $10.00 • overseas add 15% for surface mail • COD add $2.50 (COD in USA only) • orders under $15.00 add $1.50 • NY residents add 7% sales tax • 90 day parts warranty on all kits • 1 year parts & labor warranty on all wired units.

RAMSEY

RAMSEY ELECTRONICS, INC.
2575 Baird Rd.
Penfield, N.Y. 14626

CIRCLE 65 ON FREE INFORMATION CARD

TOLL FREE
800-854-8230
CA Residents **714-558-8813**

OUR POLICY
- Surcharge for VISA or Mastercard.
- Volume purchasing agreements available.
- Orders subject to availablity.
- Pricing subject to change without notice.
- ACP Retail Store pricing may vary. Not responsible for typos.

CORPORATE BUYERS CALL BARRY

10 Mb $399.00
Shugart SA712 w/Controller & Cables. Ready for Installation in IBM™ PC and Compatibles. (1 Year Warranty)

Shugart SA712 10Mb HD **$229.00**
Seagate ST225 20Mb HD **419.00**

MAJOR BRAND PRICE BREAKTHRU

Retail Value $5000
Save up to 60%
ADVANCED XT
ACP PRICE
NOW ONLY!
$1695.00
Monochrome Monitor Included
10 Mb Hard Disk

ACP has sold over 2,000 of this system to major customers including Rockwell Int'l, Hughes Aircraft and Emulex Corp. See for yourself why these customers prefer the Advanced XT over the IBM XT.

BASE SYSTEM CONSISTS OF:
- 256K Expandable to 640K on the Motherboard.
- (1) 360K DS/DD Floppy Disk
- Serial & Parallel Ports
- Deluxe Keyboard w/LED's
- Mouse with Software
- LCD, Lightpen & RF Ports
- RGB and Mono Ports
- VLSI Circuit Design
- (3) Expansion Slots
- Ergonomic Design & Packaging
- GEM or PC Works Software
- 90 Day Warranty

SYSTEM A (P/N BDACP100)	Base System (See Left)	**$ 995.00**
SYSTEM B (P/N BDACP101)	Base System with additional Floppy Disk Drive	**$1099.00**
SYSTEM C (P/N BDACP102)	Base System w/12'' Grn Monitor w/Tilt & Swivel base and additional Floppy Drive	**$1295.00**
SYSTEM D (P/N BDACP103)	Base System w/RGB Color Monitor w/Tilt & Swivel base and additional Floppy Drive	**$1495.00**
SYSTEM E (P/N BDACP104)	Base System w/10Mb Hard Disk and Green Monitor with Tilt & Swivel base	**$1695.00**
SYSTEM F (P/N BDACP105)	Base System w/10Mb Hard Disk and RGB Color Monitor with Tilt & Swivel base	**$1985.00**

ADVANCED XT ACCESSORIES

6 Slot Expansion Chassis (IBM or IBM Compatible) . . . **$399.00**
LCD Display (80x25) for use with Advanced XT LCD Port **299.00**
Monochrome Hi-res text card . . . **69.95**
Monochrome IBM style Monitor . **99.95**
256K Upgrade (Uninstalled) **59.95**
PC DOS 2.1 . . . . **$65.00**
GW Basic **75.00**
PC Works 1.15 (Touchstone) Regualr $195 . . . . **65.00**
Archive Tape B.U. (ext. 10Mb) . **995.00**
Maintenance Manual **50.00**
Technical Reference Manual **50.00**

SPECIAL SYSTEM w/Printer

1. System E with Diablo 620 Serial Printer **$1995.00**
2. System F with Diablo 620 Serial Printer **2285.00**
3. Canon LBP-8A1 IBM compatible laser printer. Purchase for a low price of **$2895.00** and we will give you System A **FREE**!

PC UPGRADE SPECIAL

$4.95 SET OF (9) 64K RAMS
$26.95 SET OF (9) 256K RAMS
$5.95 4128 PIGGYBACK RAM

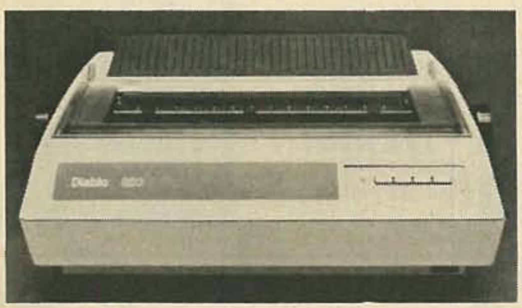
1200 Baud Hayes™ Comp. Modem
Short Card by U.S. Robotics with Telpac I Software.
List $499 ACP . . **$179.00**
Buy (6) **$159.00**

10Mb Tape Back-up

Archive, #1 in tape back-up technology.
High speed 10Mb back-up for only
$995.00

External Box w/Power Supply
Great for adding Hard Disk to your PC.
Same as photo **$179.00**

DIABLO 620 DAISYWHEEL PRINTER



The Finest Letter Quality Printer at a Spectacular Price. We have sold 1000's. You can have a spare at this price.

620 Serial	List 1495	ACP	$395.00
620 API	List 1695	ACP	495.00
620 D36	List 1695	ACP	550.00
F-21 Sheet Feeder	List 895	ACP	249.00
620 Tractor	List 395	ACP	99.00
Cable		ACP	29.00
Serial to Par. 64K Buffer		ACP	125.00

DELUXE JOYSTICK

$11.95

Compatible w/Atari 2600, 400, 800, VIC-20/64 and Apple. Apple requires optional cable adaptor. Add **$2.95**

APPLE DISK DRIVE

$115.00

High quality ½ high drive for Apple II, II+, IIe or IIc. Apple IIc requires optional cable adaptor. Add **$10.00**

CIRCLE 106 ON FREE INFORMATION CARD

★ Advanced Computer Products Inc.

Mail Order: P.O. Box 17329 Irvine, CA 92713 • Retail: 1310 B E. Edinger, Santa Ana, CA 92705

CIRCLE 106 ON FREE INFORMATION CARD

ADVERTISING INDEX

RADIO-ELECTRONICS does not assume any responsibility for errors that may appear in the index below.

Gernsback Publications, Inc.
200 Park Ave. South
New York, NY 10003
(212) 777-6400
Chairman of the Board:
M. Harvey Gernsback
President: Larry Steckler

ADVERTISING SALES 212-777-6400

Larry Steckler
publisher
Arline Fishman
advertising coordinator
Shelli Weinman
advertising associate
Lisa Strassman
credit manager
Donna Sala
credit associate
Naomi Matten
advertising assistant

Sales Offices

EAST/SOUTHEAST
Stanley Levitan
Radio-Electronics
200 Park Ave. South
New York, NY 10003
718-428-6037, 212-777-6400

MIDWEST/Texas/Arkansas/Okla.
Ralph Bergen
Radio-Electronics
540 Frontage Road—Suite 339
Northfield, IL 60093
312-446-1444

PACIFIC COAST/ Mountain States
Marvin Green
Radio-Electronics
15335 Morrison St.—Suite 227
Sherman Oaks, CA 91403
818-986-2001

Electricity and water don't mix. At least not in our Heavy Duty Digital Multimeters. Because these Oops Proof™ instruments are protected by a system of seals to ensure contamination-free dependability in even the cruddiest conditions.

Other abuse-proof features include the best mechanical protection ever built into a precision Digital Multimeter. In fact, every one of our Oops Proof multimeters will survive a drop from ten feet onto a concrete surface!

All the Heavy Duty series meters measure up to 1000 volts AC and 1500 volts DC, with full overload protection to those maximum voltages even on the lowest range settings. Overload circuitry also provides transient protection to 6KV on all voltage ranges and up to 600 volts on all resistance ranges.

We also invented a unique, long-life rotary switch for our Digital Multimeters. You can actually feel the difference just by rotating the function selector knob.

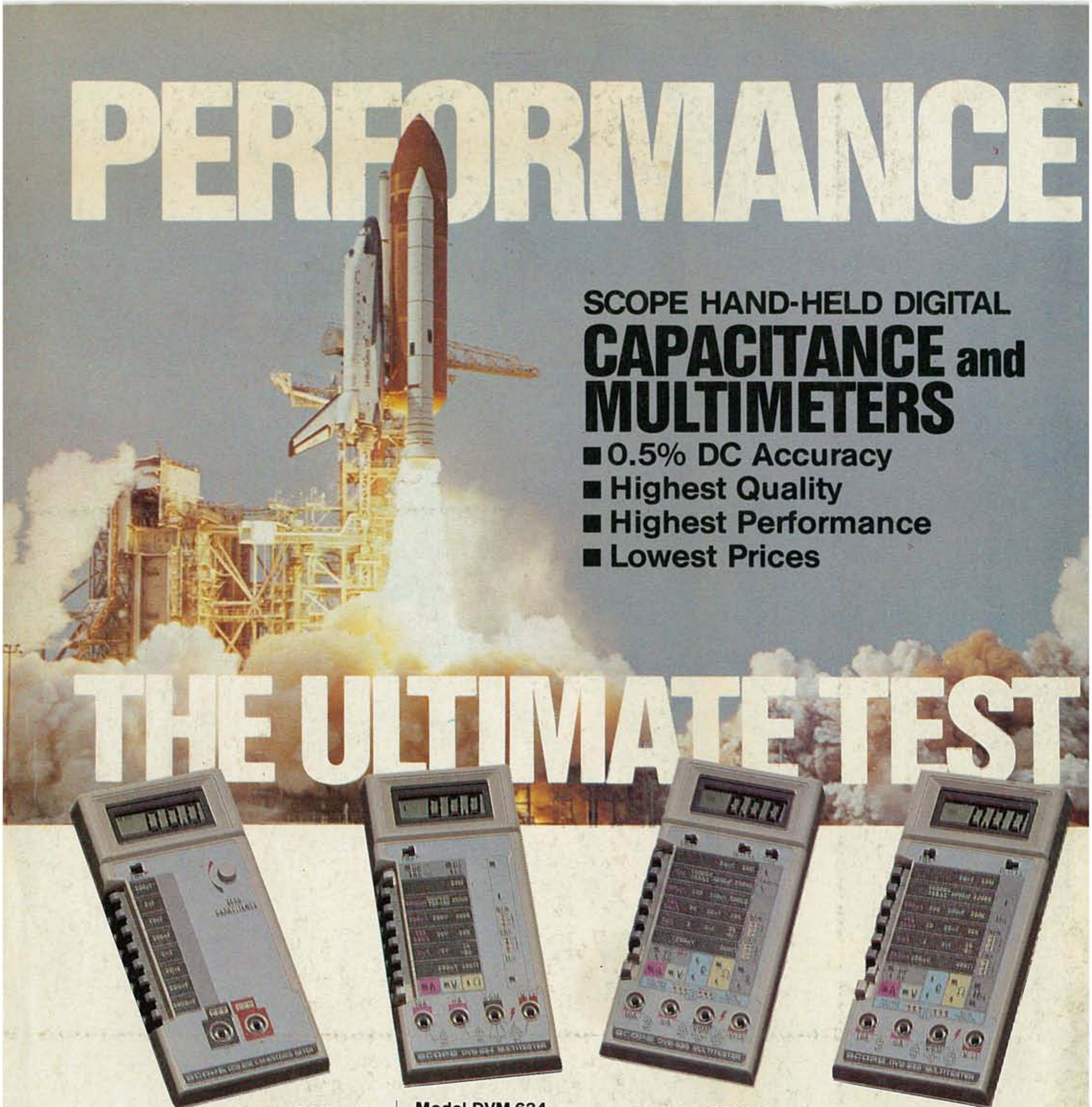
You'll find these features in a full line of Heavy Duty DMMs that offer a 4½ digit readout, 0.05% VDC accuracy, a 10-amp current range, a 2000-hour battery life, diode test, true RMS and temperature measurement. All this and a no-questions, one-year warranty.

You'll want to try one out, of course, so drop into your nearest electronics distributor and drop one.

Our lips are sealed.

Beckman Industrial™

CIRCLE 98 ON FREE INFORMATION CARD



Model DCM-602
$69.95

3½ Digit Capacitance Meter

8 ranges with full scale values to 2000 uF

FEATURES • Broad test range - 1 pF to 2000 uF • LSI circuit provides high reliability and durability • Lower power consumption • Crystal time base • Protected from charged capacitors • Frequency range - 800 Hz to 8 Hz

Model DVM-634
$48.75

7 functions, 32 ranges. Transistor measurement included.

Model DVM-638
$79.95

11 functions, 38 ranges. Includes logic level detector, audible visual continuity, capacitance and conductance measurement.

Model DVM-636
$62.75

8 functions, 37 ranges. Capacitance measurement included.

3½ Digit Multimeters

FEATURES • DC Voltage 100 uV - 1000 V • AC Voltage 100 uV - 750 V • AC/DC Current 200 uA - 10 Amps • Resistance 20 Megohms • Capacitance (DVM 636/638) 1 pF - 20 uF • Overload Protection • Auto-decimal LCD readout • Polarity indication • 3000 hour battery life with 9V transistor battery • Low battery indication

ASK FOR FREE CATALOG.
Money orders, checks accepted. C.O.D.'s require 25% deposit.

Service & Shipping Charge Schedule Continental U.S.A.

FOR ORDERS	ADD
$25-$100	$4.50
$101-$250	$6.00
$251-500	$8.00
$501-750	$10.50
$751-1,000	$12.50
$1,001-1500	$16.50
$1,501-2000	$20.00
$2,001 and Up	$25.00

Fordham

Toll Free 800-645-9518
In NY State 800-832-1446

260 Motor Parkway, Hauppauge, NY 11788