Radio-Electronics

THIS YEAR'S MOST INNOVATIVE CONSUMER PRODUCTS

$1.95 DEC. 1985
IN CANADA $2.50

48783

TECHNOLOGY - VIDEO - STEREO - COMPUTERS - SERVICE

What's new in IC's. This year's advances in digital and analog integrated circuits.

Build a home-security system. The features of a professional system at a fraction of the cost.

Build a video titler. Spice up your home video movies.

Switching power supplies: Design and build your own!

How to service CD players: How they work, and what to do when they don't.

A GERNSBACK PUBLICATION

PLUS:

★ Computer Digest ★ Designer's Notebook
★ Antique Radios ★ State-Of-Solid-State
★ Service Clinic ★ Robotics ★ PC Service

COVER 1

What's new in IC's? Find out what 1985 had to offer in both digital and analog IC's. Find out what innovations came our way. Find out about a voltage regulator that "plugs into the wall." Find out about software that lets you use your PC to design custom gate arrays. Find out about nonvolatile shadow RAM and bubble memory. Find out about a complete telephone on a chip, and much much more.

Our thanks to Motorola for providing the photo of the silicon and end-products that you see on the cover. To find out just what that silicon can do, turn to page 45.

NEXT MONTH

THE JANUARY ISSUE IS ON SALE DECEMBER 3

BUILD YOUR OWN SATELLITE RECEIVER
For less than one hundred dollars? Yes, it is possible.

BUILD A VIDEO TITLER
Part 3. Now you can build it! Wasn't it worth the wait?

BUILD A HOME-SECURITY SYSTEM
Part 2. We continue with construction details.

SEASON'S GREETINGS

The editors and staff of Radio-Electronics join in sending holiday greetings and our best wishes for a happy new year

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

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

Radio-Electronics

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

Cover photo by Motorola

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 138.

NEW! uniden® Bearcat® Regency® Scanners

Communications Electronics,™ the world's largest distributor of radio scanners, introduces new scanners and scanner accessories from J.I.L., Regency and also Uniden/Bearcat. Chances are the police, fire and weather emergencies you'll read about in tomorrow's paper are coming through on a scanner today.

NEW! Regency‡ MX7000-K

List price $699.95/CE **price $429.00/SPECIAL**
10-Band, 20 Channel • Crystalless • AC/DC
Frequency range: 25-550 MHz. continuous coverage and 800 MHz. to 1.2 GHz. continuous coverage
In addition to normal scanner listening, the MX7000 offers CB, VHF, and UHF TV audio, FM Broadcast, all aircraft bands (civil and military), 800 MHz communications, cellular telephone, and when connected to a printer or CRT, satellite weather pictures.

NEW! Regency® MX5000-K

List price $599.95/CE **price $329.00/SPECIAL**
Multi-Band, 20 Channel • No-crystal scanner
Search • Lockout • Priority • AC/DC
Selectable AM-FM modes • LCD display
World's first continuous coverage scanner
Frequency range: 25-550 MHz. continuous coverage.
Never before have so many features come in such a small package. The *Regency* MX5000 mobile or home scanner has continuous coverage from 25 to 550 MHz. That means you can hear CB, Television audio, FM broadcast stations, all aircraft bands including military and the normal scanner bands, all on your choice of 20 programmable channels.

NEW! Regency® MX4000-K

List price $629.95/CE **price $299.00/SPECIAL**
Multi-Band, 20 Channel • No-crystal scanner
Search • Lockout • Priority • AC/DC
Selectable AM-FM modes • LCD display
Bands: 30-50, 118-136, 144-174, 440-512, 800-950 MHz.
The *Regency* MX4000 is gives coverage in the standard VHF and UHF ranges with the important addition of the 800 MHz. and aircraft bands. It features keyboard entry, multifunction liquid crystal display and variable search increments.

NEW! Regency® Z60-K

List price $379.95/CE **price $216.00/SPECIAL**
8-Band, 60 Channel • No-crystal scanner
Bands: 30-50, 88-108, 118-136, 144-174, 440-512 MHz.
Cover your choice of over 15,000 frequencies on 60 channels at the touch of your finger.

NEW! JIL SX-400-K

List price $799.95/CE **price $469.00/SPECIAL**
Multi-Band, 20 Channel • No-crystal Scanner
Search • Lockout • Priority • AC/DC
Frequency range: 26-520 MHz. continuous coverage. With optionally equipped RF converters 150KHz.-3.7 GHz.
The *JIL* SX-400 synthesized scanner is designed for commercial and professional monitor users that demand features not found in ordinary scanners. The SX-400 will cover from 150 KHz to 3.7 GHz. with RF converters. Order the following RF converters for your SX-400 scanner. **RF-1030-K** at $259.00 each for frequency range 150 KHz.-30 MHz. USB, LSB, CW and AM. (CW filter required for CW signal reception); **RF-5080-K** at $199.00 each for 500-800 MHz.; **RF-8014-K** at $199.00 each for 800 MHz.-1.4 GHz. Be sure to also order **ACB-300-K** at $99.00 each which is an antenna control box for connection of the RF converters. The **RC-4000-K** data interface at $259.00 each gives you control of the SX-400 scanner and RF converters through a computer. Add $3.00 shipping for each RF converter, data interface or antenna control box. If you need further information on the JIL scanners, contact JIL directly at 213-926-6727 or write JIL at 17120 Edwards Road, Cerritos, California 90701 U.S.A.

SPECIAL! JIL SX-200-K

List price $499.95/CE **special price $159.00**
Multi-Band - 16 Channel • No-Crystal Scanner
Frequency range 26-88, 108-180, 380-514 MHz.
The *JIL* SX-200 scanner tunes military, F.B.I., Space Satellites, Police and Fire, Drug Enforcement Agencies, Defense Department, Aeronautical AM band, Aero Navigation Band, Fish & Game, Immigration, Paramedics, Amateur Radio, Justice Department, State Department, plus other thousands of radio frequencies most other scanners can't pick up. The SX-200 has selectable AM/FM receiver circuits, tri-switch squelch settings - signal, audio and signal & audio, outboard AC power supply - DC at 12 volts built-in, quartz clock - bright vacuum fluorescent blue readouts and dimmer, dual level search speeds, tri-level scan delay switches, 16 memory channels in two channels banks, receive fine tune (RIT) ± 2KHz., dual level RF gain settings – 20 db pad, AGC test points for optional signal strength meters.

Regency® HX1000-K

List price $329.95/CE **price $209.00**
6-Band, 30 Channel • No Crystal scanner
Search • Lockout • Priority • Scan delay
Sidelit liquid crystal display • Digital Clock
Frequency range: 30-50, 144-174, 440-512 MHz.
The new handheld *Regency* HX1000 scanner is fully keyboard programmable for the ultimate in versatility. You can scan up to 30 channels at the same time. When you activate the priority control, you automatically override all other calls to listen to your favorite frequency. The LCD display is even sidelit for night use. Order **MA-256-K** rapid charge drop-in battery charger for $79.00 plus $3.00 shipping/handling. Includes wall charger, carrying case, belt clip, flexible antenna and nicad battery. Order now.

NEW! Bearcat® 100XL-K

List price $349.95/CE **price $229.00**
9-Band, 16 Channel • Priority • Scan Delay
Search • Limit • Hold • Lockout • AC/DC
Frequency range: 30-50, 118-174, 406-512 MHz.
The world's first no-crystal handheld scanner now has a LCD channel display with backlight for low light use and aircraft band coverage at the same low price. Size is 1⅜" x 7½" x 2⅞". The *Bearcat* 100XL has wide frequency coverage that includes all public service bands (Low, High, UHF and "T" bands), the AM aircraft band, the 2-meter and 70 cm. amateur bands, *plus* military and federal government frequencies. Wow...what a scanner!
Included in our low CE price is a sturdy carrying case, earphone, battery charger/AC adapter, six AA ni-cad batteries and flexible antenna. Order your scanner now.

NEW! Regency® HX2000-K

The World's First 800 MHz. Handheld Scanner
List price $569.95/CE **price $359.00**
7-Band, 20 Channel • No-crystal scanner
Priority control • Search/Scan • AC/DC
Sidelit liquid crystal display • Memory backup
Bands: 118-136, 144-174, 440-512, 800-950 MHz.
The HX2000 scanner operates on 120V AC or 6 VDC. Scans 15 channels per second. Size 3" x 7" x 1½." Includes wall charger, carrying case, belt clip, flexible antenna and nicad batteries. Selectable AM/FM modes.

NEW! Bearcat® 800XLT-K

List price $499.95/CE **price $329.00**
12-Band, 40 Channel • No-crystal scanner
Priority control • Search/Scan • AC/DC
Bands: 29-54, 118-174, 406-512, 806-912 MHz.
The Uniden 800XLT receives 40 channels in two banks. Scans 15 channels per second. Size 9¼" x 4½" x 12½."

OTHER RADIOS AND ACCESSORIES

Panasonic RF-2600-K Shortwave receiver	$179.00
Panasonic RF-B300-K Shortwave receiver	$195.00
RD95-K *Uniden* Remote mount Radar Detector	$139.00
RD55-K *Uniden* Visor mount Radar Detector	$119.00
BC 20/20-K *Bearcat* 40 channel scanner	$274.00
BC 210XW-K *Bearcat* 20 channel scanner	$219.00
BC-WA-K *Bearcat* Weather Alert™	$39.00
DX1000-K *Bearcat* shortwave receiver	$459.00
PC22-K *Uniden* remote mount CB transceiver	$99.00
PC55-K *Uniden* mobile mount CB transceiver	$59.00
Z10-K *Regency* 10 channel scanner	$139.00
Z30-K *Regency* 30 channel scanner	$154.00
Z45-K *Regency* 45 channel scanner	$179.00
R1060-K *Regency* 10 channel scanner	$98.95
MX3000-K *Regency* 30 channel scanner	$189.00
C403-K *Regency* 4 channel scanner	$69.00
R106-K *Regency* 10 channel scanner	$99.00
RH250B-K *Regency* 10 channel VHF transceiver	$329.00
RU150B-K *Regency* 10 channel UHF transceiver	$449.00
RPH410-K 10 ch. handheld no-crystal transciever	$399.00
BC10-K Battery charger for *Regency* RPH410	$79.00
MA256-K Drop-in charger for HX1000 scanner	$79.95
MA257-K Cigarette lighter cord for HX1000	$19.95
MA917-K Ni-Cad battery pack for HX1000	$24.95
EC10-K Programming tool for *Regency* RPH410	$20.00
SMRH250-K Service man. for *Regency* RH250	$20.00
SMRU150-K Service man. for *Regency* RU150	$20.00
SMRPH410-K Service man. for *Regency* RPH410	$20.00
SMMX7000-K Svc. man. for MX7000 & MX5000	$20.00
SMMX3000-K Service man. for *Regency* MX3000	$20.00
B-4-K 1.2 V AAA Ni-Cad batteries (set of four)	$9.00
A-135C-K Crystal certificate	$3.00
FB-E-K Frequency Directory for Eastern U.S.A.	$12.00
FB-W-K Frequency Directory for Western U.S.A.	$12.00
TSG-K "Top Secret" Registry of U.S. Govt. Freq.	$15.00
TIC-K Techniques for Intercepting Comm.	$15.00
RRF-K Railroad frequency directory	$10.00
CIE-K Covert Intelligenct, Elect. Eavesdropping	$15.00
A60-K Magnet mount mobile scanner antenna	$35.00
A70-K Base station scanner antenna	$35.00
USAMM-K Mag mount VHF/UHF ant. w/ 12' cable	$39.95
USAK-K ¾" hole mount VHF/UHF ant. w/ 17' cable	$35.95
USATLM-K Trunk lip mount VHF/UHF antenna	$35.95

Add $3.00 shipping for all *accessories* ordered at the same time.
Add $12.00 shipping per shortwave receiver.
Add $7.00 shipping per scanner and $3.00 per antenna.

BUY WITH CONFIDENCE

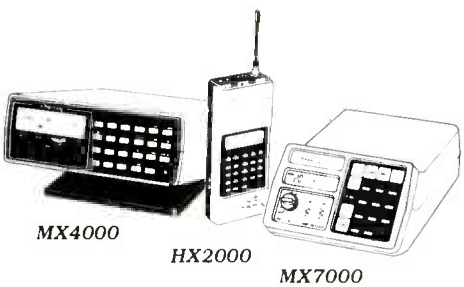
To ***get the fastest delivery from CE*** of any scanner, send or phone your order directly to our Scanner Distribution Center.™ Michigan residents please add 4% sales tax or supply your tax I.D. number. Written purchase orders are accepted from approved government agencies and most well rated firms at a 10% surcharge for net 10 billing. All sales are subject to availability, acceptance and verification. All sales on accessories are final. Prices, terms and specifications are subject to change without notice. All prices are in U.S. dollars. Out of stock items will be placed on backorder automatically unless CE is instructed differently. A $5.00 additional handling fee will be charged for all orders with a merchandise total under $50.00. Shipments are F.O.B. Ann Arbor, Michigan. No COD's. Most products that we sell have a manufacturer's warranty. Free copies of warranties on these products are available prior to purchase by writing to CE. Non-certified checks require bank clearance.

Mail orders to: Communications Electronics,™ Box 1045, Ann Arbor, Michigan 48106 U.S.A. Add $7.00 per scanner for U.P.S. *ground* shipping and handling in the continental U.S.A. For Canada, Puerto Rico, Hawaii, Alaska, or APO/FPO delivery, shipping charges are three times continental U.S. rates. If you have a Visa or Master Card, you may call and place a credit card order. Order toll-free in the U.S. Dial 800-USA-SCAN. In Canada, order toll-free by calling 800-221-3475. Telex CE anytime, dial 810-223-2422. If you are outside the U.S. or in Michigan dial 313-973-8888. Order today.

For credit card orders call 1-800-USA-SCAN

COMMUNICATIONS ELECTRONICS INC.™
Consumer Products Division
P.O. Box 1045 □ Ann Arbor, Michigan 48106-1045 U.S.A.
Call 800-USA-SCAN or outside U.S.A. 313-973-8888

Regency RH250



MX4000
HX2000
MX7000

CIRCLE 79 ON FREE INFORMATION CARD

WHAT'S NEWS

"Expert" computer program teaches how to sail a boat

A prototype computer program called *Skipper*, that will help teach the basics of sailboat handling, was described by RCA researchers at the past International Conference on Consumer Electronics in Chicago.

The learner interacts with the system through the graphic display and game paddles of his personal computer. In the experimental system demonstrated, a larger computer connected to the user's personal computer contains the tutoring program.

PROTOTYPE COMPUTER SYSTEM teaches the beginner the language of boating. Engineer R.M. Peterson of RCA's Princeton Laborators is at the helm of *Skipper*.

The user selects from "menus" that cover the various lessons. For example, one menu contains: Parts of a Boat, Steering Practice, The Sail in Detail, and Practice with the Sheet (the line that controls the sail position).

Other menu choices allow control of the boat by the game paddles. A graphic display shows a chart of the course and a representation of the boat, including orientation, rudder angle, sail angle, and wind direction. With the program, the beginner can try to sail the boat by trial and error, secure in the knowledge that a mistake could not be fatal. Or he can give control to the expert, *Skipper*, and see how the "pro" solves the different problems.

That type of computer program is known as an "expert system." It employs reasoning like that of a human expert to solve problems in a narrow area of expertise. *Skipper* is intended as a demonstration of possible future "how-to" intelligence systems, which could be made available to students accessing remote computers through telecommunications, or on their own computers as they become more powerful.

Electronic translator is boon to tourists

A pocket electronic translator that makes 4,000 words of one of three foreign languages available to the tourist or student, or supplies English equivalents to 4,000 foreign words, has been made available by Langenscheidt, the world's largest publisher of bilingual dictionaries. At present three editions are available: French, German and Spanish.

Translator 8000, as it is called, features a 48K memory and can also double as a pocket calculator. It is made for Langenscheidt by Sharp.

With just a few keystrokes, the translator can locate an English word and then provide the user with its equivalent in either German, French, or Spanish, depending on the model. The unit also will inform the user of any variant translations or alternate meanings. In addition, the unit can translate from the selected foreign language to English.

To test someone's command of a language, the *Translator 8000* can be set up to call up words at random. The user can then check his understanding of the word with a touch of a button.

For further information, contact Langenscheidt Publishers, Inc., 46-35 54th Road, Maspeth, NY 11378.

Cordless speaker system can be put anywhere

A completely portable cordless high-fidelity speaker system that includes a built-in two-channel FM receiver, an amplifier, a microphone, and a miniature stereo transmitter, has been introduced by Nady Systems of Oakland, CA. The system uses either batteries or an AC adapter for power.

The transmitter is the size of a pack of cigarettes. The stereo receiver and amplifier are housed within the portable speaker enclosure.

Applications for the system are numerous. Used as a public address system or for sound reinforcement, speakers can be spotted around a large hall, or outdoor area, within 100–200 feet from the transmitter. As an adjunct to a home stereo system, a pair of speakers can be placed on the patio or at the poolside. Each speaker has its own volume and tone control.

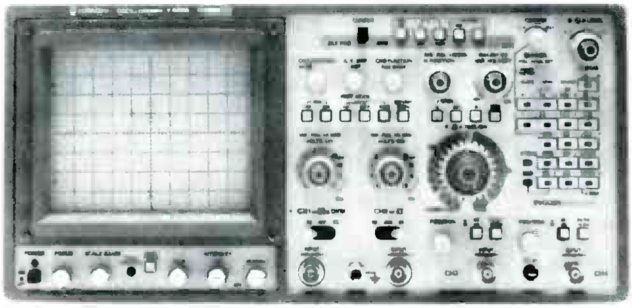
Suggested retail price for the complete system is $199.95. Additional receiver-amplifier-speaker units are $99.99. An additional handheld microphone with built-in transmitter is also available. **R-E**

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

RAG ELECTRONICS, INC.

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

HITACHI Hitachi Denshi, Ltd. — V1100A DC to 100 MHz Portable Readout Oscilloscope

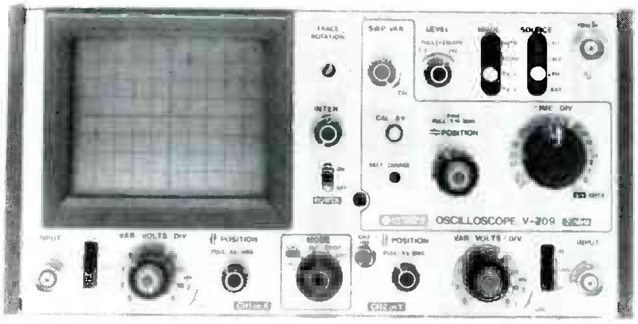


FEATURES

- Character display of set-up information on CRT (VOLTS/DIV, TIME/DIV, CAL or UNCAL, Delay Time, Trigger source, etc.)
- Cursor read-out function eliminates conventional calculation procedures (V, ΔV, ΔV%, ΔT, 1/ΔT, ΔT%, phase).
- Digital measuring function displays, DC voltage, AC voltage, and Frequency.
- Comment display function allows user's comments to be displayed on the CRT such as date and measurement data. Excellent for photo documentation.
- 4 channel, 8 trace, DC to 100 MHz, High sensitivity 1 mV/Div, Delayed sweep, Full TV triggering, Alternate triggering.

List Price $2,490.00 **Sale Price $2,250.00**

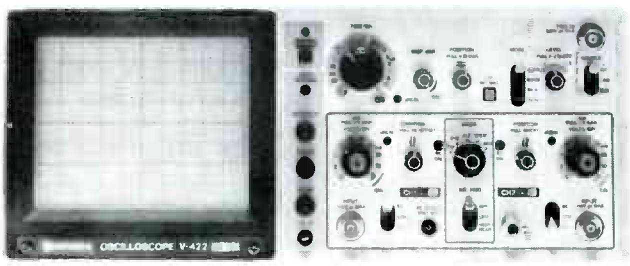
HITACHI Hitachi Denshi, Ltd. — V-209 DC to 20 MHz Mini-Portable Dual-Trace Oscilloscope



- A three-way power supply takes the V-209 anywhere, anytime for speedy field measurements.
- High sensitivity (1mV/div at 10MHz) and fast sweep times (50ns/-div) make the V-209 a valuable tool in R&D as well as servicing in a wide variety of applications including computers and video equipment.
- A Built-in TV sync separation circuit with easily selectable TV-V and TV-H modes ensures stable observation of both vertical and horizontal TV signal waveforms.
- An auto focus feature maintains constant trace without the necessity of troublesome manual focus adjustments.
- The V-209 is just what it claims to be—a powerful field service tool in a compact, lightweight package.

List Price $945.00 **Sale Price $708.00**

HITACHI Hitachi Denshi, Ltd. — Portable Oscilloscopes



Model V-422 shown

CIRCLE 126 ON FREE INFORMATION CARD

MODEL V-212 **$461.00**

DC to 20 MHz, 1 mV/div, Dual Trace. Features 6" Rectangular CRT (w/two X10 probes).

MODEL V-422 **$694.00**

DC to 40 MHz, 1 mV/div, Dual Trace, D.C. offset for DMM Output, Verticle Mode Trigger 6" CRT (w/two X10 probes).

MODEL V-1050F **$1,276.00**

DC to 100 MHz, .5 mV/div, Quad Trace, Delayed Sweep. Full TV Triggering, Alternate time base (w/two X10 probes).

Full 2 year parts and labor warranties on the above scopes.

HITACHI GSA CONTRACT NUMBER GS00S57322

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

• **VHS Progress.** The long-term future of the VHS recording format is a major preoccupation among Japanese manufacturers. For the immediate future, they have decided to avoid any improvements that will sacrifice compatibility. But as for the more distant future, there is a sharp dispute as to whether to forsake compatibility, at least partly, in favor of a broadcast-quality picture. One proposal under consideration is the use of metal tape and a high-band video signal. That would be completely incompatible with present VHS recorders and tapes, but proponents of that approach also advocate a "compatibility switch," or automatic switching, so that conventional VHS tapes would still be playable on the super VHS machines. According to one VHS recorder manufacturer, that new "super" format could be introduced in about two years.

• **8mm Gaining.** The only threat to VHS on the horizon comes from the new 8mm video format. Sony, which insists it is not abandoning the Beta format, continues to push 8mm in a way that indicates that it is being positioned as the next generation of VCR's. Sony's first 8mm video products were portable camcorders, taking advantage of the 8mm cassette's small size. Those, however, were followed by a home deck with digital audio and a switch to double the cassette's playing time to four hours. In its latest move, Sony is priming the pump with pre-recorded 8mm cassettes. Sony made its first software move in England, where it sponsored the duplication of some 50 cassettes—divided about half-and-half between major movies and music videos, many of them with digital stereo soundtracks. Eastman Kodak has now joined the movement to 8mm home decks by preparing to introduce one of its own, and Pioneer is expected to do the same.

• **Compact Discs with Video.** The success of the digital audio Compact Disc, or CD, is leading to a new effort to develop a compatible version with interactive video applications. That project is backed by some of the world's biggest companies—Matsushita, Philips, and Sony in the hardware field, and Warner Records and Polygram in software. The new system is tentatively called CV (for Compact Video), and it could be available to the public in 1987. The discs, as currently envisioned, would have a combination of digital still and motion pictures and could be used for music videos, games, data, entertainment, education, and instruction, with emphasis on interaction.

CV players are expected to be microprocessor-based, with audio and video outputs and interface devices such as keypad, joystick, or mouse. For audio purposes, CV and CD discs will be compatible. That is, a CD will be playable on a CV turntable, while the audio portion of a CV will play back on a CD player.

• **More digital TV's.** The expected avalanche of digital television sets hasn't yet materialized because of a continued shortage of IC's; but at press time, three sets using digital signal processing had been introduced for the 1986 model year. Toshiba's 20-inch set with the picture-in-picture feature was the first and has been on the market for several months at a suggested list price of $1,300. Panasonic's first digital set, at $1,200, also is a 20-inch unit and has the picture-in-picture feature. (An image from any video source can be superimposed in any corner of the screen.) Sony's digital TV, using its black-faced XBR Trinitron, is a 25-inch model with an alphanumeric wireless remote-control keyboard and an 80-page memory. Called the "Home Management Helper," it can be programmed to give reminders of birthdays, anniversaries, bills due, and so forth. The suggestd list price is $1,350.00.

Zenith, which had originally scheduled a digital set for early 1985, has now postponed the introduction until an unstated future date. "They look great in the lab," said Chairman Jerry Pearlman, "and we are continuing a major development effort. We have been working on it for six years, and when the product is ready we will introduce it. We will introduce digital only when it works to our satisfaction." **R-E**

Take home a world champion.

$85* gets you a technical knockout. **The Fluke 70 Series. Winners of the digital vs. analog battle.**

Since their debut, they've become the worldwide champions of the industry.

Never before have such tough, American-made meters offered so many professional features at such unbeatable prices.

Each comes with a 3-year warranty, 2,000+ hour battery life, and instant autoranging.

You also get the extra resolution of a 3200-count LCD display, plus a responsive analog bar graph for quick visual checks of continuity, peaking, nulling and trends.

Choose from the Fluke 73, the ultimate in simplicity. The feature-packed Fluke 75. Or the deluxe Fluke 77, with its own protective holster and unique "Touch Hold" function** that captures and holds readings, then beeps to alert you.

So don't settle for just a contender. Take home a world champion.

For your nearest distributor or a free brochure, call toll-free anytime **1-800-227-3800, Ext. 229.** From outside the U.S., call 1-402-496-1350, Ext. 229.

FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

FLUKE 73	FLUKE 75	FLUKE 77
$85*	$99*	$129*
Analog/digital display	Analog/digital display	Analog/digital display
Volts, ohms, 10A, diode test	Volts, ohms, 10A, mA, diode test	Volts, ohms, 10A, mA diode test
Autorange	Audible continuity	Audible continuity
0.7% basic dc accuracy	Autorange/range hold	"Touch Hold" function
2000+ hour battery life	0.5% basic dc accuracy	Autorange/range hold
3-year warranty	2000+ hour battery life	0.3% basic dc accuracy
	3-year warranty	2000+ hour battery life
		3-year warranty
		Multipurpose holster

* Suggested U.S. list price, effective July 1, 1984.
** Patent pending.

FLUKE®

CIRCLE 277 ON FREE INFORMATION CARD

SATELLITE TV

BOB COOPER, JR.*
SATELLITE TV EDITOR

Et tu Ku?

VIRTUALLY EVERYTHING YOU HAVE READ (or heard) about home TVRO's involves the 3.7- to 4.2-GHz satellite band, also known as the C band. That band was established in the early 1960's, by international agreement, for the purpose of relaying communications between two points via satellite. Unfortunately, that same band was also allocated for terrestrial use as a terrestrial trunk system for telephone services including AT&T, MCI, and others.

As TVRO systems have spread from rural to metropolitan locations, a conflict between TVRO reception and terrestrial microwave users has developed. The FCC, revising its 1979 rules governing licensing of TVRO terminals, foresaw that conflict and went on record as being unwilling to arbitrate any disputes between TVRO and terrestrial microwave users unless the TVRO system had filed for an otherwise optional license. The FCC still routinely grants such licenses, and, although few home-TVRO owners bother with it, cable and SMATV system operators still file for the license.

After the FCC grants such a license, a cable (or other) TVRO system can protest telephone-company applications to add new terrestrial microwave systems when any such system might cause interference to the licensed TVRO. Of the more than 1.2 million home TVRO's now in operation, few have filed for such a license, and the TVRO industry has found counter-measures for dealing with TI (*T*errestrial *I*nterference). Those measures include special antennas, special signal traps, and special filters that may be added on to an otherwise conventional home-TVRO system.

*publisher of CSD magazine

FIG. 1

However, the FCC has always maintained that, although C-band TVRO's are legal, TVRO should really be relegated to the Ku band. Ku band is the next-higher internationally-allocated satellite-to-earth frequency, and in various parts of the world it includes frequencies from 11.7 to 12.2 GHz, from 12.2 to 12.7 GHz, and, in some European countries, from 11.0 to 11.7 GHz. Ku band's chief advantage is that Ku-band assignments are not shared with terrestrial users (such as telephone companies), so the number of earth locations where terrestrial interference is likely to occur is far smaller than with C band.

Television and Ku band

Some years ago, when the four major U.S. television networks were studying their own use of satellites, PBS was the first to choose satellite transmission, and PBS programming is still found on Westar 4. That system now also includes the National Public Radio (NPR) service (in a slightly different format). NBC then chose to use Ku band for several reasons:

- From the beginning NBC saw satellite delivery as a two-way system. They believed (correctly, as it turned out) that, while getting programs *to* their 200 or so network affiliates was important, getting news and sports feeds *from* those affiliates was equally, if not more, important.
- It was also easier to send a mobile news van equipped with a Ku-band dish than a ten- or twelve-foot C-band dish to a news scene. Early this year NBC completed equipping its affiliates with Ku-band receivers, and 50 or so affiliates are now receiving Ku-band transmitters as well.
- NBC also foresaw the great number of problems with terrestrial interference in the C band, and elected to bypass those problems by going to what was, at the time, the untested Ku band.

ABC and CBS subsequently chose to build their networks around existing C-band satellites, and both networks now routinely connect with affiliates using AT&T's Telestar 301 and 302 satellites. That gives home TVRO viewers a multitude of unscrambled network feeds to select from.

From the home-TVRO owner's point of view, even with NBC now using Ku band to reach its affiliates, there are three network C-band services still available, plus PBS. That is because NBC operates

a C-band backup feed for its East Coast network feed, which covers the eastern and central time zones (on F1R). Although the bulk of NBC programming is carried on Ku band, for the time being the full eastern network schedule continues on F1R. However, this fall will be the first time in years that much of NBC's professional football coverage will *not* be found on C band. And that has some home-TVRO users and sellers concerned.

On a typical Sunday, a high percentage of all professional football games played are broadcast via satellite. That has been one of the fringe benefits of owning a TVRO since its inception. The solution, as you may have guessed, is to equip yourself with a Ku-band terminal.

Until very recently you could not receive both C- and Ku-band signals with the same antenna. Ku-band antennas and electronics present no real technical problems in and of themselves; finding an economical way to receive both bands with the same equipment is the real problem. However, at the recent SPACE/STTI trade show in Nashville, several suppliers displayed combination systems that could receive both C- and Ku-band signals using one dish and (more or less) a single electronics package. Here is how the designers have approached the "dual band" problem:

1. The first problem is the dish. Many of the more popular mesh-antenna systems have mesh openings significantly larger than the minimum required for suitable Ku-band reception. The solution was to close up the mesh by making the holes smaller.

2. The second problem is the feed. Both C- and Ku-band feeds must be at the focal point of the dish, and there is an old law of physics that states that two objects cannot occupy the same space at the same time. Several solutions have been proposed by the equipment manufacturers.

Chaparral and others have combined feeds for both bands into a single feed so that the Ku-band feed sits slightly offset from the dish's focal point. That reduces Ku-band gain, but since a Ku-band dish only needs to be one-third the size of a C-band dish to provide the same gain, that

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.

shouldn't be much of a disadvantage.

Southern Star Satellites took a different approach; their C-band antenna is Cassegrain-fed, but they cut a tiny opening in the Cassegrain sub-reflector where they mount a Ku-band feed. Thus, on C band, the dish is a Cassegrain type, and on Ku it is a prime-focus type.

3. The third problem is the downconverter. One early approach was to design primarily for C-band reception, and include a subconverter for Ku band that translated the 11.7- to 12.2-GHz signals down to 3.7 to 4.2 MHz for final conversion. That proved to be unworkable, so modern receivers use dual "heads" (the "head" consists of the feed, antenna, LNA, and downconverter); each one downconverts signals from its band to a common IF between 950 and 1450 MHz. The user has a C/KU switch at his receiver that he may use to select the desired band; the receiver automatically selects the proper conversion head at the antenna. The receiver deals with only one frequency: the downconverted 950- to 1450-MHz IF signal.

4. The fourth problem is bandwidth. Most C-band signals operate in a 36-MHz transponder channel, but few actually use more than 27 or 28 MHz for video information. Ku-band channels are typically 54-MHz wide, and the Ku people have adopted a technique whereby they split a 54-MHz channel into a pair of 27-MHz wide channels. They can then transmit two completely separate TV programs through one transponder. Thus, by pure luck, 27 MHz bandwidths are appropriate for both C and Ku bands.

The future

Ku band is to present-day TVRO what UHF was to terrestrial TV reception in the 1950's. It is the "new kid on the block," and, for now, equipment available for Ku is expensive and hard to find. A handful of C-band OEM's, looking for a marketing nitch they can call their own, have moved into Ku with dual-band systems. Others are certain to follow soon as the Ku-band satellite services continue their rapid expansion. **R-E**

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

RAG ELECTRONICS, INC.

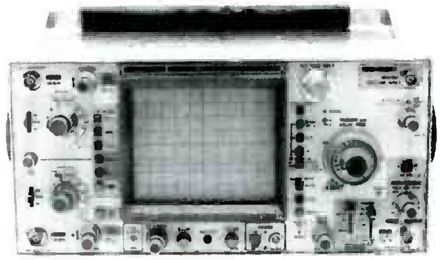
New and Used Electronic Test Equipment
Sales • Service • Rental • Leasing

LEADER Instruments Corporation — SPECIAL SALE ON LEADER SCOPES

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.

$749.00

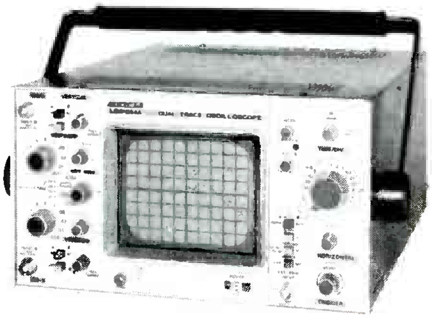


LBO-516 DC to 100 MHz

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.

$1195.00



LBO-514A DC to 15 MHz

The LBO-514A is a compact 5-inch oscilloscope that offers maximum performance at low cost. Equipped with both vertical and horizontal magnifiers, it has 1-mV sensitivity with X5 magnification and a maximum sweep speed of 0.1 us/cm (0.2 s/cm to 0.5 usec in 18 calibrated steps plus X5 magnification). The LBO-514A provides both chop and alternate dual trace displays.

$447.00

Ask about Leader's Video and RF Generators

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 Warrantee Parts & Labor

$395.00

CIRCLE 265 ON FREE INFORMATION CARD

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.

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

IET IWATSU KEITHLEY LEADER Instruments Corporation LOGICAL OK Polaroid

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

GIANT 15th ANNIVERSARY SALE!

FLUKE® DMM Accessories

$89.00

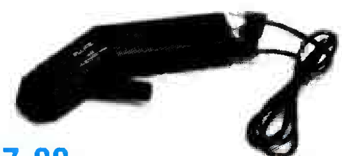
801-600 AC Current Probe

÷1000 transformer. Features large jaw opening for industrial use.
Accuracy: ±3%
Range: 1A to 600A 30 Hz to 1 kHz
Jaw Opening: 2 inches (50 mm)

$52.00

Fluke's 80TK plug-in thermocouple accessory converts virtually any DMM with standard banana plug inputs in a convenient, easy to use temperature measuring device.

80TK SPECIFICATIONS
Temperature Measurement Range
−50 to 1000°C
−58 to 1832°F
Battery Life: 1600 Hours (9V)



$197.00

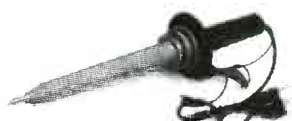
Y8100 DC/AC Current Probe

Uses Hall-effect to measure dc or ac current without electrical contact. Battery powered. Two ranges, 20A and 200A
Accuracy: ±2% of range (dc to 200 Hz)
Range: to 200A and 1 kHz
Jaw Opening: 0.75 inch (19 mm)

85 RF Probe

$76.50

Accuracy: ±0.5 dB above 0.5V
Range: 100 kHz to 500 MHz
Input Level: 0.25V to 30V rms

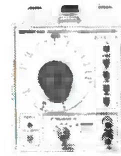


$72.00

80K-40 High Voltage Probe

(÷1000 resistive divider).
Accuracy: ±2%, 20 kV to 30 kV
Range: to 40,000V dc or peak ac (60 Hz)

LEADER Instruments Corporation



Audio Sine/Square Wave Generator

- Distortion from <.05%
- 10 Hz to 1 MHz
- 3V 600Ω

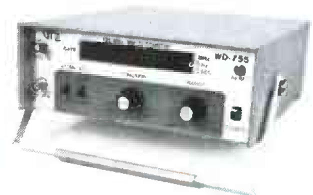
LAG-120B
$259.95

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

VIZ 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

ESCORT DMM's & Capacitance Meter

MODEL EDM 1116A $89.00

- 0.5 basic DC accuracy
- AC/DC 200mV, 2V, 200V, 1000V
- AC/DC 2mA, 20mA, 200mA, 10A
- 200Ω, 2kΩ, 200kΩ, 2MΩ, 20MΩ
- 2nF, 20nF, 200nF, 2μF, 20μF
- Diode Testing
- hFe Testing
- Audible Continuity Testing

4½-Digit Multimeter

MODEL EDM 1346A $189.00

- Audible Continuity Testing
- Diode Testing
- Data Hold

DC Voltage: 200mV-1000V ±(0.05%rdg + 3dgt)
AC Voltage: (True RMS - 200 mV-200V @45Hz-1KHz ±(0.75%rdg + 10dgt)
DC Current: 2A-10A ±(0.75%rdg + 3dgt)
AC Current: (True RMS / 20mA – 200mA @45Hz-400Hz ±(0.75%rdg + 10dgt)
Resistance: 2KΩ-200KΩ±(0.1%rdg + 3dgt)
Frequency: 20KHz-200KHz ±(0.5%rdg + 3dgt)

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)

CIRCLE 265 ON FREE INFORMATION CARD

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

Our book has more adapter varieties and combinations than you'll care to count. The point is, we want to make sure that one or more of our adapter models will suit your design and test requirements to a tee.

And now that you have an idea of our depth and variety, you should also be aware that the adapters we design and manufacture are considered by electronic design engineers to be right at the top. No question.

A superior product? You know you've got that. And you should know, also, that we make sure you receive fast service and specified quantity through your favorite electronic parts distributor.

After all, we wrote the book.

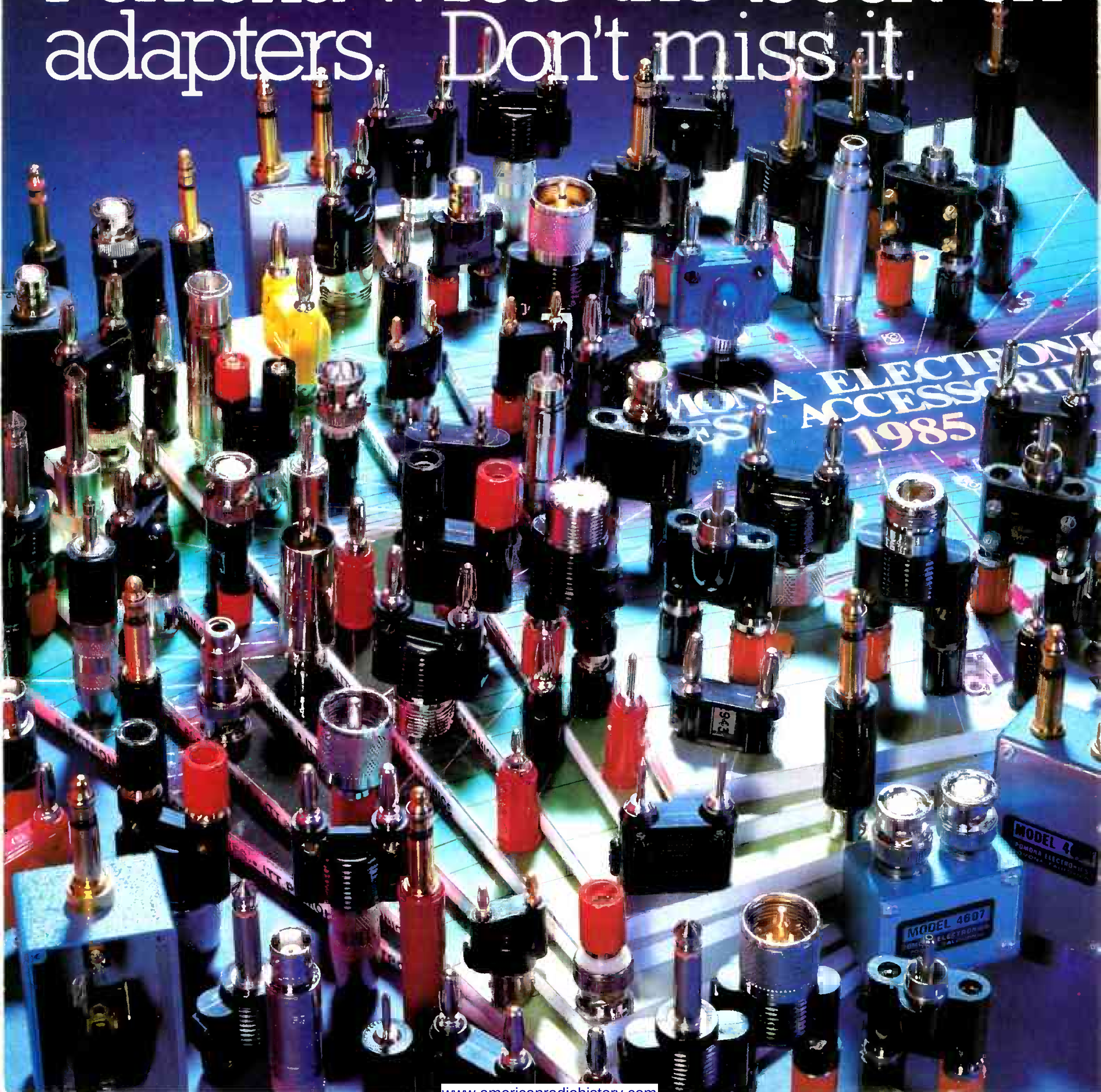
And it's free. Our products are described and illustrated in our 1985 general catalog.

Just call (714) 623-3463 or 623-6751. Or, write to us at ITT Pomona Electronics, a division of ITT Corporation, 1500 E. Ninth St., Pomona, CA 91769.

CIRCLE 101 ON FREE INFORMATION CARD

ITT
Pomona Electronics

Pomona wrote the book on adapters. Don't miss it.



BOOKS

SILICONNECTIONS, by Forrest M. Mims III; McGraw-Hill Book Company, 1221 Avenue of the Americas, New York, NY 10020; 240 pages, including 8-page photo section; 6 × 9 inches; $16.95

This book, subtitled *Coming of Age in the Electronic Era*, is an autobiography that captures some of the history of electronics from before 1960 to 1985. It covers some of Mims' experiences with MITS (the company that developed the Altair computer); the now-defunct *Popular Electronics* magazine and other electronics-related press; his fight with Bell Labs over patent infringement; his ideas on and experiences with electronics entrenpeneurships, and much more.

Mims' excellent writing style makes reading *Siliconnections* a pleasure. And readers of **Radio-Electronics** will find it fun to find out how we "scooped [our] uptown rival with the first digital computer-construction article, Jonathan Titus's article on the Mark-8." That article appeared back in our July 1974 issue. And it's only part of the facinating history of the electronics era.

HOW TO DESIGN CIRCUITS USING SEMICONDUCTORS, by Mannie Horowitz; TAB Books, Inc., Blue Ridge Summit, PA 17214; 341 pages, including index; 5⅛ × 8¼"; softcover; $11.50.

Here is a sourcebook giving practical details of today's semiconductor technology *without* overwhelming you with theory and superfluous information. It's a handbook designed for realistic bench use by both experimenters and professionals who need to design semiconductor circuits for specific applications.

The extensive coverage includes transistors, thyristors, varistors, thermistors, photoresistors, Hall-effect devices, junction diodes, point-contact diodes, JFETS, FOTOFETS, IGFETS, Zener diodes, triacs, diacs, active and passive filters, op amps, oscillators, and bootstrapping. **R-E**

career servicing computers.

fine tune your computer skills. And you also get over $1,000 worth of software, including WordStar and CalcStar.

Learn to service today's computers

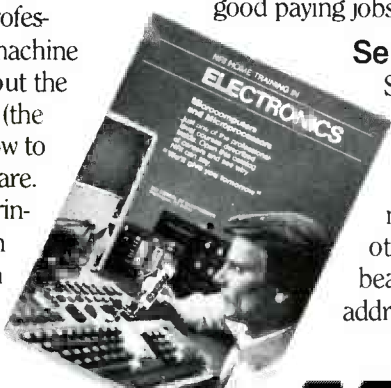
As you train with your Sanyo, you'll gain the knowledge you need to become a computer professional. You'll learn to program in BASIC and machine language. You'll use utility programs to check out the operation of the Sanyo's 8088 microprocessor (the same chip used in the IBM PC). You'll learn how to debug programs and write your own new software.

Most importantly, you'll understand the principles common to all computers. Only a person who fully understands all the fundamentals can hope to be able to tackle all computers. NRI makes sure that you'll get the training you need to maintain, troubleshoot and service computers.

Learn at home in spare time

With NRI training, you'll learn at home on your own time. That means your preparation for a new career or part-time job doesn't have to interfere with your current job. You'll learn at your own pace, in the comfort and convenience of your own home. No classroom pressures, no rigid night school schedules. You're always backed up by the NRI staff and especially your NRI instructor, who will answer questions, give you guidance and be available for special help if you need it.

Let others worry about computers taking their jobs. With NRI training, you'll soon have computers making good paying jobs for you.



Send for free NRI catalog

Send the post-paid reply card today for NRI's 100-page catalog, that gives all the facts about computer training plus career training in Robotics, Data Communications, TV/Video Servicing and many other fields. If some other ambitious person beat you to the card, write to NRI at the address below.

NRI SCHOOLS

McGraw-Hill Continuing Education Center
3939 Wisconsin Avenue, NW
Washington, DC 20016

We'll Give You Tomorrow.

IBM is a Registered Trademark of International Business Machines Corporation.

LETTERS

WRITE TO:

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

VERSATILE POWER SUPPLY

The printed-circuit board for the versatile bench power supply that was featured on our October cover is available from Specialty Electronic Services, Inc., PO Box 3320, San Antonio, TX 78211 for $8.50 postpaid. (The price was incorrectly posted in the Parts List.)

BUILD YOUR OWN PC/XT

Inadvertently, we gave the impression that you should *only* use the Compaq version of MS-DOS in the HiTech PC/XT. That is not correct. The HiTech 2001 requires PC-DOS version 2.0 or higher. It won't boot with Compaq DOS. However, you will need the Compaq version for its BASIC programming language. (IBM's PC, of course, has parts of its BASIC in ROM.)

The "Y" adapter mentioned in the article is no longer necessary. New units are being shipped with 130-watt supplies that already have 3 drive connectors.

Any readers with comments or questions can write directly to the author, but enclose a self-ad-

dressed and stamped envelope if a reply is needed.
ELLIOTT S. KANTER
8631 West Creighton Pl.
Savannah, GA 31406

PLEASE PUBLISH THOSE LISTS

I am planning on building the printer buffer described in the August and September issues of **Radio-Electronics**. I am disappointed that the micro code for the ROM was not published.

It seems to go against the do-it-youself attitude of your magazine. I do not have the facilities to burn a ROM, but I know there are many companies that will burn ROM's for a modest fee. I think that paying $26 for one ROM is a bit too expensive. I would like to suggest the following policy to you.

I suggest that you either publish the micro code, or keep some type of price limit on parts available only through the author. Perhaps a percentage of the part's raw price could be added on.

I think you publish a fine magazine overall, and if you develop some policy regarding programmed parts, future microprocessor-based projects may be even more popular with your readers.
ALAN ARKEVEIN
Binghamton, N.Y.

MAKE YOUR PROJECTS BUILDABLE

I am consistently impressed with the quality and variety of projects included in your "Build This" articles; the "Printer Buffer/Converter" in the Aug. & Sept. 1985 issues seemed an especially challenging and interesting project to tackle. However, I was disappointed when the article concluded without listing the software necessary to make the system *work*.

Although the machine code has been made available through a pre-programmed EPROM, you do your build-it-from-scratch readers a disservice by providing such thorough guidelines to build a project, but then withhold the key information necessary for a reader to complete the project on his own.

You have done a terrific job making your projects "buildable"; detailed assembly instructions, parts sources, and the new PC Service are outstanding features that I hope you will not change. But I urge you to please reconsider the space limitation mentioned in the article and print for us "build-it-all" readers the operating code listing in future issues.
WADE UMPHRIES
Cape Girardeau, MO

CAN YOU HELP?

Reference Build This: August and September issues of **Radio Electronics**,"Buffer/Converter For Your Printer."

I contacted the address listed in the article for the purchase of a board-set for the printer *Buffer-Converter* and was informed that the items were not for sale as listed in your magazine; they were only available as a set (boards and EPROM). I can appreciate the company's position; however, the

"One sportscaster was on the left, the other on the right, and the crowd was all around me as I watched my first stereo baseball game on TV."

TE-800

I COULDN'T BELIEVE IT

My living room seemed as though it was 300 yards wide. I could hear action far to the left, and far to the right. I could hardly believe I was watching television in my living room on a 15-inch black and white TV.

It was Saturday afternoon and the Braves' game was being broadcast in stereo, as it usually is. However, I would never have heard it on my TV and stereo without the TE-800 Stereo Decoder.

HOOKUP

The TE-800 was plugged into the earphone jack on the TV, and then the left and right outputs of the TE-800 were plugged into the auxiliary inputs on my stereo. The way the TE-800 is designed, it could have just as easily been connected to the mono audio output on my VCR, or alligator-clipped to the speaker terminals of the TV if my TV had no earphone jack. The unit is even designed with an MPX input to be used with the newer stereo-ready TVs.

FEATURES

Only our SPC™ (patent pending) circuitry of the TE-800 allows it to be this versatile, and to decode stereo from so many sources. The auto-stereo circuitry automatically senses when a stereo signal is tuned by the TV or VCR, and triggers the decoder and the front auto pilot light.

The Stereo-Plex™ circuitry of the TE-800 is even special. When you are tuned to a TV station or program that is not stereo, the Stereo-Plex™ circuitry may be activated. It makes the program sound just like stereo, spreading it out to fill the room.

★ MADE IN AMERICA ★

I personally think it proper that the company that started *Good TV Listening* twelve years ago with the world's first Teledapter in 1972...the first TV Audio Tuner in 1974...and the first TV Power Amp in 1983, is first again with the universal stereo TV decoder.

When you call the factory, you may be assured that the salesperson you talk with is able to handle your order knowledgeably. And should a Teledapter ever need service, it will be repaired quickly and correctly. All Teledapters come complete with cables, hookup instructions, a Helpline phone number, and a satisfaction guarantee.

Sincerely,

David Rhoades

David Rhoades

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-800, $195.00 plus $4.00 postage and handling.

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

24 HOURS

VISA | MasterCard | AMERICAN EXPRESS | DINERS CLUB

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

RHOADES
NATIONAL CORPORATION
Department 240
Highway 99 East • P.O. Box 1316
Columbia, TN 38402

Add stereo sound to your TV or VCR with the TE-800 TELEDAPTER® MTS Stereo Decoder

CIRCLE 285 ON FREE INFORMATION CARD

items I requested were listed as being available as separate items.

I realize that your magazine does not have anything to do with the way these items are advertised; however, they were not available as listed and therefore could be considered as an improper advertisement by Alpha Electronics.

DONALD J. GARDNER
Friendswood, Tx

In answer to the previous three letters: If possible, we try to publish the source code for any ROM-based project that appears in **Radio-Electronics**, *or at least get the author to sell the listing for a modest fee. In the case of the printer buffer, however, the author refused. We were then forced to answer the question of whether or not we should publish the article. We came to the conclusion that our readers would benefit more if we published the article—even without the source code—than if we decided not to go ahead.*

Is the price of the ROM excessive? Not if you consider that the software for such a project can easily take more time to design than the hardware—including the PC-board layout. Alpha's reason for refusing to sell their PC boards without the EPROM is to reduce the illegal copying of their copyrighted software. That's difficult to argue against. But we'd like to hear what other readers have to say.

A final note: the Parts List is not an advertisement. Suppliers of hard-to-get parts are listed by **Radio-Electronics** *as a service to our readers.—Editor*

SUGGESTED PROJECT

I have been a regular subscriber to and avid reader of **Radio-Electronics** for several years, and am glad that your magazine has kept the electronics touch.

I would like to see in your columns, in due course, the necessary details to build a frequency standard, phase-locked to WWV or some other suitable radio transmitter. Such a project, I feel, would be appreciated by many readers.

BRYAN PITWALA
Bronx, NY

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.

630 Puente Street, Brea, CA 92621 (714) 671-4800.

Beckman Industrial™

CIRCLE 207 ON FREE INFORMATION CARD

EQUIPMENT REPORTS

JNEL Cablemaster Cable/VCR programmer

Cable users can now use all of the features of their VCR's.

CIRCLE 5 ON FREE INFORMATION CARD

MENTION THE WORD "PROGRAMmability" to a cable subscriber/VCR owner and the response is likely to be a scowl. The reason is quite simple: VCR's, even the so-called cable-ready models, lose much of their programmability when used with cable TV.

The reason for that is the cable converter. That unit is only capable of outputing a single channel at a time. That may not seem like such a big deal, but consider what happens when you want to do some unattended taping. Let's say you are going away for the weekend and you want to record two movies that are scheduled to be shown during that time. One is on HBO on Saturday night; the other on Showtime on Sunday morning. Setting up the VCR to record the first movie is no problem: Set the cable converter to the channel for HBO, and set up the VCR to record the converter's output channel (usually either channel 3 or 4) at the appropriate time.

But what about the second movie? There's no way to change the channel output by the converter, and thus no easy way to record both channels. Of course, if you are only interested in the basic, non-scrambled services, you can get around that problem on some cable systems by using a cable-ready VCR. But to view the premium, scrambled services such as HBO, Showtime, etc., you must still use the cable-converter, limiting you to but a single channel—unless you own a *Cablemaster* from JNEL (792 S. Main Street, Mansfield, MA 02084).

The *Cablemaster*

The *Cablemaster* is designed to be used with an infrared remote-controlled cable converter (it cannot be used with any other type of cable converter). Perhaps the simplest and most direct way to describe the unit is to call it a timer-controlled infrared remote.

Measuring roughly half the size of a typical cable converter, it is programmed in much the same way as a VCR is. Here, however, what you are programming is the cable channel you wish to record, the time and day you wish recording to start, and the length of the recording time. In response to those instructions, the *Cablemaster* turns on the converter, selects the appropriate channel, and turns the converter off

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 110.

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

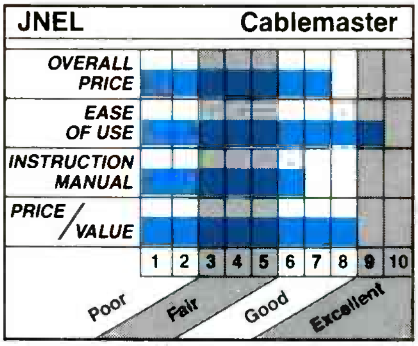
FROM THE WORLD LEADER IN DIGITAL MULTIMETERS.

FLUKE®

when recording is finished.

The unit features an 8-event, 14-day timer. It is set in much the same way a VCR timer is set, using just five pushbutton controls. Time, channel selected, mode of operation, etc. are displayed on an LED readout. Both the readout and controls are hidden under a flip-up panel when not in use.

Obviously, since all communications between the unit and the converter are via infrared signals, there are no connections between the two units. That does not mean, however, that there are no installation considerations. First of all, cable-TV systems do not all use the same infrared units. In fact, there are many different infrared remote-controlled converters used by cable-TV companies. And, of course, each uses its own particular infrared "code" for communications. Thus, each *Cablemaster* must be "customized" for use with your particular converter. That is done via a plug-in module that



JNEL calls a "personality module." By tackling that problem in that way, the manufacturer has made sure that the unit will not become obsolete if your cable company changes equipment. If that should happen, merely remove the old module and replace it with the appropriate new one. One personality module is included with the unit; additional ones can be ordered from the manufacturer. Currently, personality modules are available for almost all converters in common use.

Another installation consideration is the placement of the unit. Since communication is via an infrared link, that obviously means that the *Cablemaster* must be placed so that the cable converter can "see" the infrared signals. For situations where that is difficult or undesirable, a "remote sender" is included. Simply an infrared transmitter that is connected to the main unit via a 5-foot cable, the remote sender allows the *Cablemaster* to be placed on top of, next to, or even behind the cable converter.

The manual that accompanies the unit is pretty much standard fare for that type of equipment. It tells you how to set up and use the unit, and about the manufacturer's 90-day warranty, but nothing else.

Admittedly, this may not appear to be the most "elegant" way to solve the VCR programmability problem. After all, it requires that two units—the *Cablemaster* and the VCR—be programmed for coordinated operation. However, the approach is simple, and it works.

The *Cablemaster*, with remote sender, wall-plug power supply, and one personality module, sells for $99.95. **R-E**

continued on page 30

MUST LIQUIDATE
Commodore Compatible Total Telecommunications™
MODEM

FCC Approved

- ***Access the stock market, take college classes, do your shopping, and a whole lot more!***
- ***For Commodore 64K or SX64!***
- ***Has modular jacks for quick, easy hookup to your phone system!***
- ***Works on TouchTone® and Rotary (Pulse) dialing system (not PBX)!***
- ***Factory Reconditioned With Warranty!***

This single communications package connects your Commodore 64K or SX64 for on-line telephone use. No special computer knowledge is required. Super-intelligent software is completely menu-driven! Plus, this reconditioned modem carries a **90-Day Limited Factory Warranty!**

Features: 30K software buffer, 300 Baud, auto dial, auto answer helps eliminate complex modem steps. Works on Tone and Rotary phone systems (not PBX). Upload and download of text, programs, data files. Prints or stores downloaded files. Captures and displays high resolution, mapped graphics files. Color selection menu. Connect-time clock keeps track of log-on time. ASCII or Commodore characters. Smooth screen rolling. Includes 6-ft. modular phone cord. **Equipment needed:** C64, Monitor, and disk drive or SX64.

NOTE: Price includes trial subscription to over 52 data base services for vast information. Initial sign-up fee is FREE. All you pay for is the on-line time you use, plus monthly rate.

Original List Price: $109.95

Liquidation Priced At $19

Item H-888-63646-01 Ship, handling: $4.00

Price subject to change after 60 days. Sales outside continental U.S. are subject to special conditions. Please call or write to inquire.

Credit card customers can order by phone. 24 hours a day. 7 days a week VISA MasterCard

Toll-Free: 1-800-328-0609

Your check is welcome! No delays in orders paid by check.

C.O.M.B. CO.® Item H-888-63646-01
14605 28th Ave. N./Minneapolis, MN 55441-3397

Send ____ Modem(s) at $19 each plus $4.00 each for shipping and handling. (Minnesota residents add 6% sales tax. Allow 3-4 weeks for delivery. Sorry, no C.O.D. orders.)

☐ My check or money order is enclosed. (No delays in processing orders paid by check, thanks to TeleCheck.)

Charge: ☐ MasterCard® ☐ VISA

Acct. No. ____________ Exp. ______

PLEASE PRINT CLEARLY

Name ____________

Address ____________

City ____________

State ____________ ZIP ______

Phone ____________

Sign Here ____________

C.O.M.B. CO.®
Authorized Liquidator
14605 28TH AVENUE NORTH
MINNEAPOLIS, MINNESOTA 55441-3397

MUST LIQUIDATE!
LIMITED INVENTORY OF ULTRA FAMOUS
64K COMPUTERS
AT FAR BELOW DEALER COST!

A GREAT GIFT FOR STUDENTS!

Factory Reconditioned with Warranty.

Monitor is not available. See footnote.*

Millions sold at regular prices . . . and STILL being sold at regular prices!

Sorry, we're NOT permitted to print the brand name. But if you phone us, all details can be divulged.

Phone Toll-Free: 1-800-328-0609

PLENTY OF SOFTWARE AVAILABLE! Thousands upon thousands of programs are available for it from computer stores across the nation.

FOR BUSINESS! This is an ideal entry level business computer. Use the computer for word processing, data base, accounts payable/receivable, general ledger, payroll, inventory, tax accounting, spreadsheets, mailing lists . . . and much, **MUCH** more!

FOR EDUCATION! Perfect for everyone from Ph.D. candidates to preschool youngsters. A vast number of programs are available to challenge and educate the mind.

FOR HOME! Use for analysis of personal investments, income tax planning, storage of recipes and household data. And of course, there are **hundreds** of exciting, fast-paced arcade games available!

Units sold SINGLY or in any combination you desire.	Original List Price	YOUR COST
64K COMPUTER Item H-887-63553-00	$200.00	**$99**
DISK DRIVE Item H-887-63553-01	$269.00	**$149**
PRINTER Item H-887-63831-00	$200.00	**$118**
We reserve the right to limit quantity purchases. **TOTAL**	$669.00	**$366**

COMPUTER
64K RAM. 20K ROM standard (includes operating systems and BASIC interpreter). Text characters. High resolution graphics. 320 x 200 pixels. Music synthesizer produces 3 independent voices, each with a range of 9 octaves.

Typewriter keyboard with 66 keys for upper and lower case letters, numerals, symbols, reverse characters. 2 cursor control keys. 4 function keys, programmable to 8. Input/output ports for user, serial, ROM cartridge, 2 joystick/paddles, video, cassette drive interface. 16 background, border, character colors.

DISK DRIVE
Intelligent, high-speed. External 5¼" floppy diskette recorder. 2K RAM, 16K ROM. Maximum storage of 170K formatted data; 35 tracks. Uses single sided, single density disk. Serial interface. Second serial port for chaining second drive or printer. Data transfer rate of 400 bytes per second.

DOT MATRIX PRINTER
Bi-directional 6x7 dot matrix impact printer. 60 characters per second. Has upper and lower case letters, numerals and symbols. All PET graphic characters. Standard friction feed. Maximum of 80 columns width, dot addressable. CBM ASCII character codes. Original plus maximum of two copies. Paper width: 4.5" to 8.5". Size: 13"W x 8"D x 3¼"H. Weight: 6½ lbs. Power requirements: 120 volts AC, 60 Hz.

Factory Reconditioned With Factory Warranty.

*NOTE: If you do not have a monitor, you can use your TV as a display unit. The computer comes already to be hooked up to your TV.

Credit card customers can order by phone. 24 hours a day. 7 days a week VISA MasterCard

Toll-Free: 1-800-328-0609

Your check is welcome! No delays in orders paid by check.

C.O.M.B. CO.®
Authorized Liquidator
14605 28TH AVENUE NORTH
MINNEAPOLIS, MINNESOTA 55441-3397

C.O.M.B. CO.® Item H-887
14605 28th Ave. N./Minneapolis, MN 55441-3397

Send the following items. (Indicate quantity of each.)
____ 64K Computer(s) Item H-887-63553-00 at $99 each plus $8 each for shipping and handling.
____ Disk Drive(s) Item H-887-63553-01 at $149 each plus $8 each for shipping and handling.
____ Printer(s) Item H-887-63831-00 at $118 each plus $7 each for shipping and handling.

(Minnesota residents add 6% sales tax. Allow 3-4 weeks for delivery. Sorry, no C.O.D. orders.)

☐ My check or money order is enclosed. (No delays in processing orders paid by check, thanks to TeleCheck.)

Charge: ☐ MasterCard® ☐ VISA

Acct. No. ____________ Exp. ______

PLEASE PRINT CLEARLY

Name ____________

Address ____________

City ____________

State ____________ ZIP ______

Phone ____________

Sign here ____________

A NEW BREED OF HIGH-PRECISION, high-performance, yet moderately-priced multimeters has slowly been infiltrating the electronics scene. These meters combine 4½-digit precision, true RMS measurement capability and microprocessor control. Not too many years ago, a 4½-digit voltmeter going for a price like that of the *4750* would have been perceived as an uncommon value. But, as in so many other areas of electronics, the microprocessor lowers costs and at the same time provides previously undreamed-of utility.

Triplett's *Model 4750* is one such DMM. It measures AC and DC voltage in five ranges (to 750 and 1000 volts, respectively), AC and DC current in two ranges (250 mA and 10 A for both AC and DC), and resistance in six ranges (to 25 megohms). Voltage and resistance ranges may be selected manually, or automatically by the *4750*. The 250 mV range allows a resolution of 10 μV for both AC and DC measurements; 100 mv resolution is obtainable on the highest ranges (750 and 1000 volts).

Accuracy of the *Model 4750*

DC voltage accuracy is between 0.04% and 0.05% for all ranges. AC voltage accuracy is ±1% over the audio frequency range (10 Hz to 20 KHz). It is important to understand that the *4750* measures and displays AC voltages as true RMS values. Most DMM's measure the *average* value and multiply it by 1.11 to obtain an RMS value for display. That leads to severe errors when measuring anything but low-distortion sinewaves. However, the *4750* measures and displays the true RMS values of triangular waves, squarewaves, half- and full-wave rectified sinewaves, and pulses of variable width.

So far so good, but many DMM's offer comparable measurement accuracy. What really distinguishes the *4750* DMM is its ability to measure frequency, temperature and dBm, and its data-hold, peak-hold and relative display modes.

Special features

The *4750* measures frequency in one of four automatically selected ranges from 99.999 Hz to 99.999

KHz at an accuracy of ±0.05%. In the 10-Hz range, 4½ digits of precision gives a resolution of 0.001 Hz; and in the highest range you get a resolution of 1 Hz. In the frequency mode, the range keys select input attenuation, and allow you to measure up to ±1000 volts peak. Input impedance in the low range exceeds 1000 Megohms, and in the other ranges is about 10 Megohms.

Temperature can be measured using a standard K-type thermocouple probe; the *4750* can display temperature in either Fahrenheit (−58°–+2192°) or Celsius (−50°–+1200°), both at a resolution of 1°, and both at an accuracy of 0.5% of the current reading.

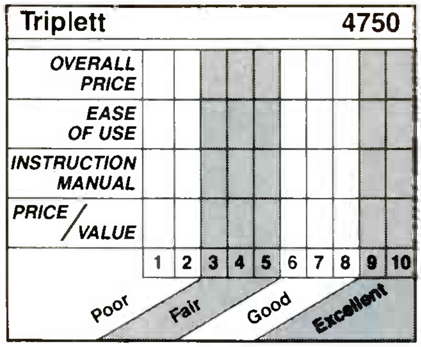
Relative voltage levels may be read using the dBm function; 0 dBm corresponds to a level of 0.7746 volts RMS at 600 ohms and 1 mW. As with frequency measurement, the *4750* automatically selects the proper range for you.

The DATA-HOLD and PEAK-HOLD functions really increase the versatility of this DMM. Pressing the DATA-H switch freezes the value currently displayed by the LCD (except when measuring frequency). In the PEAK-HOLD mode, the display is frozen at its current value, and is only updated if that value is exceeded. PEAK-HOLD works in the manual mode only; you may use it to measure AC or DC voltage or current, and temperature.

Similarly, you may measure AC or DC voltage or current, and resistance in the RELATIVE mode. When you press the REL switch, the value currently displayed by the LCD will be taken as a reference, and subsequent values will be displayed relative to that value. For example, if you press the REL switch when the display reads 10.000 volts, a subsequent input of 15.000 volts will display as 5.000 volts, and a 5.000 volt input will display as −5.000 volts. You may use the REL switch when making resistance measurements to cancel out the effects of lead resistance.

Convenience features

The *4750* includes a number of features that make it a pleasure to use. One such feature is the continuity checker that beeps if the circuit under test has a resistance of less than about 20 ohms. The *4750* also has a diode-check function that feeds a 1-mA current through the device under test; the meter then displays the forward voltage drop of that device. Also included are an auto-polarity indicator and a 3½ digit display mode.



The mechanics

At power-up the *4750* is set to measure DC voltage in the autoranging mode. Other measurements are selected by means of a 20-key membrane keypad. The ½-inch high digits make the LCD display quite readable; the display also has several small annunciators that indicate the quantity currently being measured, special modes etc.

The *4750* weighs about 3/4 pound (with standard nine-volt battery in place), and measures about 7 × 3½ × 1½ (all dimensions in inches.) It includes a convenient tilt stand and recessed safety probe-input jacks. The *4750* also includes an input jack for an AC adapter (power drain is about 50 mW) and another for a special "touch-hold" probe that allows the data-hold function to be activated without having to move your hands from the circuit to the *4750's* keypad. A 40-page instruction manual is included; its organization leaves something to be desired, and there is no index. But the necessary material is covered more or less adequately. No schematic is included.

So if you're looking for a high-performance DMM with many convenience features, consider the Triplett *4750*. We recommend it. The *4750* lists for $340. For more information, contact Triplett Corporation, One Triplett Drive, Bluffton, Ohio 45817. **R-E**

Your guide to everything that's new in electronics, computers and technical education. Over 400 items. Discover fascinating kits to build, enjoy and learn with, as well as assembled high tech products for home, business and hobby.

Get our famous High Tech Catalog FREE

Heath Company
Dept. 020-364
Benton Harbor, Michigan 49022

MAIL COUPON TODAY and receive the latest issue of the Heathkit Catalog free of charge

Name ____________________

Address ____________________

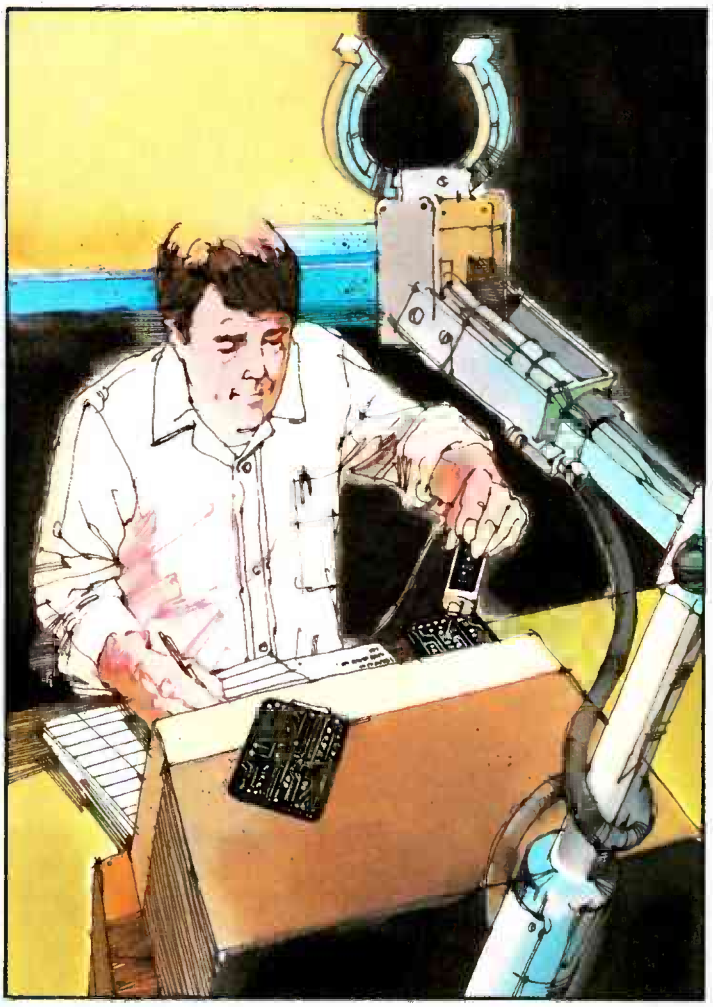
City ____________________ State __________

CL-783B Zip __________

Heathkit®
Heath Company

A subsidiary of Zenith Electronics Corporation

CIRCLE 86 ON FREE INFORMATION CARD



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.

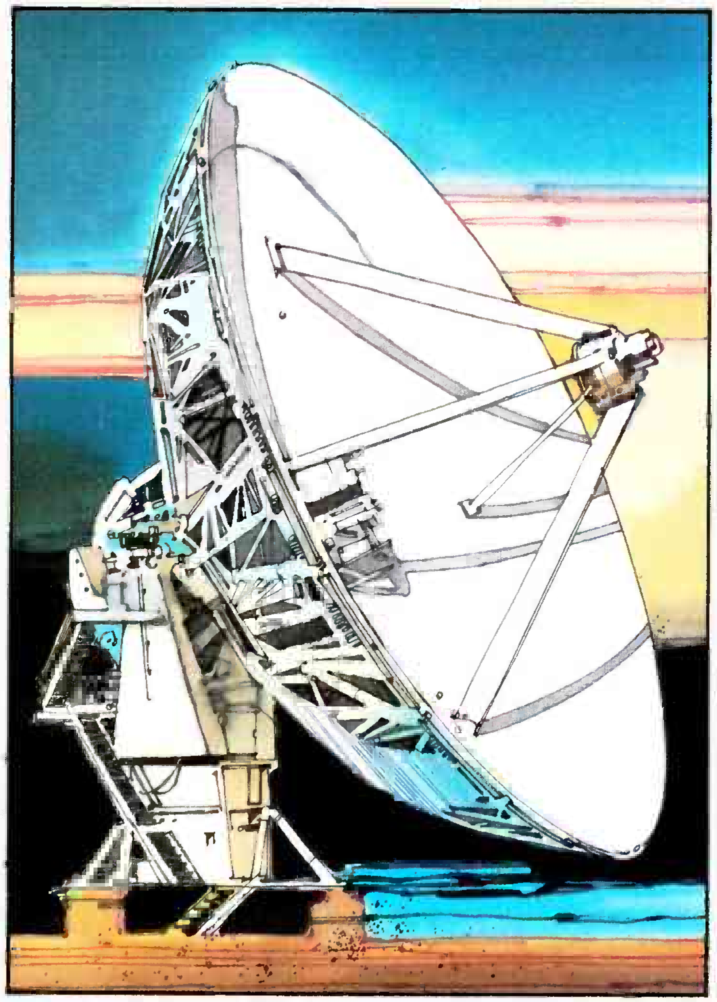
Leading the world in specialized electronics training, CIE is the largest school of its kind with over 25,000 students at home and abroad. And with over 50 years of experience teaching electronics to thousands of men and women through proven methods of independent study **without** classroom sessions.

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



with electronics?

anything.

, So most of our courses include special-
training laboratories keyed to specific less-
or practical experience through teaching
eriments. Our CIE Microprocessor, for
xample, comes fully assembled and ready to
ise to teach you how a computer CPU works
nrough a series of experiments you perform
on your own.

Are you ready?

if you're ready to do something now about your
future, there's no waiting to enroll with CIE. Get
all the information you need to enroll simply by
calling us toll-free at **1-800-321-2155** (in Ohio,
-800-362-2105). Or mail in the handy reply
coupon or card to Cleveland Institute of
lectronics, 1776 East 17th Street, Cleveland,
hio 44114.

NEW IDEAS

This electronic metronome emphasizes the downbeat!

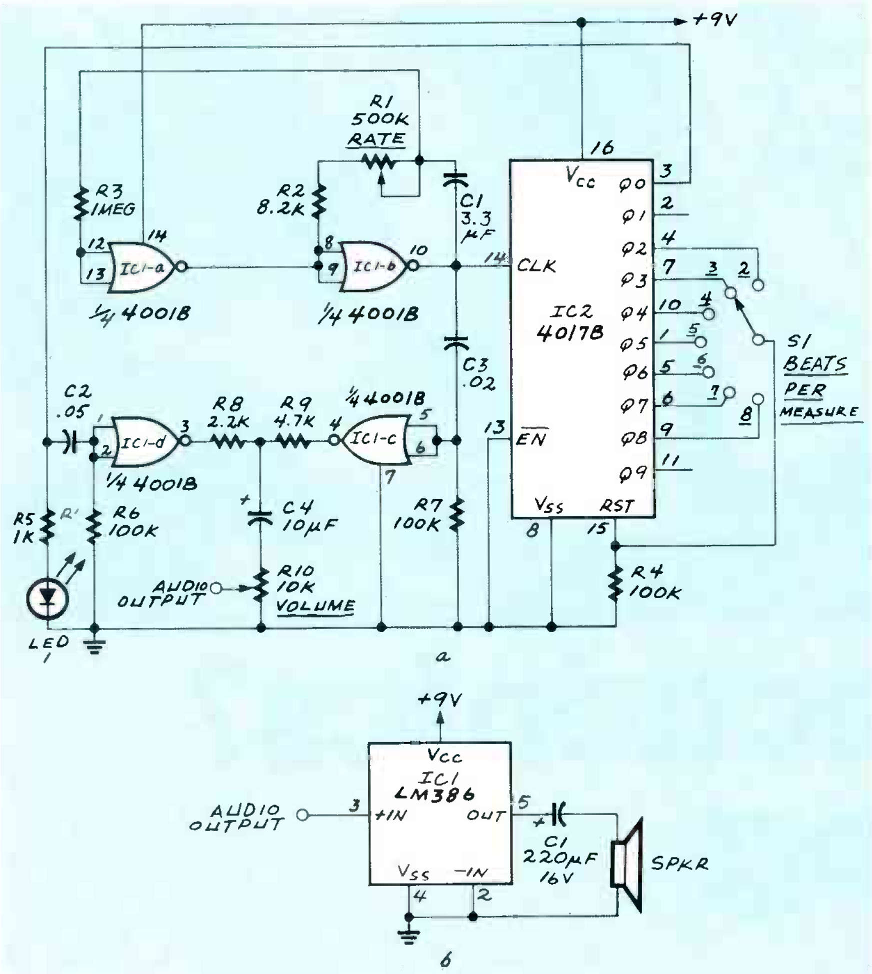
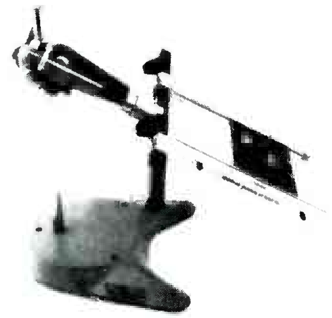


FIG. 1

ELECTRONIC METRONOMES HAVE LONG been popular with both electronics experimenters and musicians with a practical bent. All metronomes provide a steady stream of pulses, but few accent the first beat of the measure—the downbeat. The metronome presented here does, and it allows you to vary the counting rate from about 1 to 200 beats per minute. A rotary switch allows you to select an emphasized beat every other beat, every third beat, etc., all the way to once every nine beats.

As shown in Fig. 1-*a*, IC1-a and IC1-b form an astable multivibrator whose period of oscillation is approximately equal to 1/(2.2 × C1 (R1 + R2)). The astable's signal is fed to IC1-c, which buffers the signal for further amplification. The astable's output is also fed to the CLOCK input of IC2, a 4017B (a 4017A is also suitable) decade counter. That IC's Q0 through Q9 outputs go high one at a time for each successive clock pulse received at pin 14. Switch S1 feeds one of those outputs to the 4017B's RESET input; whenever the selected output goes high, the 4017B restarts its counting cycle. That is what deter-

continued on page 111



PHILIPS KEITHLEY WESTON NLS Non-Linear Systems Simpson B+K PRECISION LEADER

FLUKE SERIES 70 MULTIMETERS

77

- 0.3% Accuracy
- Manual or Autorange
- 10A + mA Range
- Beeper
- "Touch-Hold" Function

Sale (with holster) **$119.95**

- Analog Display • Rotary Knob • Volts AC & DC • Resistance to • 32 MΩ • 10 Amps • Diode Test • 3200 Counts • Fast Autoranging • Function Annunciators in Display • Power-Up Self Test • 2000 + Hour Battery Life w/ Power Down "Sleep Mode" • New Test Leads • VDE & UL Approval

WE CARRY A FULL LINE OF FLUKE MULTI-METERS.
IN STOCK NOW

SALE ENDS DEC. 85

SALE **$89.95**

75

- 0.5% Accuracy
- Manual or Autorange
- 10A + 300 mA Range
- Beeper

SALE **$79.95**

and free C70 holster 73

- 0.7% Accuracy
- Autorange Only
- 10 Amp Only

4½ DIGIT MULTIMETERS

$349.00

MODEL 8060A

FLUKE

- Frequency measuements to 200KHz
- dB measurements
- Basic dc accuracy 0.4%; 10μV, 10 nA and 10 mΩ sensitivity
- Relative measurements
- True RMS
- High-speed Beeper

B+K PRECISION

100 MHz Dual Time Base SCOPE

MODEL 1590

$1395.00

PRICE DOES NOT INCLUDE PROBES

- 1mV/division sensitivity to 70 MHz
- 500 μ V/division cascade sensitivity
- Four-input operation provides trigger view on 4 separate inputs
- Alternate time base operation
- Switching power supply delivers best efficiency and regulation at lowest weight

B+K PRECISION

INDUSTRIAL TRANSISTOR TESTER

$219.95

MODEL 520B

- Now with HI/LO Drive
- Works in-circuit when others won't
- Identifies all three transistor leads
- Random lead connection
- Audibly and visually indicates GOOD transistor

B+K PRECISION DYNASCAN CORPORATION

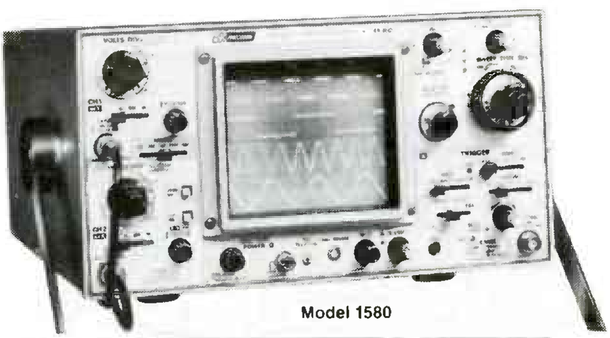
BREAKS THE PRICE BARRIER WITH THESE HIGH PERFORMANCE OSCILLOSCOPES

100 MHz Dual Trace/ Dual Time Base

- 1 mV/div sensitivity
- 23 calibrated sweeps
- Rectangular CRT with internal graticule and scale illumination
- Signal Delay Line

$995

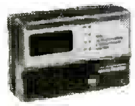
Does not include probes
($60.00 a pair when purchased with scope)



Model 1580

QUANTITIES ARE LIMITED

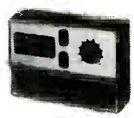
CAPACITANCE METERS



$209.95

MODEL 830

- Automatically measures capacitance from 0.1pF to 200mF
- 0.1pF resolution
- 0.2% basic accuracy
- 3½ digit LCD display



$169.95

MODEL 820

- Resolves to 0.1pF
- 4 digit easy-to-read LED display
- Fuse protected against charged capacitors
- Overrange indication

DATA PRECISION · HITACHI · TRIPLETT · FLUKE · AWS · DORIC · HICKOK · VIZ

BECKMAN'S CIRCUITMATE®
ALL UNDER $100

AVAILABLE NOW. . . .

The DM73 is the smallest digital multimeter on the market. Its probe-style design makes it ideal for taking measurements in hard-to-reach test areas.

SALE $59.95

- Small Size
- Complete Autoranging
- "Touch Hold"
- Audible continuity checking

$64.95

Circuitmate DM 20— 3½-digit, pocket-size multimeter; 0.8% Vdc accuracy, diode test, hFE test, conductance, 10 amps AC and DC ranges, auto-polarity auto-zero, auto-decimal

$69.95

Circuitmate DM-40 — 3½-digit multimeter; 0.8% Vdc accuracy, diode test, auto-polarity, auto-zero, auto-decimal

$89.95

Circuitmate DM 45 — 3½-digit multimeter; 0.5% Vdc accuracy, diode test,continuity beeper, 10 amps AC and DC ranges, auto-zero, auto-polarity, auto-decimal

$79.95

Circuitmate DM-25— 3½ digit, pocket-size multimeter; 0.5% Vac accuracy, diode test, capacitance, continuity beeper, conductance, 10 amps AC and DC ranges, auto-polarity, auto-zero, auto-decimal

$76.95

The DM 77 gives you the convenience of autoranging plus 10 amps ac/dc measurement capability. You simply select the function you want, and the DM 77 automatically sets the required range.

SUPER REBATES ON B&K SCOPES CALL NOW

REBATE ENDS DEC. 31, 1985

...*Quality and* Performance Beckman *and* 4½ Digits...

MODEL 4410

True RMS

$239.00

AVAILABLE NOW!

BECKMAN does it again...a true RMS 4½ DMM w/1 year calibrated cycle at a 3½ digit price.

NEW Beckman Circuit-mate DM10

$39.95 in stock now

Model DM 10B with Beeper $49.95

B+K PRECISION POWER SUPPLIES

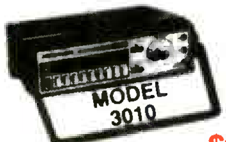
$319.95 MODEL 1601

- Isolated 0-50VDC, continuously variable; 0-2A in four ranges
- Fully automatic shutdown, adjustable current limit
- Perfect for solid state servicing

$339.95 MODEL 1650

- Functions as three separate supplies
- Exclusive tracking circuit
- Fixed output 5VDC, 5A
- Two 0 to 25VDC outputs at 0.5A
- Fully automatic, current-limited overload protection

FUNCTION GENERATORS



$199.95

- Sine, square and triangle output
- Variable and fixed TTL outputs
- 0.1 Hz to 1MHz in six ranges
- Push button range and function selection
- Typical sine wave distortion under 0.5% from 1 Hz to 100kHz

MODEL 3020 **$329.95**

SWEEP FUNCTION

- Four instruments in one package — sweep generator, function generator, pulse generator, tone-burst generator
- Covers 0.02Hz-2MHz
- 1000:1 tuning range
- Low-distortion high-accuracy outputs

TOLL FREE HOT LINE
800-223-0474

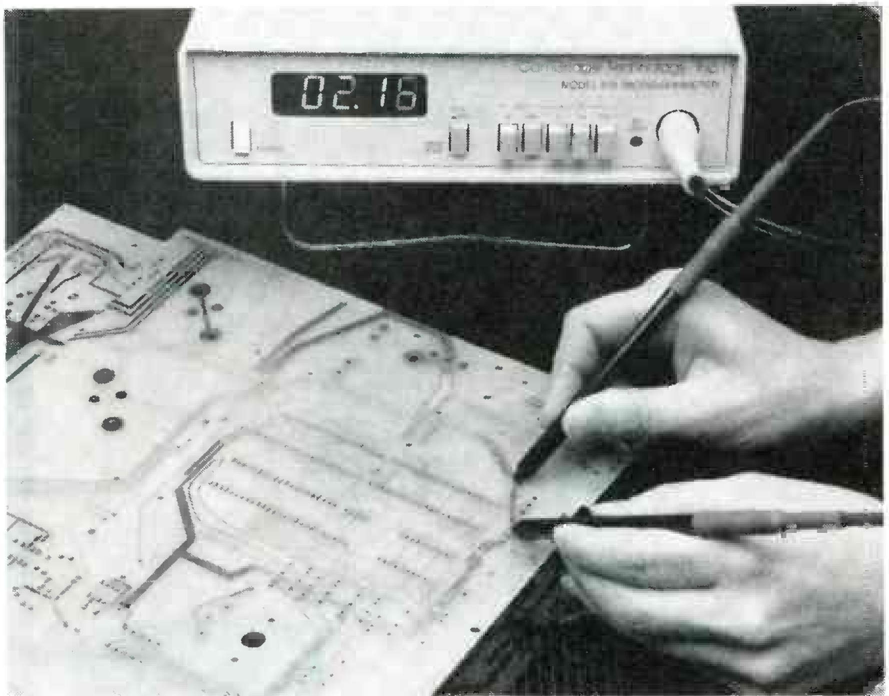
212-730-7030

26 WEST 46th STREET, NEW YORK, N.Y. 10036

THE TEST EQUIPMENT SPECIALISTS

ADVANCE ELECTRONICS

NEW PRODUCTS



CIRCLE 21 ON FREE INFORMATION CARD

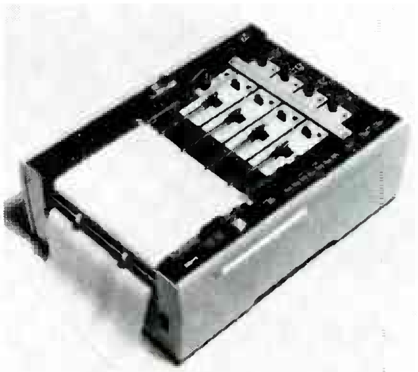
MICRO-OHMMETER, model *510*, is a 4-1/2 digit micro-ohmmeter designed to measure the resistance of switch and relay contacts, precision resistors, transformer and motor windings, connectors, or any other low-resistance devices. It has five ranges, from 19.999 milliohms to 199.99 ohms full scale, 1 micro-ohm resolution, and a basic accuracy of 0.02%. A parallel BCD interface is also provided.

Three measurement modes are provided. The continuous DC mode is useful for measuring the resistance of inductive components; the switched DC mode removes the effect of thermal voltages, the largest source of error in low-resistance measurements; and a pulsed mode is provided for thermally sensitive devices like fuses.

The model *510*, with standard probes, is priced at $895.00. It is also available with model *506* micro-probes, at $945.00.— **Cambridge Technology, Inc.,** 2464 Massachusetts Avenue, Cambridge, MA 02140.

THERMAL WRITING OSCILLOGRAPHS, the *8K20 Series*, feature large LED elapsed-time readout, frequency response to 125 Hz, long-life thermal pens, and 2 to 16 channels of recording. The recorder is available with either 40-mm or 80-mm galvanometers in seven different mainframes.

Three types of input amplifiers are available: high gain, low gain, and direct fixed range with sensitivities from 0.5 mV/cm to 200 volts/cm. Paper speeds are selectable from 500 mm/second to 1 mm/minute., and timing intervals available are 0.1 second, 1 second, 0.1 minute, or 1 minute. Several of these recorders may be slaved to a master *8K20* recorder using the timing-signal output to increase the number of channels recorded synchronously.



CIRCLE 22 ON FREE INFORMATION CARD

Also standard on this recorder are: a character printer that can print the date and data record number, elapsed time, and will also accept and print an ASCII type input; automatic electronic over-range protection; event marker; simultaneous pen lift, and provision for roll or Z-fold chart paper. Remote control of chart drive, pen heat on/off, paper-drive synchronizer, timing marker, and event marker is also standard. Additionally, this recorder provides timing, record on/off, and record-status outputs. Optional are: a paper take up, a standard 19-inch rackmount adaptor, and a paper rewinder.

The *8K20 Series* is priced from $3475.00.— **Soltec Corporation,** 11684 Pendelton Street, Sun Valley, CA 91352.

PC-BOARD LAYOUT KIT, model *G5024PC*, is based on a 18" × 24", blond-hardwood light box with a fitted royal blue carrying case. The case features dual zipper closure, and a full-size pocket with zipper

continued on page 112

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 0314 $14.95

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 AMPLIFIER

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 ~~$45.95~~ $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 ~~$45.95~~

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 and Shipping Charge Schedule

FOR ORDERS	ADD
$25-250	$4.50
$251-500	$6.50
$501-750	$8.50
$751-1,000	$12.50
$1,001 and up	$15.00

What's New in DIGITAL IC's

Want to learn about 1985's most interesting developments in digital IC's? Read on!

ROBERT GROSSBLATT, CIRCUITS EDITOR

IF WE HAD TO SUM UP 1985'S OVERALL trend in digital IC development, we would have to say "faster, less power consumption, and smaller." 1985 also saw a continuation of the trend to push CMOS to its limits—and beyond. It's safe to say that, although we haven't really approached those limits yet, the semiconductor industry is working hard to get there as quickly as possible.

The majority of new digital IC's are CMOS, and the majority of those that aren't CMOS are faster versions of IC's already in production. Most of 1985's new entries were memory IC's and programmable gate arrays. The most exciting event in 1985, however, has to be the progress attained by the government-sponsored VHSIC (*V*ery *H*igh *S*peed *I*ntegrated *C*ircuits) program.

VHSIC and the feds

The Pentagon began its VHSIC program in 1980; it is scheduled to continue until 1990. Eight companies are involved in the program: Honeywell, TRW, Hughes, IBM, Texas Instruments, Motorola, National Semiconductor, and Westinghouse. From the beginning, VHSIC's main goal has been to increase the maximum operating speeds of integrated circuits. That goal was to be approached in two stages: operating speeds of 25 MHz, then speeds of 100 MHz.

The first stage was attained in 1985; VHSIC contractors are now producing and delivering 25-MHz IC's. Those high speeds have been attained by reducing IC trace width. The industry standard is about three microns, although some manufacturers have *selected* parts available with two-micron spacing. TI, AMI, and National are among the companies producing custom gate arrays with two-micron spacing.

By contrast, phase one of the VHSIC program was achieved by developing IC's with a spacing of 1.25 microns. The goal of phase two is to attain widths of 0.5 micron Shrinking the trace width does more than just allow an increase in the clock rate; more components can also be squeezed onto the substrate of the IC. Hence, reducing trace widths gives us IC's that can both operate faster and handle more complex tasks.

VHSIC IC's presently being produced for the Pentagon are designed for specific applications. The day you'll be able to call your local supplier and order standard gates with 25-MHz operating speeds is still some time in the future. But in the past, restricted government technology has tended to migrate—eventually—to the civilian market, so it's only a matter of time until VHSIC parts become commonly available.

However, that's not to say that the VHSIC contractors have ignored the commercial market altogether. Honeywell, for example, has signed a licensing agreement with ETA Systems to market the HC20,000, shown in Fig. 1. It is a CMOS array containing 20,000 gates. The HC20,000 uses Honeywell's CMOS HI technology to attain 1.25-micron trace spacing.

Of the 20,000 gates on the chip, 18,000 are available for user programming: the remaining 2,000 gates are used by ETA's proprietary BEST (*B*uilt-in *E*valuation and *S*elf *T*est) system, a diagnostic and test-pattern generator that will run user simulations of the IC at full operating

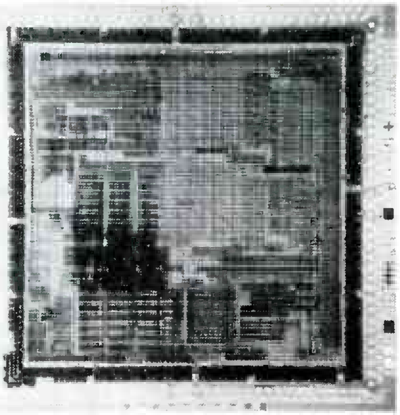


FIG. 1—HONEYWELL'S HC20,000 GATE ARRAY is a CMOS part that has 20,000 gates, 1.25-micron spacing, and built-in self-test capability.

speed—25 MHz. The BEST system can feed the IC with four pseudo-random test patterns, one per clock cycle, and store the resulting checksum in onboard registers.

The CMOS III technology allows internal gate delays of a staggeringly low 400 picoseconds. As Honeywell points out, that makes the HC20,000 the fastest high-density gate array currently on the market. Such high speed doesn't come cheaply, of course; when the first production parts become available early in 1986, the price is expected to be at least $300.

The manufacture of VHSIC components involves unique fabrication, production, and environmental problems that are just now beginning to be solved. Once the contractors work those problems out, VHSIC parts will become generally available, and they will undoubtedly have a major impact on the OEM market.

CMOS memory

The introduction of new IC's is always done with the market place in mind, and the major market for the semiconductor industry has always been, and continues to be, OEM's. New, high-density IC's have always been difficult to sell when they were available only from a single source, even though everyone marvels when a new IC replaces an entire circuit board. However, the decision to redesign for such a new IC is a major one for OEM's. They worry about being able to obtain proper quantities of such new parts when they need them. Hence it's interesting to note that several companies introducing new IC's this year are announcing second sourcing at the same time.

National Semiconductor, for example, introduced the NMC27C256 this year; it is a 256K byte-wide (32K by 8) CMOS EPROM with access speeds as low as 200 nanoseconds. They also announced that the part would be available from VLSI Technology as the VT27C256. National's second-sourcing arrangements are not the whole story, however. Development of the 27C256 was a joint effort: National designed the IC, and VLSI Technologies developed the manufacturing process. That significantly reduced the time needed to get the IC into production, reduced the cost of development, and, as a result, lowered the IC's price.

One-megabit ROM

Mostek introduced the MK3901M, a one-megabit ROM with standard address- and data-bus multiplexing. Internal storage arrangements are unique in that a control pin allows you to organize the IC's memory matrices as either 128K × 8 or 64K × 16. Obviously, Mostek has both the 8- and the 16-bit computer markets in mind.

The MK3901M comes in a standard 28-pin package, and has an access time of 120 nanoseconds. Mostek achieved those feats by using 1.5-micron spacing and double-level metal fabrication techniques. Typically, initial pricing is high: about $55.00 in 1000-piece lots. But as the MK3901M gains in popularity, that price is certain to fall considerably.

High-speed RAM

Intel uses a similar fabrication technology in their double-metal CHMOS III process to produce the 51C66 and the 51C67, 16K × 1 static RAM's with access times of 35 nanoseconds. Both parts are housed in the industry-standard 20-pin package, so those IC's are pin-compatible replacements for standard 16K × 1 memories such as the 2167.

The two parts differ in that the 51C67 has the automatic power-down feature introduced by Intel with their 2147H some years ago. That feature is completely transparent to the user of the IC; it can result in a 90% savings over the already low power requirements of the CMOS family.

Automatic power-down works as follows. One clock cycle after the 51C67 is three-stated by putting a high on its SELECT pin, the IC automatically goes into its power-down, data-retention mode, where it stays until the IC is again enabled. The difference in current drain is impressive. The IC uses 60 mA when active, but only 3 mA during power down.

CMOS DRAM and controller

Although many CMOS DRAM's were introduced in 1984, 1985 saw a dramatic increase in CMOS storage capacity. The 51C64 and 51C256 from Intel (and similar parts available from other manufacturers) are CMOS IC's that are pin compatible with the familiar NMOS 4116's and 4164's.

With CMOS DRAM becoming available, CMOS memory controllers couldn't be far behind. Intel's 82C08 is a pin-compatible CMOS version of their 8208. It can directly control dynamic RAM parts as large as 256K, and, like many CMOS parts that appeared this year, it has a power-down mode in which only the refresh circuitry operates. Energy savings are substantial; 60 mA is used in the active mode, but only 1 mA in the power-down mode.

Undoubtedly, the 82C08 will most commonly be used with microprocessors. Although it works well with eight-bit CPU's, the fact that it can directly control as much as 1 megabyte of memory shows that it was designed with sixteen-bit microprocessors in mind. And that's not surprising considering that Intel is the prime source for the 8088 microprocessor used in the IBM PC.

Non-volatile RAM

Over the years manufacturers have tried to design memory components that have the ease-of-use characteristics of static RAM, and that also retain data when power is removed. As CMOS technology has improved, the amount of power needed for data retention has been reduced drastically. Today, a few microamps are often enough to ensure complete data retention. Mostek has introduced what must be the ultimate memory of that type: the MK48Z02. As shown in Fig. 2, it is a 2K × 8 CMOS static RAM similar to the familiar 6116.

The IC differs from standard CMOS parts in that it is what Mostek calls a "Zeropower" RAM. That means the IC has a built-in power source that provides all the power needed for data retention. The MK48Z02 constantly monitors V_{CC}, and if it falls within the range of 4.5 to 4.75 volts, the IC automatically write-protects itself. If the supply falls below 4.5 volts, the IC completely disables itself: inputs are disabled and outputs are three-stated. If the supply falls below about three volts, one of two lithium cells built in the IC will be connected to the internal storage cells, hence guaranteeing data retention. Special comparator and reference circuitry selects which cell to use, and sets an error flag if either cell falls below two volts.

Shadow RAM

Another non-volatile RAM design is the shadow RAM, which provides invisible, automatic back-up of memory by an EEPROM. Xicor has been manufacturing shadow RAM's for several years now, and only recently have they been appearing in consumer-oriented products. Both Hayes Microcomputer Products and Videx, Inc. have used these "Novrams" to store configuration data in their computer products. This year Mostek introduced the MK4701, shown in Fig. 3, a 128 × 8 shadow RAM in a standard 28 pin package.

Mostek's part differs from the competition in that the user has much more flexibility in specifying how the "store"

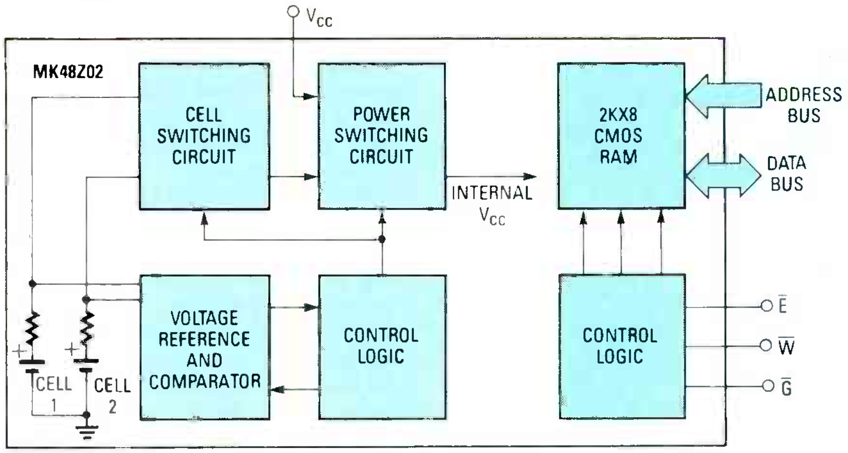


FIG. 2—MOSTEK'S MK48Z02 IS A 2K × 8 CMOS "ZERO-POWER" RAM featuring two built-in lithium cells that automatically supply power to the RAM array whenever power falls below about three volts.

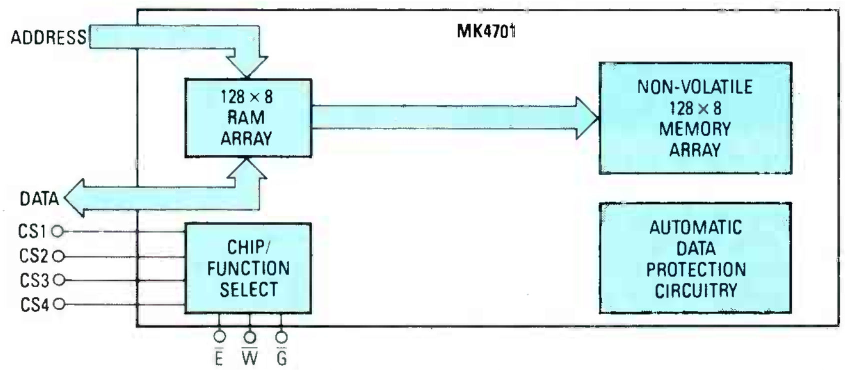


FIG. 3—MOSTEK'S MK4701 IS A 128 × 8 SHADOW RAM with ten-year data-retention capability. Data may be written to the IC more than 10,000 times.

function works. In addition to the software-controlled store command, the MK4701 can be set up to store data automatically whenever it detects a power failure. The trip point for the Auto Store function can be adjusted to prevent false triggering.

Mostek added those features to the IC, and still made it pin compatible with the 6116. The MK4701 acts as a normal RAM until the user puts it in a special configuration mode. In that mode, the user writes directly to EEPROM cells outside the normal memory address space, and those cells contain data on the IC's trip point, how the chip-select pins (CS_1–CS_4) function, etc. The access time of that IC (150 nanoseconds) makes it the fastest shadow RAM on the market.

Bubble memory

If you thought that bubble memory was dead and gone, Intel has a surprise for you. They have introduced the BPK70AZ, a complete 128K × 8 bubble-memory subsystem. The complete system is composed of seven IC's:

- 7110AZ, One-megabit bubble memory
- 7230, Current pulse generator
- 7242, Dual formatter/sense generator
- 7250, Coil predriver
- 7254, Quad VMOS coil-drive transistors
- 7220, Bubble-memory controller

The maximum data transfer rate is 100 kilobaud; random access time is 48 ms. If you compare bubble memory speeds with some of the new memory devices discussed above (or older devices, for that matter), bubble memory may not appear to be on the forefront of technology. But if you compare bubble access times to those of floppy disks, bubble looks much better.

Programmable Gate Arrays

1985 will also be remembered as the year that Programmable Gate Arrays (and other customizable IC's) came of age. For some time now, development efforts have concentrated on increasing speed while simultaneously reducing power requirements. Memory devices such as NOVRAM's, ROM's, and PROM's may be used to achieve solutions with microprocessors and software. But other solutions are still possible with old-fashioned logic—gates, flip-flops, and the like.

The two-micron CMOS processes used by many IC manufacturers have enabled them to jam an astounding number of gates onto a single substrate. By fabricating a custom mask for the array, individual gates can be connected together to solve specialized logic problems. The OEM defines the layout of the mask, and the collection of standard logic elements becomes a "custom" part. The advantage for the OEM is that he gets a customized, economical part that can operate at the high speeds associated with simple logic. Of course the entire process is rather complicated as it involves software emulators to design and test the planned array. But the hardware portion is similar to mask-programmable ROM.

AMI has been in the custom-gate-array business since 1966, and their current two-micron double-metal CMOS technology allows single packages to contain as many as 10,000 gates. If that doesn't impress you, you're probably thinking about transistors, not gates. Remember that each gate can contain four or more transistors.

Sceptre II

As you no doubt imagine, designing a custom array can be a lengthy process even with the proper tools. To aid that process, AMI has designed a unique piece of software called Sceptre II, a CAD (*C*omputer *A*ided *D*esign) program that translates user-entered schematic drawings into files that can be processed at AMI to generate array masks.

Sceptre II has several features worthy of mention. First of all it contains an emulation package that allows the user's design to be tested for problems such as bus contention, electrical integrity, and so on. Moreover, unlike similar software from other manufacturers, Sceptre II runs on an IBM PC! The photograph shown in Fig. 4 shows a sample Sceptre screen. After the OEM finalizes the design, a floppy disk is sent to AMI for processing that ultimately results in the array mask.

Other custom arrays

Both National and Mostek (among others) have realized the advantages of custom gate arrays, and both began pushing the technology heavily in 1985. Mostek announced their GB series of gate arrays fabricated with two-micron technology. Available parts range from the MKGB1000D, with the equivalent of 1120 NAND gates, to the MKGB10000D, with 9776 gates. Those IC's have gate delays of only 1.5 nanoseconds! In Fig. 5-*a*, we show a schematic equivalent of one cell, and in Fig. 5-*b*, a representation of the actual layout of one such cell on the IC's substrate. The Mostek LDD/TT fabrication process uses two-micron spacing, but actually produces gate lengths of 1.8 microns.

National's gate-array series, the SCX6200, is built with their two-micron technology called "MicroCMOS." Like

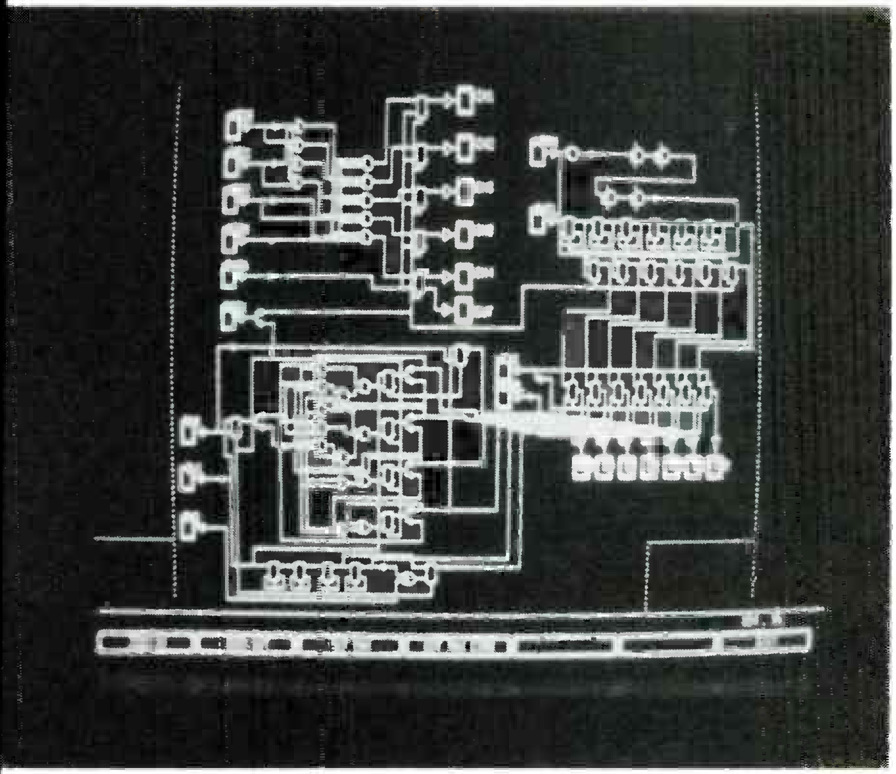


FIG. 4—AMI'S SCEPTRE II PROGRAMMABLE gate-array design program runs on an IBM PC.

Mostek, National has a software design package (with a library of standard gates and macro definitions) that greatly simplifies designing a custom gate array.

Sprague's BiMOS II IC's

Anyone who has ever designed a circuit with CMOS IC's is aware of the output-power limitations imposed by that logic family. Those limitations are a consequence of CMOS's internal construction, and that is one area in which reduced trace widths have no advantage whatsoever. Sprague has solved the problem by distinguishing between pure-CMOS components and CMOS-compatible components. After all, power-handling capability is a problem for an IC's output, not its input.

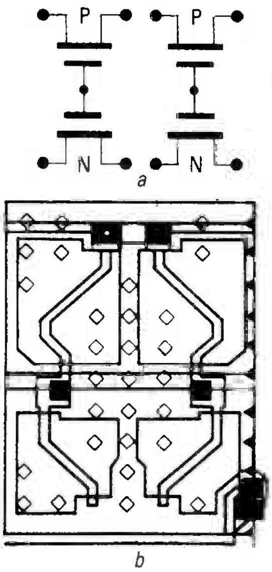


FIG. 5—AN INDIVIDUAL CELL IN MOSTEK'S MKGB1000D series is composed of four individual MOS transistors, as shown at *a*. The actual layout of those transistors is shown at *b*.

Sprague's BiMOS II family of high-speed power drivers is fabricated with seven-micron spacing. (Effort is underway to upgrade to 5-micron BiMOS III). What makes BiMOS IC's unique is that they have CMOS inputs for the data and control lines, as shown in Fig. 6-*a*, and bipolar outputs, as shown in Fig. 6-*b*, for power handling. Sprague thereby maintains CMOS compatibility, and provides IC's like the UDN2545B, a universal quad driver that can deliver 80 volts at 2 amps! That is possible for two reasons: the hybrid CMOS/Bipolar IC configuration and Sprague's special packaging.

Sprague's batwing package is actually an old technique, but it's well suited for increasing thermal transfer from the IC's substrate to the outside world. The internal wafer is mounted on a copper frame; that frame is brought outside the IC as two connected pins on both sides of the package. That allows internally generated heat to exit the IC via a path that is highly thermally conductive.

Other features of the BiMOS family include the kind of chip-enable logic you find in standard CMOS parts; BiMOS components also feature thermal-shutdown and over-voltage protection.

One of Sprague's more interesting 1985 introductions is the UDN2541/42 quad NAND gate. Each gate appears to the circuit driving it as a logic-level input. But each output is a transistor stage composed of non-Darlington saturated outputs controlled by an on-chip variable current source. Each output is protected from inductor transients by surge-surpressing diodes. That allows the IC to drive loads of 1.5 amps at 80 volts.

Sprague's BiMOS II UCN-58XX family contains a variety of latching logic elements with word widths ranging from four to thirty-two bits, in both serial and parallel configurations. All members of the family have high drive capability, and although they're not strictly CMOS parts, the internal configuration is transparent to the user. For example, the UCN-5821A is an 8-bit serial-to-parallel converter with CMOS inputs; the IC's outputs can sink 350 mA at 50 volts.

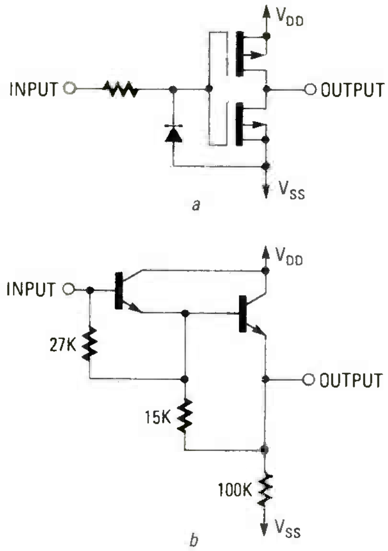


FIG. 6—SPRAGUE'S BIMOS II SERIES of digital and analog IC's makes use of a MOS input stage, like that shown in *a*, and a bipolar output stage, like that shown in *b*.

Conclusions

Tremendous increases in speed have been brought about in 1985, along with complementary decreases in power consumption. As advances continue to be made in digital technology, the result will be an ever-narrowing gap between "digital" and "analog." For example, sampling rates for DAC's are increasing rapidly, so it's only a matter of time before digital-to-analog conversion becomes the first processing step in what used to be exclusively analog applications.

When phase two of the government's VHSIC program really takes off, operating speeds of 100 MHz will become commonplace. And when that happens, the difference between digital and analog may disappear altogether. But for now, analog is still very much with us, so, to find out what's new in that field, turn to the next article and keep on reading. **R-E**

What's New in ANALOG IC's

1985 was not a banner year for analog-IC development; but things haven't exactly ground to a halt, either. Read about some of the year's most exciting innovations here.

ROBERT GROSSBLATT, CIRCUITS EDITOR

THE EXPLOSIVE GROWTH OF THE PERSONAL-COMPUTER market the past few years has caused semiconductor manufacturers to emphasize development of digital integrated circuits to such an extent that one might think development of analog IC's had been discontinued altogether. Well, that's not really the case. There is still quite a bit of analog development going on; in this article we'll discuss some of 1985's more interesting innovations.

Low-power voltage regulators

National Semiconductor's LP2950 is the latest member of their low-power, low-dropout regulator family. It has specifications that are real eye-openers for anyone used to the old LM78XX series. For example, standby current (the amount of current necessary to keep the device functioning in standby mode) is only 75 μA, and dropout voltage (the potential difference between the input and output terminals) is a mere 40 millivolts! Equivalent figures for the LM78XX series are 8 mA and 2 volts! Even National's earlier LM2931 series can't match the specifications of the new LP series. The LM2931's quiescent draw is 0.4 mA, and dropout voltage is 60 mv.

There are two different versions of the LP2950. Either can supply as much as 100 mA of current, but one has an output that is fixed at five volts, and the other has an output that can be varied from 1.25 to 29 volts.

The fixed regulator comes in a three-pin TO-220 package similar to the LM2931. The variable version, however, comes in an eight-pin, modified TO-220 package. The extra pins provide two new functions: power strobing and error flagging. Internal reference circuitry is used to monitor the output voltage. If it drops, (due to low input voltage, excessive load, etc.), an output goes high, and that signal can be used trigger an alarm. The regulator also has a TTL-compatible input that can be used to turn the regulator off (and on) with logic-level signals. If you have ever designed power-strobing circuitry to work with three-terminal regulators, you'll welcome that function with open arms.

As you know, new IC's often have high prices until development costs have been amortized, but the LP2950 is currently selling for about a dollar in quantities of 100.

Switching regulator

National has introduced the LM1578, a switching regulator on an eight-pin mini-DIP that can provide a positive or negative output voltage from a positive input voltage. The LM1578 operates over a range of two to forty volts, can supply as much as 750 mA, and sells for $1.35 in quantities of 100 or more.

Power converter

National has added an interesting member to their family of hybrid products. The HS9151 power converter, shown in Fig. 1, is a single-package five-volt, three-amp power supply. The HS9151 comes in a metal package with

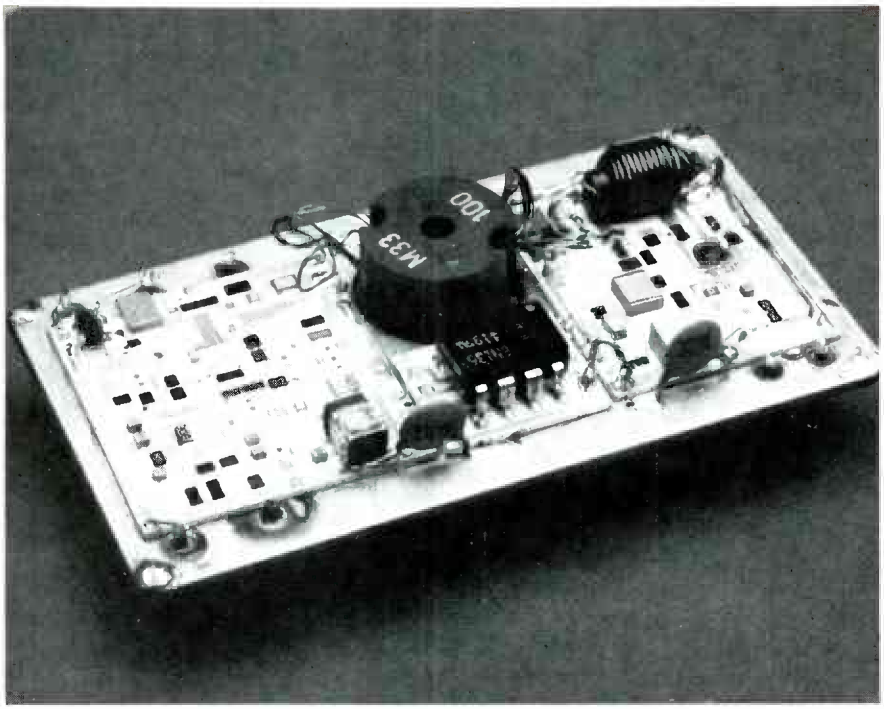


FIG. 1—NATIONAL'S HS9151 hybrid power converter supplies five volts at three amps; it measures just 3.5 × 1.5 × 0.4 inches.

dimensions of 3.5 × 1.5 × 0.4 inches. It contains a complete switching power supply with built-in current-limiting and thermal-shutdown circuitry. Using the IC is simple: regulated DC comes out of one end, and—get this—the other end plugs directly into a 117-volt AC socket!

The 1-MHz system clock is brought out of the HS9151 via two pins so that several HS9151's may be cascaded. One HS9151 is designated the master unit, and its clock is used to drive that of the others. Connections to the internal filter capacitor are also brought out on two pins, since that capacitor has a value of only 100 μF. By connecting an external capacitor in parallel with the HS9151's internal capacitor, ripple may be greatly reduced.

Pricing of the HS9151 is a bit steep compared with standard voltage regulators—about $80.00 in quantities of 100. What it will eventually cost in low quantities is anyone's guess, but we hope that price will come down soon!

Pressure transducers

Motorola has introduced the MPX2010 series of pressure transducers. As shown in Fig. 2, they are small, silicon piezoresistive sensors with unusually linear response curves. Preliminary specifications reveal that output voltage increases linearly from zero to 25 millivolts, corresponding to a 0- to 1.5-PSI increase in pressure. The IC uses a small silicon diaphragm as a strain gauge, and a thin-film resistor network provides the varying output voltage. After the wafers are fabricated, a laser is used to trim them into specification for linearity, temperature compensation, and offset calibration.

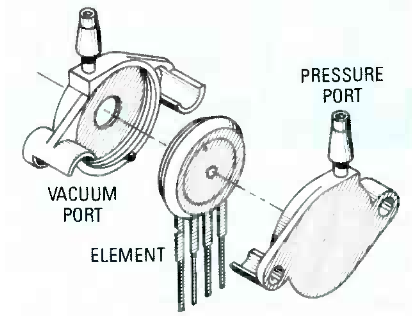


FIG. 2—MOTOROLA'S MPX2010 pressure transducers feature output voltage that increases linearly from zero to 25 millivolts, corresponding to a zero to 1.5 PSI increase in pressure.

The MPX2010 is available in several different packages, so that either pressure or vacuum measurements may be made. Moreover, a double-ported package is available if a single application requires both types of measurements to be made.

Telephone on a chip

Most of Mostek's innovations in 1985 were in digital circuits, but they have announced one new communications product. The MK5375 is a CMOS IC that contains, in one package, almost all the electronics needed to build a working telephone. A block diagram of that IC is shown in Fig. 3. The MK5375 can pulse or tone dial, and it can store ten sixteen-digit numbers. It also has last-number redial and the ability to store both the "*" and "#" keys. Data retention at power-down is guaranteed with a backup supply of 1.3 volts at 200 nanoamps. That gives the backup battery an expected life-span approximately equal to its shelf life.

Video multiplexer

Although not strictly an analog part, Harris' HI524 makes a big step forward in high-speed CMOS technology. The HI524 is a single-ended four-channel multiplexer that switches reliably at rates exceeding 1 MHz and handles analog inputs exceeding 10 MHz. Harris calls that IC a "video multiplexer," but its 700-ohm "on" resistance will cause problems for video switching because of the resulting signal loss. A further complication is the fact that 700 ohms is only a nominal value. As with all analog switches, the "on" resistance may vary from batch to batch by as much as twenty percent. That means signal balancing will have to be done whenever parts or boards are switched.

Harris recommends that the HI524 be used with their HA2541 buffer amp so that the output level can be trimmed into specification for unity gain or the required input/output differential. Harris is presently considering design and production of a HI524-type part with an on-board buffer amp, so that the signal level through the IC can easily be trimmed, regardless of a particular IC's "on" resistance. That would make the HI524 much more useful as a video switch.

In spite of its limitations, the HI524 is still an exciting part. Two switches are used in each channel of the IC: that cuts crosstalk down to an impressive −60 dB at 10 MHz. It's that switch arrangement, by the way, that causes the IC's unusually high "on" resistance. The 10 MHz bandwidth is, at the moment, the highest in the industry, and if you're willing to live with an additional 3-dB drop, you can push the bandwidth to 16 MHz.

PCM transcoder

Harris has also introduced the world's first PCM (*P*ulse *C*ode *M*odulator) transcoder, the HC5560. What distinguishes the HC5560 from other CODEC (*CO*der-*DEC*oder) and PCM devices currently available is that this IC can match any of the four common line encoding/decoding schemes currently used in Europe and North America. Two mode-select pins on the IC allow the user to choose among the following encoding schemes: HDB3 (High Density Bipolar Three), AMI (Alternate Mark Inversion), B6ZS (Bipolar Six Zero Substitution), or B8ZS (Bipolar Eight Zero Substitution).

The HC5560 is a CMOS part. It has TTL-compatible inputs and outputs, and it operates from a 5-volt, 100-mA supply. The HC5560 includes additional features such as simultaneous encoding and decoding, and asynchronous operation with loopback control and transmission-error detection.

High-speed DAC's

1985 marked Honeywell's first foray into the commercial market. Signal Pro-

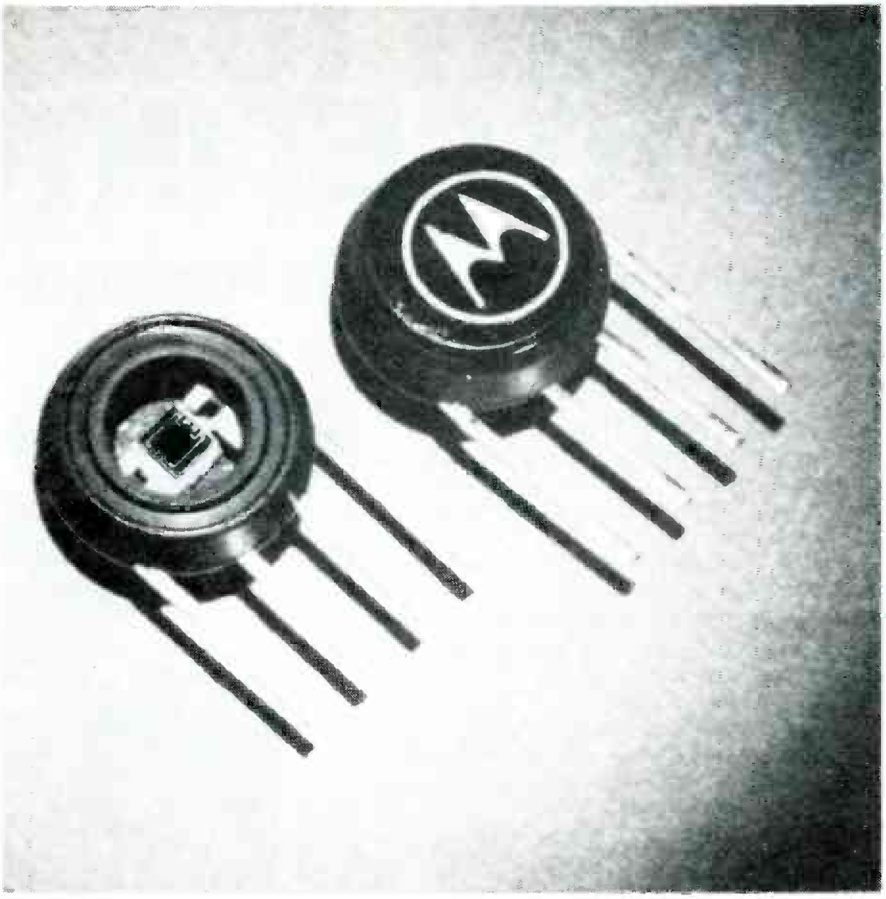


FIG. 3–THE HEART OF MOTOROLA'S MPX2010 pressure transducer is a moloithic pressure-seiser chip that can be seen in the package on the left.

cessing Technologies, Honeywell's commercial division, brought out two new high speed DAC's (*D*igital to *A*nalog *C*onverters) aimed particularly at CAD (*C*omputer *A*ided *D*esign) applications. The DAC3401 and DAC3402, shown in Fig. 5, are ECL IC's with TTL compatible inputs and outputs; the two IC's can clock data at 200 and 100 megawords per second, respectively. Either IC can accommodate a CRT display with a resolution of 2000 by 2000 pixels, and either can directly drive a standard RS-343A 75-ohm video load. Honeywell has included a variety of onboard video adjustments including sync, blank, reference white, as well as +10% luminance.

High-power components

Sprague, famous for high-voltage and high-current components, has come out with a new series of power op-amps, the ULN37XX series. They are available in single and dual combinations, and they come in two different package styles, depending on the amount of power they can handle. The ULN3751, for example, is a single op-amp in an eight-pin mini-DIP.

High-power semiconductors are traditionally packaged in metal cans, as metal is a good thermal-transfer medium. However, metal packages are expensive. Ideally, we'd like to get high-power capability in a low-cost plastic package. The people at Sprague have moved a step

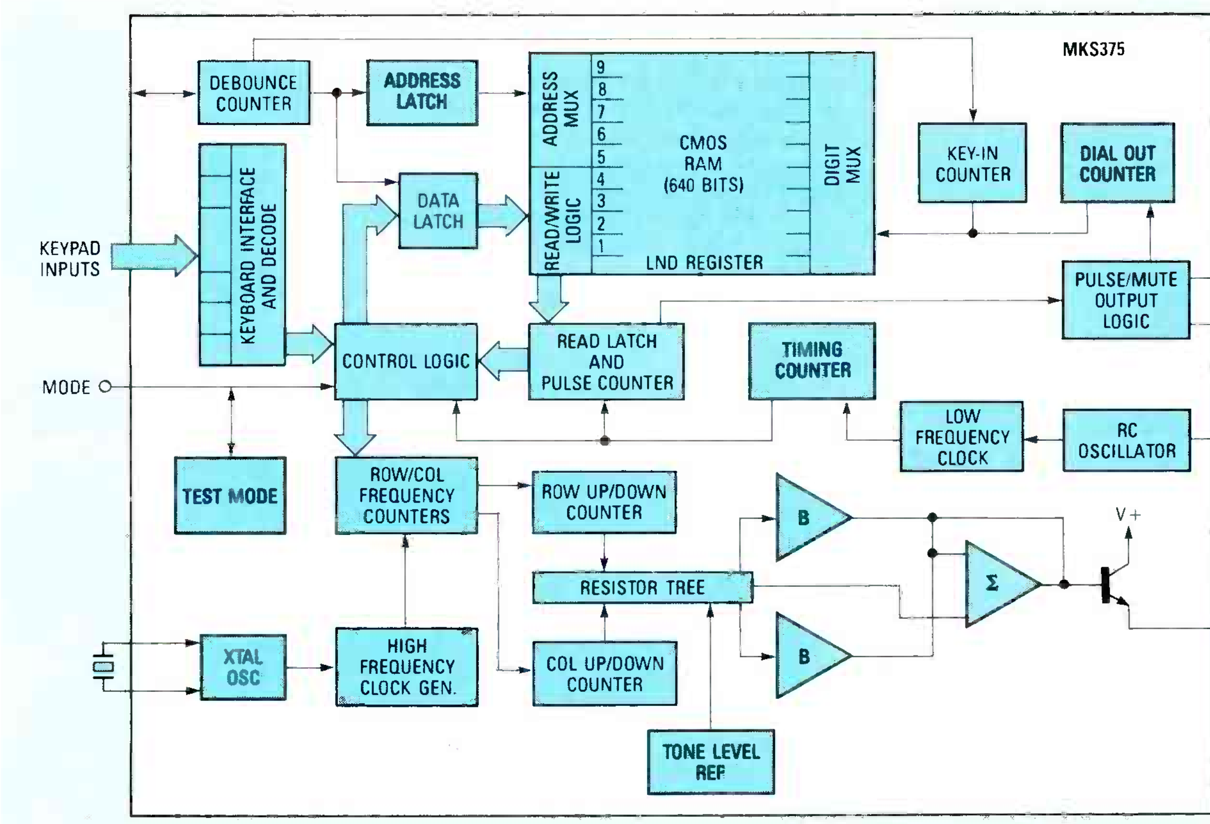


FIG. 4—MOSTEK'S MK5375 TELEPHONE-ON-A-CHIP requires only a few additional components to make a complete, working telephone.

IF YOU WANT TO GET
YOU HAVE TO GET INTO

Learn PC Servicing By Building Your Own NTS/HEATH HS-151 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.

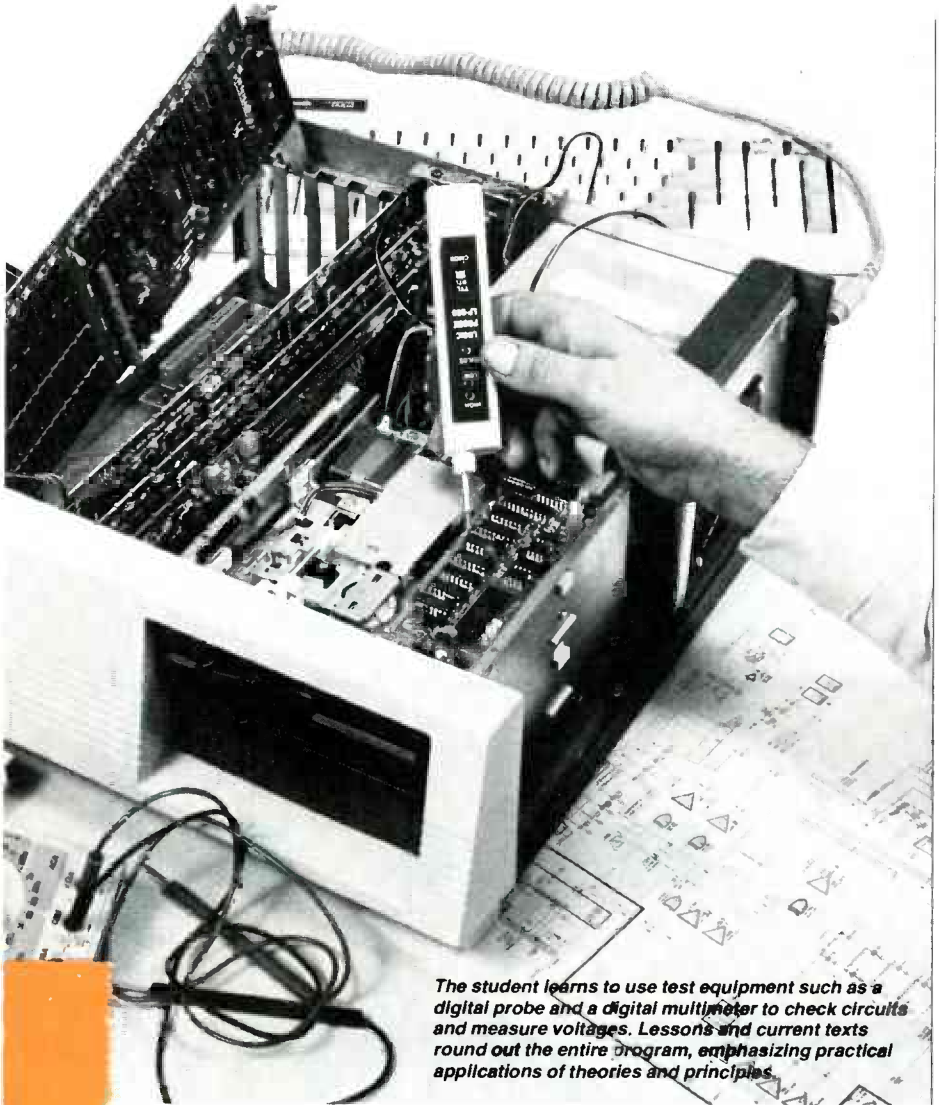
Your NTS training course will teach you to program on this outstanding PC, using lessons, texts, and diagrams to make full use of its capabilities. Catalog contains complete details.

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.

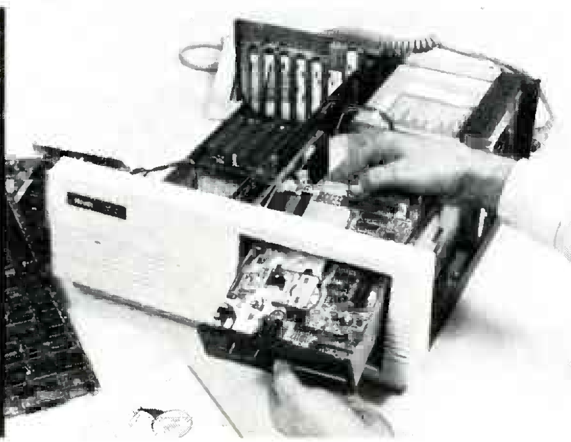
The NTS/HEATH HS-151 PC completed, includes monitor and full-function keyboard with calculatc style keypad, and typewriter format.

INTO 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

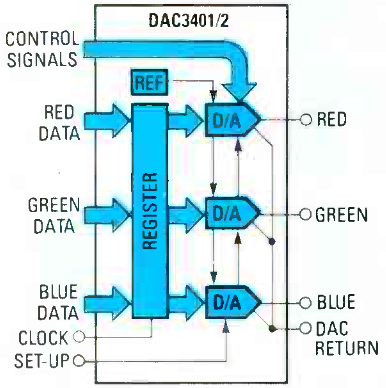


FIG. 5—HONEYWELL'S DAC3401 AND DAC3402 are ECL digital-to-analog converters that can clock data at 200 and 100 megawords per second, respectively.

closer to that ideal by mounting the IC wafer on a copper frame and bringing the frame outside the package as "batwings" on both sides of the IC. Pins 2 and 3, and pins 6 and 7, are joined together to form the batwings. That allows a standard mini-DIP to handle output currents of up to 2.5 *amps!* Since the frame is electrically connected to the substrate of the IC, maximum thermal transfer can occur. Sprague has, in effect, built the heatsink into the IC's package.

Like National, Sprague is also using a multi-lead, modified TO-220 package. Devices like the ULN3751Z and ULN3755W (single and dual op-amps, respectively) are rated for output currents of 3.5 amps!

Members of the Sprague power op-amp series can operate with supply voltages ranging from ±3 to ±15 volts, and they typically have output-voltage swings of 9 volts peak-to-peak. A motor-drive circuit, for example, usually has several components between the motor and the control circuitry that take care of voltage translation, current boosting, etc. The new Sprague parts allow you to drive a 6-volt DC motor directly.

All members of the ULN37XX family feature an open-loop gain of 90 dB, unity gain stability, high supply and common-mode rejection, thermal shutdown, and so on. The dual versions have some extra features. Each op-amp in the package has what Sprague calls a "boost pin." Ordinarily, the peak-to-peak voltage swing of an op-amp will be several volts less than the supply voltage. However, by applying a voltage at least three volts higher than the supply voltage to the boost pins, the output-voltage swing will increase by about 20%. And though you can still draw as much as 3.5 amps through the main output circuitry, the boost voltage only has to supply about 50 ma. Hence you can generate that higher voltage from the main power supply with a standard diode-capacitor voltage multiplier.

Low-power audio amplifier

Sprague's ULN2283B low-power amplifier is packaged in an eight-pin mini-DIP, and it uses the batwing packaging configuration discussed above. With a nine-volt supply, the IC can provide a voltage gain of about 40 dB and one watt of audio power into an eight-ohm load. As shown in Fig. 6, necessary support circuitry is minimal: two capacitors. If you need more than one watt of output power, Sprague has introduced a whole family of single-IC audio power amps ranging from the ULN2283B to the ULN3793W. The latter IC is packaged in a TO-220-style case; it can supply twenty watts of power to a four-ohm load!

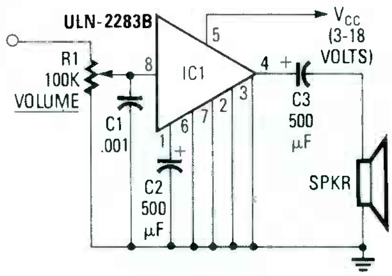


FIG. 6—SPRAGUE'S ULN2283B LOW-POWER audio amplifier requires only a few capacitors to make it a fully functional amplifier.

Motor drivers

Sprague has also been adding to their line of motor drivers. The UDN2944W, shown in Fig. 7, is a quad driver that handles as much as 60 volts and 4 amps per channel. That means you can control a load of 240 watts with a single section of an IC! It's amazing to consider that a single IC can therefore control as much as 960 watts of power!

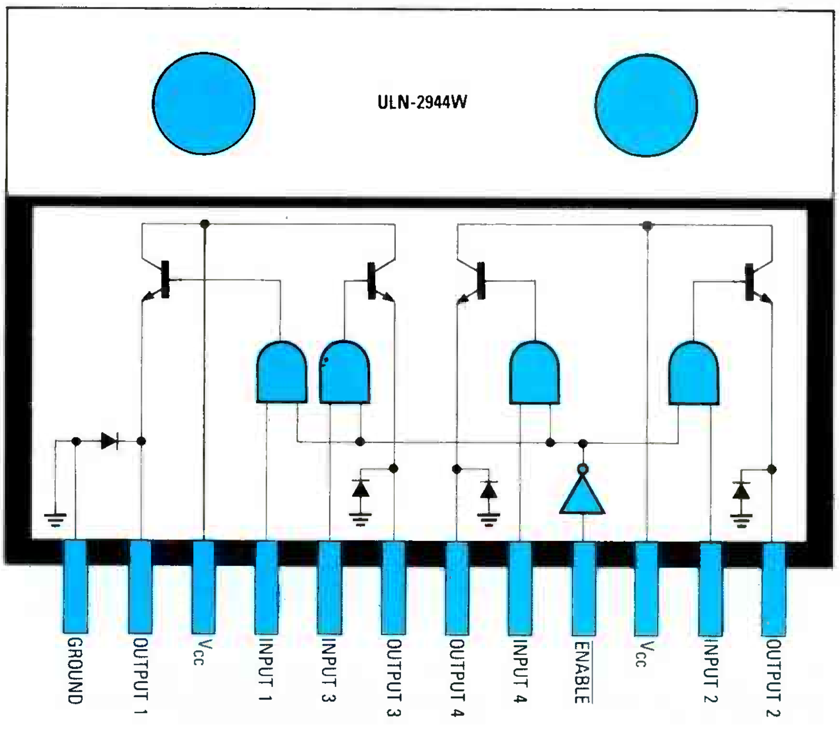


FIG. 7—SPRAGUE'S ULN2944W IS A QUAD power-driver that can supply as much as 60 volts and 4 amps per channel.

AM stereo

Motorola and Sprague (under license from Motorola) are producing AM-stereo decoders for Motorola's CQUAM stereo system. That is the system used in the "AM Stereo Decoder" project that appeared in the January 1984 issue of **Radio-Electronics.** If any significant market ever develops for AM stereo, both companies are sure to introduce a wide range of support chips specifically for CQUAM.

Conclusions

As we already mentioned, this hasn't been the most exciting year for analog technology. The semiconductor industry has been riding the crest of the computer boom for the last couple of years, so the big push for new technology has been in the digital market.

But the thrust of competition periodically swings back and forth, and we've already seen a resurgence of interest in analog components. As the computer market continues thinning out, the semiconductor manufacturers' interests will return to analog devices. That means next year we should start seeing all kinds of new analog goodies announced. **R-E**

THE MOST INNOVATIVE PRODUCTS OF 1985

DANNY GOODMAN

Looking for a "high-tech" gift for that special someone? Well, here are some items that are sure to please.

ONE OF THE FIRST PLACES WE HEAD FOR AT the Summer Consumer Electronics Show, held annually in Chicago, is the exhibit honoring the recipients of the special Design and Engineering Awards. Those awards, presented by the EIA (*E*lectronics *I*ndustries *A*ssociation), honor products that represent the vanguard in consumer electronics. All the products feature either the use of an innovative technology or an innovative design. While much of what is shown in the exhibit is high-end equipment, most of the designs and innovations honored will eventually appear in more modestly priced versions.

1985 was a banner year for innovation, and the EIA chose to honor more than 150 products. We've had a chance to examine a number of those, and what follows are some of the highlights.

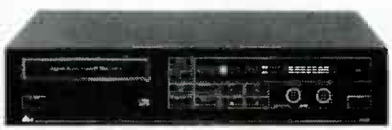
Audio

There was scarcely a visitor to CES who didn't have the *C*ompact *D*isc (CD) in mind while walking through the aisles. Sony (Sony Drive, Park Ridge, NJ 07656), which had been the first company to produce a completely portable CD player, built the diminutive disc player into the *CFD-5* "boom box" portable stereo. The

THE SONY *CFD-5* portable stereo features a built-in compact disc player

CFD-5 houses not only the disc player (a non-programmable one that is remarkably immune to casual bumps), but also an AM/FM stereo receiver, stereo cassette deck, five band equalizer, and two detachable speakers. At 17.3 pounds, that unit is not something you'd want to lug everywhere, but it is sure to be the hit of many an outdoor party.

In home CD players, dbx, Inc., (P.O. Box 100C, Newton, MA 02195), well known for their professional noise-reduction systems, unveiled a player incorporating three special circuits. Those circuits give the user a wider degree of control over the sound produced by the player than previously possible.



THIS COMPACT DISC PLAYER, the *DX3* from dbx, features three circuits that allow the user to control the quality of the sound.

One of those circuits is a compression circuit. Now that may seem antithetical to the dynamic-range-enhancing premise of digital audio, but there are times when you might not want or need a wide dynamic range. For example, when using a CD for background music at a party, or when recording cassettes for use in the car. In the latter case, compression evens out the loud and soft passages so you don't have to turn the volume up to hear soft passages over ambient road noise or turn down loud sections to hear an ambulance siren behind you. Another circuit, called "digital audio impact recovery" adds impact to sharp brass and percussion hits (transients), which often get lost in the recording process. The third circuit, an ambience control, lets you adjust out-of-phase left-minus-right information; that control is used to alter the spatial characteristics of the sound.

Many audiophiles complain that there is an overt two-dimensionality to music from a CD. Some feel that that is largely due to the fact that recording variables such as poor microphone placement are much more obvious in CD than in other recording media. Barcus-Berry (5381 Production Dr., Huntington Beach, CA 92649) disagrees. That company claims that any spatial difficulties with recorded music playback stem from improper matching between amplifier and speaker. Inserted into the audio chain at the control amplifier's tape loop input/output, their *BBE-2002* "differential load reactance compensator" recovers transients and alters the L − R and L + R phase relationships of the signal. In use, the effect of the *BBE-2002* was noticeable, even on the noisy floor of CES.

In other audio electronics, the Carver (19210 33rd Ave. W., P.O. Box 1237,

THIS CARVER *2000* STEREO RECEIVER features a circuit to combat the effects of multipath reception.

Lynnwood, WA 98046) *2000* AM/FM receiver was recognized for its inclusion of a number of advanced features. In addition to its 200-watt-per-channel (into 8 ohms) magnetic field power amplifier (a Carver design), the unit included several unique features. For example, the unit's "asymmetrical charge-coupled FM stereo detector" is designed to help cancel the effects of multipath reception. Another feature, called "Sonic Holography" by Carver, improves the spatial characteristics of the stereo sound.

Turning to receiving antennas, a striking product design for an indoor FM antenna comes from Italy via Parsec Electronics (540 Madison Ave., New York, NY 10022). The Parsec *7403* is an omnidirectional antenna that is housed in a slender, black plastic case that stands almost 17 inches tall. The unit also in-

IMPORTED FROM ITALY, the Parsec *7403* antenna can dramatically improve the quality of FM reception under certain circumstances.

cludes an amplifier with an adjustable gain of 0 to 24 dB. The lead from the antenna to the receiver is 75-ohm coax, but a 300-ohm matching transformer is included for those who need it. In addition, the unit requires 117-volts AC for the built-in amplifier.

To keep your stereo system under control, Mediacom (46 Merrick Road, Rockville Center, NY 11570) offers a remote-control fanatic's dream. Not for the fainthearted, that system can be used to remotely operate virtually any microprocessor-controlled piece of stereo gear—but to do so, a control board must be installed in parallel with each component's front-panel controls. The relays on those boards, and hence the equipment in which they are installed, are controlled through a master command terminal. That terminal controls each component individually, and all the components in the house, regardless of their location, can be linked to the terminal via one or two bus lines. The master command terminal can be operated via a hand-held infrared remote control. In addition, each listening location in the house can be equipped with its own small control panel or box.

If you wish, the required equipment modifications can be performed by Mediacom dealers at a cost of about $100–$150 per component. Add to that the cost of wiring the control bus (or buses) through your house, and you can see where a moderately complex system can run into thousands of dollars to install. But then again, living like a movie star never was cheap.

Satellite TV

Satellite TV was represented in the exhibit, too. Chaparral Communications (2360 Bering Dr., San Jose, CA 95131) was honored for its *Polaramp*, a one-piece polarotor (a circuit that electronically rotates the polarity of a satellite receiving antenna), 50-dB gain low noise amplifier (LNA), and straight-through waveguide. Combining three key elements of a satellite-receiving system in a single package such as that goes a long way toward making satellite components simpler to install, match, and maintain.

Looking more like a piece of high-tech audio gear, Kenwood's (1315 E. Watsoncenter Rd., Carson, CA 90745) *KSR-1000* stereo satellite receiver features simple two-step tuning. Once you select the satellite (positions are preprogrammed into the receiver's memory) and transponder number, the receiver handles all other tasks, including selection of the proper dish position, polarization, and stereo standard. The built-in microprocessor allows parents to lock out two channels, and an infrared remote control allows complete tuning from across the room. The *KSR-1000* is part of a block-downconversion system (the downconverter is bought separately), which means that several units can be connected to a single dish for simultaneous viewing of more than one transponder.

Video

The category that seemed to generate the most excitement at the CES in general, and at the Design and Engineering exhibit in particular, was video. Magnavox (a division of NAP Consumer Products, P.O. Box 6950, Knoxville, TN

37914) picked up honors for one of its new 37-inch rear-projection TV sets. The major innovation of that set, the *RF8506AK* stereo receiver-monitor, is its new black matrix projection screen, which affords a 180-degree viewing angle with minimal color shift. The set also features an RGB video input. Most of the television settings (color, tint, picture, brightness, and sound "parameters") are adjustable via remote control. To aid in such adjustments, onscreen "dials" can be displayed. Despite its large screen size, the set is designed to take up no more space than a 25-inch console (32.5-inches wide by 20.5-inches deep).

A BLACK-MATRIX SCREEN gives this Magnavox *RF8506AK* stereo rear-projection monitor-receiver a wide (180°) horizontal viewing area.

If 37 inches isn't big enough, consider Kloss Video's (640 Memorial Drive, Cambridge, MA 02139) *VB2000* professional color-projection-monitor. Intended for presentation-quality display of computer-generated text and graphics, that monitor comes in two versions, featuring 10- or 6.5-foot screens. It offers three inputs: NTSC composite video, analog RGB, and TTL RGB. That last input is intended for use with IBM *PC* and *PC*-compatible computers. The video specifications of that unit are impressive; its RGB video bandwidth of 15 MHz allows 80- and 132-column computer-generated text to be readable.

On the VCR front, Sony was honored for two of its new products. In the half-inch Beta format, the *SL-HF900* SuperBeta VCR contains not only Beta Hi-Fi and Sony's other top-of-the-line features, but a professional-like "jog search" control to assist in editing tapes. The control resembles a large tuning knob on a communications receiver. By turning it one way or the other, you control the speed and direction of the tape travel while you

AN ALL-IN-ONE 8mm camcorder, the *CCD-V8* from Sony can record two hours of video.

watch the picture; it is even possible to advance the tape in single frame increments. That feature offers considerably more precision for editing cuts than the now standard two-button visual search controls on other VCR's.

Although Sony is not the first to introduce equipment in the relatively new 8mm video format, its *CCD-V8* camcorder won an award for its compact, one-piece design. The unit can record up to 2 hours of video on one cassette, and up to 12 hours of digital audio (only); the dynamic range of the recorded audio is claimed to be 88 dB, which approaches that of a compact disc. Having learned its lesson from the less feature-laden Betamovie units, that 8mm camcorder lets you play back the tape while you're still in the field, using the black-and-white electronic viewfinder as a display device, to make sure you got the shot you wanted. Also offered are a companion tuner/timer and a sophisticated editor console.

Computers

While computer software had its own, separate design exhibit, several hardware products were included in the main display. Perhaps the most innovative was a device called the *Space Pen* from Soniture, Inc. (480 Vandell Way, Campbell, CA 95008). Perhaps the best way to summarize the function of that unit is to call it a three-dimensional light pen. The main unit is an L-shaped box that fits around the upper left corner of the computer monitor. Connected by a wire to the unit is a handheld wand that you can move in any direction—up/down, left/right, and in/out. The box at the monitor detects the relative X, Y, and Z location of the wand at any moment. In the Z dimension, it is claimed that the unit can detect movements as small as .01-inch at distances of up to six feet from the monitor. The com-

THE *SPACE PEN* from Soniture allows three-dimensional input to a computer.

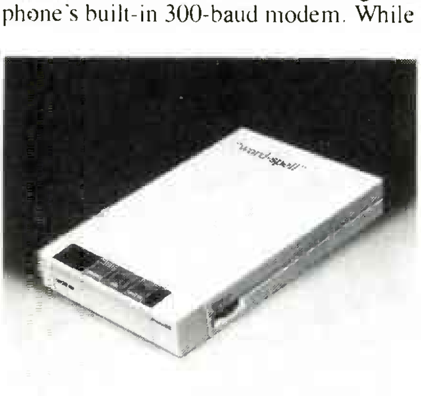
pany had on display prototype software applications in which the Z axis controlled paging through a series of screens (like flipping through pages in a book) and also the movement of a spaceship that could fly in front of and behind a fixed object on the screen. For the latter, as the pen was moved closer to the user, the ship appeared larger and the computer-generated engine sound grew louder. The unit is available for Apple, IBM, Commodore, Atari, and MSX computers; when used in its two-dimensional mode, the *Space Pen* is compatible with several popular touch-tablet software programs.

A different kind of input device by Covox, Inc. (675-D Conger Street, Eugene, OR 97402) lets you add voice recognition to a Commodore *64*, Apple *II*, or Atari *XL/XE* series computer. The *Voice Master* includes a patch to BASIC that allows you to build speaker-dependent voice recognition into your own programs. The unit also features a "voice harp" mode that causes musical notes to be generated in response to a hummed or whistled "input signal."

IT FLOATS! The handset of the *Float Fone* from Webcor can even be used in the shower.

Telephones

With the wide consumer acceptance of owning your telephone, manufacturers are loading their units with all kinds of features in a race to win a share of that profitable market. One that has apparently won that features race, and a design award as well, is the model *7890* from Superphone (47001 Benicia St., Fremont, CA 94539). That two-telephone-line model combines a number of sophisticated timer and phone features into an impressive telephone workstation. For example, you can program it to forward incoming calls to different phone numbers depending on the time of day. When you program PBX or long-distance service numbers, it listens for the intermediate dial tone before proceeding with the rest of the call. If one of the two lines attached to the phone is an outgoing WATS line, you can call in on the local number and dial out using the WATS line (that feature is commonly called a WATS Extender). Moreover, if you have two lines connected, you can dedicate one to a data line, using the phone's built-in 300-baud modem. While one line is sending and receiving computer data, you can carry on a conversation on the other line. All that flexibility is not inexpensive, however. The phone has a suggested list price of almost $700.



THE *WORD-SPELL* from Brother automatically signals whenever if finds a misspelled word.

We've all seen ads for cordless phones in which the happy owner is sitting at or in the pool talking merrily away on the unit. But have you also wondered what fate the phone suffers when the inevitable happens and the unit sinks to the bottom of the pool? Webcor Electronics (107 Charles Lindberg Blvd., Garden City, NY 11530) has put that concern to rest with its *Float Fone* cordless telephone. Operating on the new 46/49 MHz frequency pairs, the *Float Fone's* handset is waterproof and is fitted with a buoyant yellow rubber "boot." If you wish, the unit can even be used in the shower.

Personal electronics

This is a fun category because although these products don't get a great deal of attention (after all, they are not audio, video, or computer related), they often feature some rather fascinating and surprising innovations. One such product is Brother International's (8 Corporate Pl., Piscataway, NJ 08854) *Word-Spell*, a spelling checker for use with a Brother electronic typewritter. As you type along, *Word-Spell* automatically checks your spelling, alerting you to any misspelled words. The unit features a 50,000-word main dictionary, to which 300 words, chosen by the user, can be added.

These days, most of us own one of those credit-card-sized calculators. Casio (15 Gardner Rd., Fairfield, NJ 07006) has taken that product one step farther by incorporating both a full-function calculator and an FM radio into a 1.1 ounce package only 3.9 mm thick called the *RD-10* FM Card Radio.

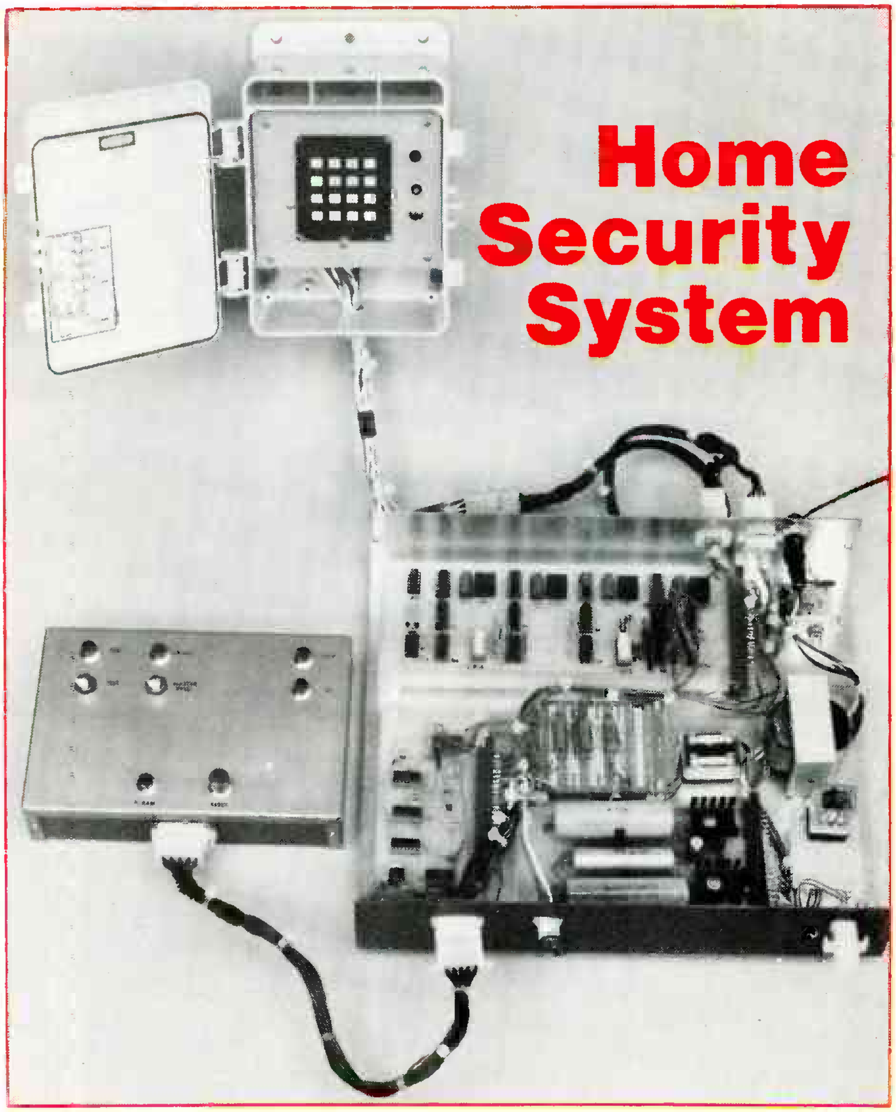
Another remarkable feat of miniaturization is the Panasonic (One Panasonic Way, Secaucus, NJ 07094) *RN-36* microcassette recorder. That dictation recorder is roughly the height and width of a credit card and measures just over one-half inch thick—dimensions that Panasonic claims make the unit the smallest microcassette recorder available. The unit's tiny motor operates on 1.5 volts, and the recorder's electronics are manufactured using surface-mounted-component technology and a flexible printed-circuit board. One way the designers were able to make the unit so small was to remove the play back speaker. It is housed in a separate small desktop module. You can still playback the tape with the portable unit, however, through earphones. And despite its small size, the *RN-36* features a digital tape counter and a removable microphone that can be clipped on a lapel. R-E

THE *RN-36* from Panasonic is the smallest microcassette recorder yet.

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



IN TODAY'S WORLD, BOTH PRIVATE HOMEowners and commercial businesses are becoming more and more concerned with security. As with many other products, what was once affordable only by large businesses is now within reach of small businesses and average homeowners. Wired and wireless alarm systems are readily available now for both new and pre-existing homes.

While the new wireless systems are grabbing the lion's share of the market, wired systems are still effective. Our system is a wired alarm, and has features found in the most expensive security systems, including a built-in exit timer, a digital combination lock with 65,535 possible combinations, a loop-test circuit, provision for both keyboard and failsafe-keyswitch entry, and multiple output-contacts for devices such as a siren, an automatic telephone dialer and floodlights.

Although primarily designed to function as a low-cost, small-business or home-security system, our alarm can be used as an automobile or marine intrusion alarm, an ignition combination lock, or both. In addition, either the intrusion alarm or the combination lock may be extracted and used as-is in other circuits.

A wired alarm system like ours may be installed during the construction phase of a home, business, shop, or garage. Our system may also be added to pre-existing homes or businesses with very little "loop wire" showing, simply by using magnetic reed switches mounted near the tops of doors and windows.

As seen in the opening photo, our alarm has three main sub-assemblies: the control panel, the main chassis and the keyboard panel. The keyboard panel is mounted outside the protected area, near the point of entry. It contains the keyboard used to punch in the digital combination that disarms the alarm.

The other two assemblies are mounted inside the protected area, in somewhat inaccessible locations, to prevent unauthorized tampering. The main chassis houses most of the alarm's electronic subassemblies; the control panel contains components used to arm the alarm, reset it, and test the sense loop. Care should be taken to ensure that unauthorized persons have no access to the control panel. It is not necessary to mount the control panel right by the exit, because the alarm's timer provides an exit delay of as long as two minutes (after you press the MASTER RESET switch) before the alarm is armed.

Alarm operation

You must do three things to operate this alarm: program the digital- entry "combination lock" code, arm the alarm when leaving the protected area, and re-enter the protected area without tripping the alarm.

- Programming—The four-digit entry code is programmed using eight-position DIP switches S1 and S2, shown in Fig. 1. Four individual switches from both S1 and S2 are used to encode each digit of the four-digit entry code. Hence, each digit may have any one of sixteen different values.
- Entry—After the proper four-digit code has been punched in, an LED on the keyboard panel is turned on and indicates that the alarm has been disarmed. When the ENTER switch, which is also on the keyboard panel, is pressed, the protected area may be entered.
- Exit—Before leaving the protected area, the TEST switch on the control panel should be pressed. If the sense loop is intact, the TEST LAMP will light up. If it doesn't, there must be a break in the sense loop, which obviously should be corrected before you leave the premises. Assuming that the TEST LAMP does illuminate, the MASTER RESET switch is pressed next. That clears the combination-decoding circuitry, which is indicated by the appearance of zeros in each digit on the display board. The MASTER RESET switch also resets the timer board, causing the exit-delay timing to begin.

The exit delay gives you between 30

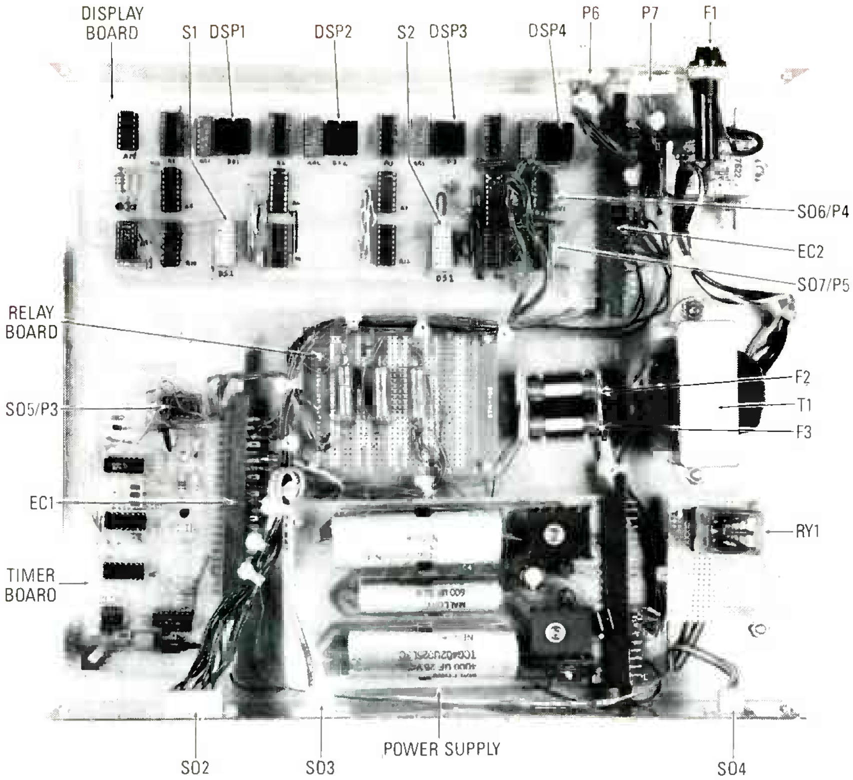


FIG. 1—THE MAIN CHASSIS ASSEMBLY of the alarm. There are two circuit boards, two relay boards, and a power-supply board.

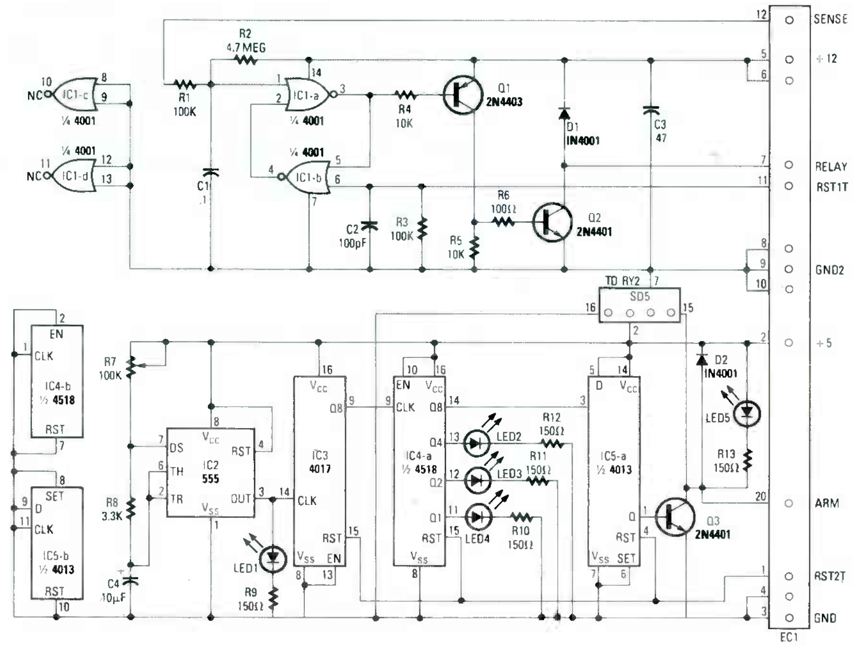


FIG. 2—SCHEMATIC DIAGRAM OF THE TIMER BOARD. Note that two separate circuits are shown here, the alarm circuit above, and the timer circuit below.

and 120 seconds (depending on the setting of a resistor on the timer board) to leave the protected area. After that time, the ARMED lamp LMP5 on the control panel illuminates, indicating that the alarm is armed. From that time on, the main relay will activate an alarm bell—or whatever devices you have connected to it—if the sense loop is broken (unless you disarm the system by punching in the proper code or activating the failsafe keyswitch).

It is important that the TEST switch not be cycled while the system is armed. That would activate the alarm, because the TEST switch contacts are part of the sense loop. If a "make before break" switch is used for the test function, that precaution will not apply.

Whenever the sense loop is broken while the alarm is armed, the ALARM lamp on the control panel will illuminate, and the main relay will activate. To disarm the alarm, the continuity of the sense loop must be restored, and the ALARM RESET switch on the control panel must be pressed.

Now that we understand how how to use the alarm, let's discuss, in some detail, how each circuit board and sub-assembly works.

Timer board

As shown in Fig. 2, both the alarm sensing circuit and the timer circuit are located on the timer board. See "PC Service" for that board's full pattern. The timer circuit uses a 555 (IC2) to generate clocking pulses with a frequency of about 1 Hz; those pulses drive the counting chain consisting of IC3, IC4-a and IC5-a. The output of the 555 is connected to the clock input of IC3, which divides that signal's frequency by eight. The output of IC3 is fed to IC4-a, which again divides the signal by eight. The final signal is applied to "D" flip-flop IC5-a. Since its DATA line is tied high, its Q output is forced high, which turns on transistor Q3 and, therefore, relay RY2.

The closing of the relay's contacts grounds the upper portion of the circuit, the *alarm sensing circuit*. Until the upper circuit obtains power, the alarm is unarmed, so breaking the sense loop would not trip alarm relay RY1. (That relay, and its associated circuitry, will be discussed more fully next time.) But after the upper circuit is grounded, of course, breaking the sense loop will trip RY1.

Visual confirmation that the counting circuit is operating is provided by LED1–LED4, and visual confirmation that the sensing circuit is operating is provided by LED5. Moreover, ARM lamp LMP3 is wired in parallel with LED5, and that provides visual confirmation (at the control panel) that the sensing circuit is operating. Diode D2 protects the coil of RY2 from high-voltage spikes induced when the relay is energized.

The MASTER RESET switch, S21, which is mounted on the control panel and will be shown next time, is normally in the RUN position; that grounds the RST lines of counters IC3, IC4-a and IC5-a. Pressing

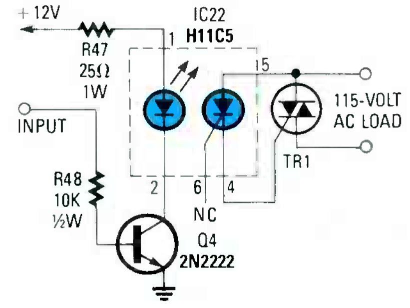


FIG. 3—THIS ISOLATION CIRCUIT may be used for safe control of 115-volt AC devices from a 12-volt DC input.

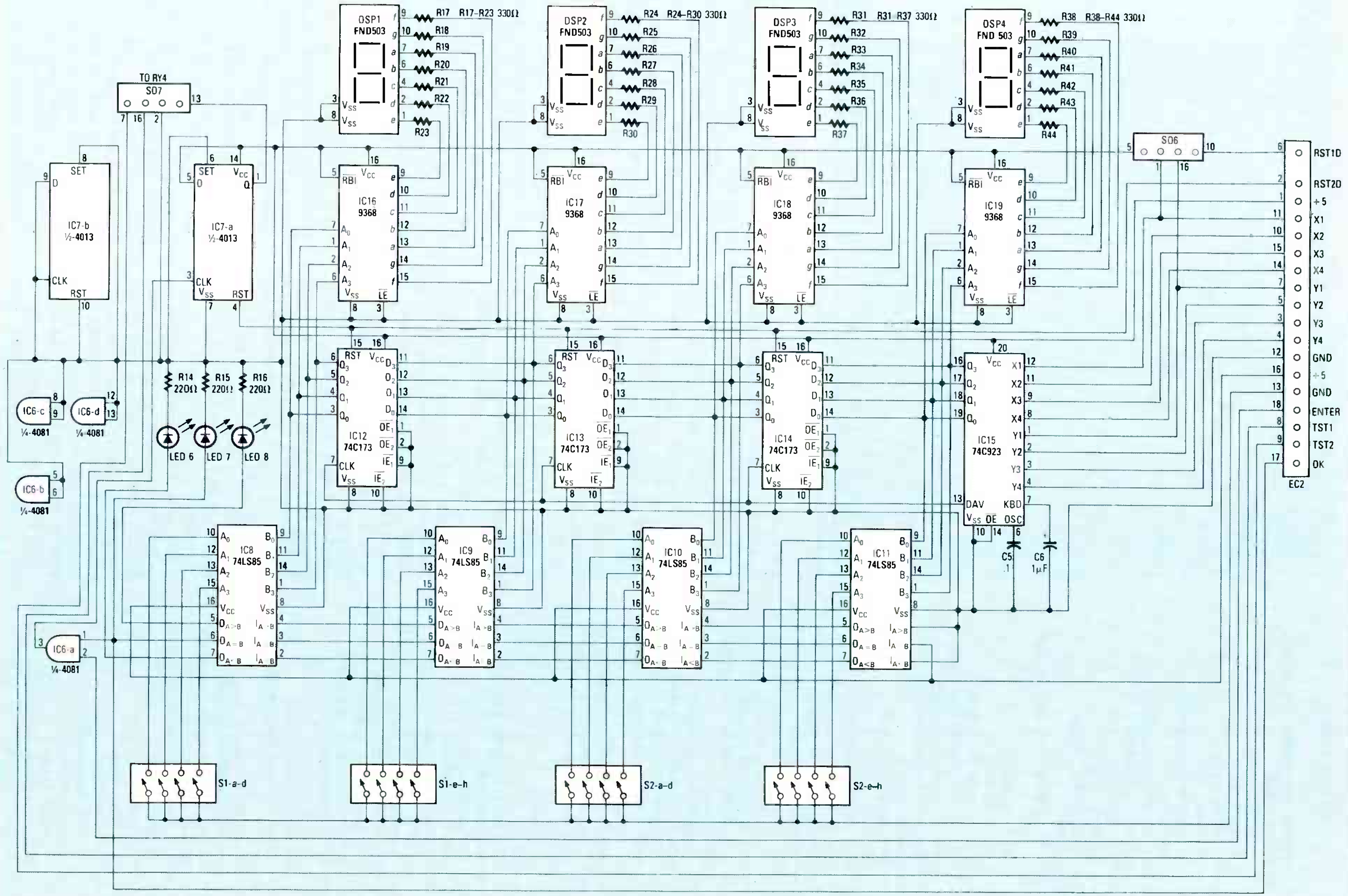


FIG. 4—SCHEMATIC DIAGRAM OF THE DISPLAY BOARD. Integrated circuits IC8–IC15 are the real heart of this circuit.

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, ceramic disc
C3—0.47 µF, ceramic
C4—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—0.6 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)
EC1, EC2—22-position edge connector
PL1, PL2—15 position Molex
PL3–PL5—16 position DIP header
PL6—9 position Molex
PL7—4 position Molex
PL8—12 position Molex
PL9—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

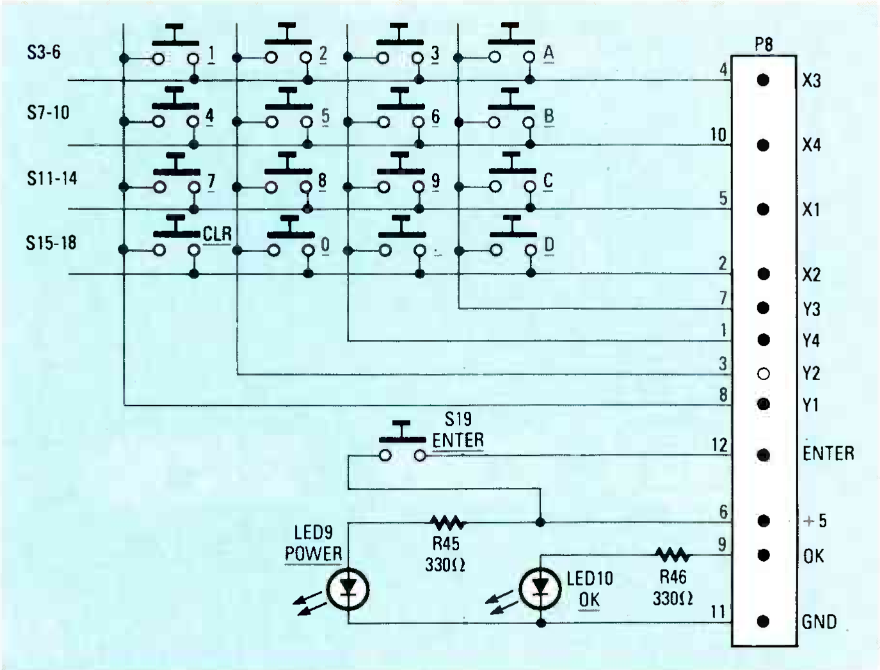


FIG. 5—SCHEMATIC DIAGRAM OF THE KEYBOARD PANEL. Switches S3–S18 may be a standard 16-key matrix keyboard or separate SPST momentary switches.

S21 applies +5 volts to those lines, thereby resetting the IC's. When that happens, a "Ø" appears at IC5's Q output, and that turns off the transistor, the relay, and, thereby, the alarm sensing circuit. At that point counting begins again and, after the pre-set time delay, the sensing circuit will again be operational.

Variable resistor R7 allows you to vary the speed of oscillation of the 555 and, thereby, the overall exit delay. With the component values shown, the overall delay may vary from 30 to 120 seconds. If a longer or shorter delay is needed, IC4's CLK input may be connected to a different output on IC3, thereby changing that IC's division constant.

The alarm circuit shown in the upper half of Fig. 2 has been adapted from an "off-the-shelf" public-domain circuit. It is composed of a bistable latch built from IC1-a and IC1-b. Pin 1 of IC1-a is normally held low by the sense loop, and that keeps pin 3 high. That prevents Q1 from getting the proper bias so it, Q2 and relay RY1 all remain off. When the sense loop is broken, C1 begins charging through R2. Pin 1 eventually goes high, so pin 3 goes low. Q1 then turns on, turning Q2 on and energizing RY1. Diode D1 is in the circuit to protect the coil of RY1.

The value of capacitor C1 could be increased to provide a longer charging time, thereby allowing additional time before activating the alarm relay. Such additional time might be useful to prevent false triggering of the alarm brought on by doors or windows that vibrate because of the wind.

The alarm circuit will remain activated until the sense line is closed and ALARM RESET switch S20 is pressed. Merely closing the loop will not shut off the alarm; S20 must also be pressed. When S20 is pressed, pin 6 of IC1 goes high, and pin 4 goes low. If the sense loop has been closed, both inputs to the upper gate are low, so that forces the output at pin 3 high, and Q1 turns off.

RY1 may suffer from contact pitting if high-current devices are switched. If it does, the simple triac isolation circuit shown in Fig. 3 may be used to control 115-volt AC devices.

Display board

As shown in Fig. 4, the display board is composed of three parts: the keyboard scanning circuit, the display circuit and the comparator circuit.

National Semiconductor's MM74C923 is a 20-key keyboard encoder. Only sixteen keys were used in our prototype, but the MM74C923 was used to facilitate future expansion. A 74C922 16-key encoder could be substituted, but the two IC's are not pin-compatible, so the PC artwork would have to be modified. The keyboard itself is a surplus unit; individual SPST momentary switches could be used if desired. The wiring diagram for the keyboard panel is shown in Fig. 5.

Capacitors C5 and C6 on the display board are used to control the keyboard scanning rate and the key-switch debounce time, respectively. We found that values of 0.1 µF and 1.0 µF, respectively, work well with several different keyboards, but the values of those capacitors may have to be adjusted slightly.

That's all we have room for this month. Next time, we'll finish up our look at the display board, and the rest of our alarm system, and begin to show you how to build the project. **R-E**

BUILD THIS

VIDEO TITLER

Now that we know the basic theory behind the titler, it's time to look at the circuit in detail and build it.

JACK FLACK

Part 2

WHEN WE LEFT OFF last month, we had just begun describing the video titler circuit. Let's start by finishing up our description of the power supply (which was shown in Fig. 6 in the November issue).

A simple battery backup circuit was included in the power supply so that 30 pages of titles could be saved in user RAM. That lets you recall and display your best page creations in a snap! The junction of D11 and D12 is set at +5.7 volts using the unregulated +8.5 volts that feeds the +5-volt regulator (IC25). When the titler power is on, D12 is forward biased, and +5 volts is supplied to the RAM. However, D13 is reverse biased, so current cannot flow into the lithium battery, B1. When the power is turned off, D13 becomes forward biased and D12 becomes reverse biased, so the RAM is supplied with +3 volts (which keeps it in the standby mode) and the battery is isolated from the rest of the titler's circuit.

The final thing we'll point out about the power-supply section is that the +3, +1.5 and +0.7 volt supplies are derived by using a simple diode chain that consists of D14 through D17.

External-sync generator

The external-sync generator section of the video titler extracts the basic timing components from the external video signal and provides the rest of the titler with them. The schematic of the external-sync section is shown in Fig. 7. The external composite video can be input to the titler either through J1 (a 10 pin connector like those used on color video cameras) or through J4, (a standard RCA-type phono jack). The VIDEO SOURCE switch (S1) determines which jack is used for input.

The external video signal is terminated with R3 and is coupled to the clamping circuit through C1. Its sync level is clamped at 0.7 volt using D1 and R4, and is fed to the inverting input (pin 6) of comparator IC1-a. The non-inverting input of that comparator is set slightly higher than 0.7 volts, and that causes a positive pulse to occur on the comparator's output (pin 1) during the most negative point of the input signal (i.e., the horizontal- and vertical-sync level). That positive pulse is referred to as "composite sync" and is used to generate three different signals.

The positive edge of the external composite signal is used to trigger a non-retriggerable one-shot (IC2-a). The negative-going output pulse (referred to as the external horizontal pulse), is set at about 50 microseconds by C4 and R9, so that alternate vertical serrations and equalizing pulses are ignored and only horizontal information is passed.

Noise that may be present in the external composite-sync signal is also reduced by the one-shot. This noise reduction improves the stability of the clock-generator circuit.

The negative edge of the external composite-sync signal triggers the other one-shot (IC2-b). The positive-going output pulse of that one-shot (referred to as the BURST GATE) is set at about 3 microseconds by C8 and R10. Three microseconds is the approximate duration of the colorburst of the external composite-video signal.

The external composite-sync signal is also fed through a lowpass filter (made up of R6, R7, C6, and C7) where only the *vertical* portion is passed. Another comparator (IC1-b) is used to generate a clean positive pulse during the vertical-sync interval.

The comparators in IC1 are open-collector devices and require pull-up re-

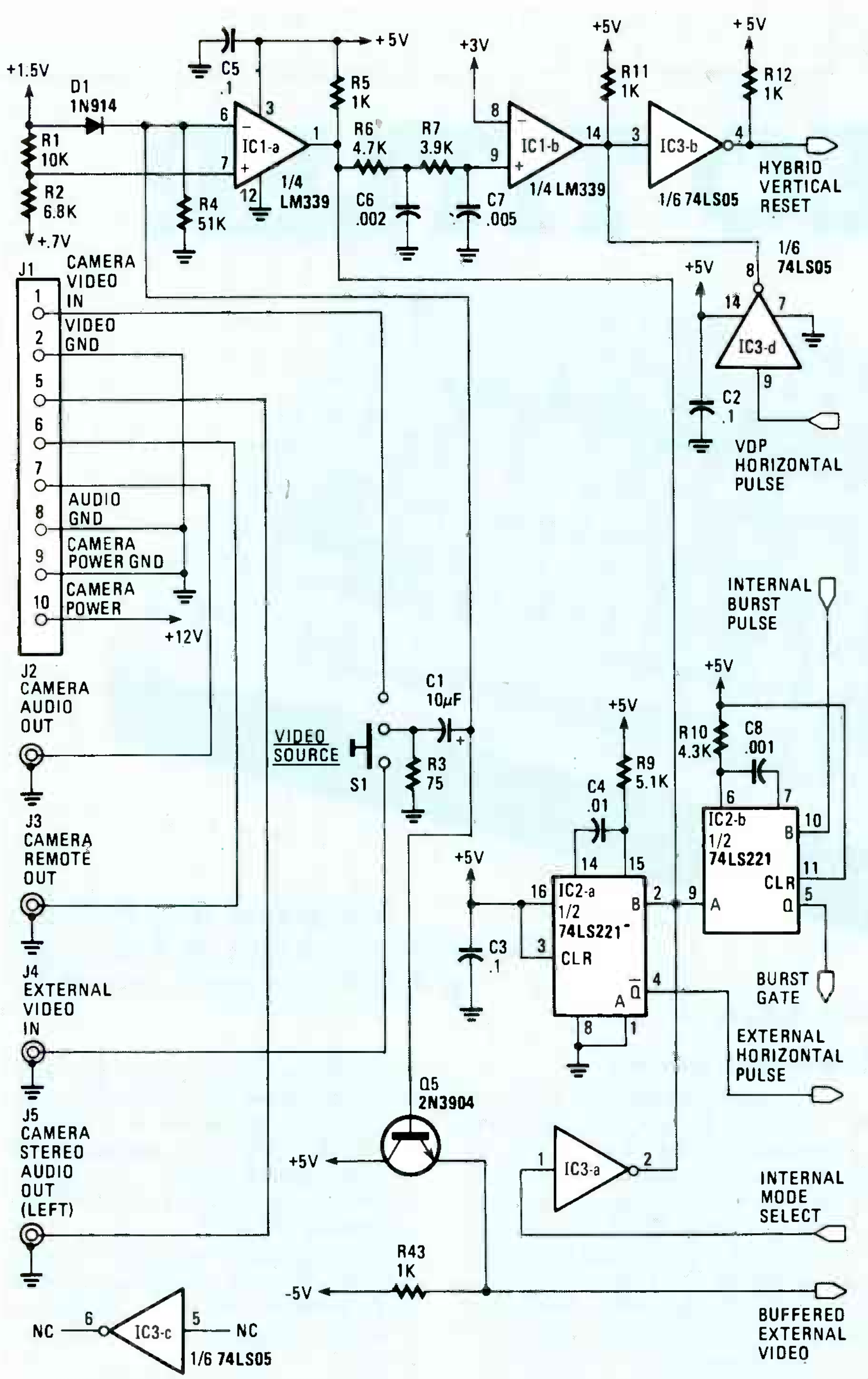


FIG. 7—THE EXTERNAL SYNC GENERATOR section of the video titler extracts the timing components from the external composite-video signal for use in the rest of the titler circuit.

sistors at the outputs. The outputs of two or more open-collector devices can usually be tied together ("or-tied") such that any one device can pull the output low. Conversely, all devices must be high for a high output.

In this case, the output of inverter IC3-a is or-tied to the output of comparator IC1-b. The input of the inverter receives the VDP HORIZONTAL PULSE, which is a narrow pulse generated external to the VDP (*V*ideo *D*isplay *P*rocessor. The trailing edge of that pulse is ultimately used to realign the VDP's internal horizontal counters.

Remember that the VDP does not provide a separate horizontal output pulse and does not generate vertical serrations or equalizing pulses in its non-standard video signal. Therefore to obtain a horizontal sync during the vertical period, a pseudo-horizontal pulse had to be constructed using available signals.

Our goal is to reset only the VDP *vertical* counters and to let the VDP's horizontal timing track the horizontal timing of the external video signal. Unfortunately, the leading edge of any vertical reset pulse applied to the the VDP's RESET/SYNC pin will also reset the VDP's horizontal counters. And since our external video signal is operating in an interlaced mode, the leading edge of the vertical portion will occur every 262.5 horizontal lines. Thus, characters on the left of the screen would jump to the center and back with each successive external vertical sync.

We got around that problem by inserting the pseudo VDP horizontal pulses into the external video signal, and using that HYBRID VERTICAL RESET signal to reset the VDP vertical counters. Thus a constant relationship between the internal VDP horizontal timing and the pseudo VDP horizontal pulse used by the PLL in the clock-generator section was re-established. Inverter IC3-b is used to establish the proper polarity of the HYBRID VERTICAL RESET signal before it goes to the level shifter.

Clock generator

The clock-generator section of the video titler provides the 10.7 MHz master system clock. Its schematic is shown in Fig. 8. The clock actually operates at one of two frequencies depending on the mode in which the titler is operating. When it's operating in the internal mode, the clock frequency is three times the chroma clock frequency. ($3.579545 \times 3 = 10.738635$ MHz.) In the external mode, the master-clock frequency is equal to the external video horizontal frequency multiplied by 684. (3.579545 MHz$/227.5) \times 684 = 10.762235$ MHz

The video titler must use two separate master frequencies because of the method by which the VDP horizontal frequency tracks the external horizontal sync.

The clock-generator section uses two IC's that operate together as a phase-locked loop or PLL. Motorola's MC4044 (IC4) digital phase detector and MC4024 (IC5-a) voltage-controlled oscillator (VCO) function as a special type of PLL referred to as a digital frequency synthesizer or frequency multiplier. (Note that those two IC's are *not* 4000-series CMOS devices)

The output of a frequency synthesizer is an an exact multiple of the reference frequency. That's accomplished by dividing the output of the VCO by a desired value before it is input to the phase detector. The PLL then manipulates the VCO such that both the reference frequency and the divided-down VCO output are always in phase. Figure 9 shows the output and reference signals of the titler's PLL frequency synthesizer in the internal and external modes of operation.

In order to simplify the design of the titler, no attempt was made to operate the VDP using standard NTSC video timing in the internal mode. Instead, the VDP operates at the frequency in which it was originally designed, using a readily available reference frequency, the CHROMA

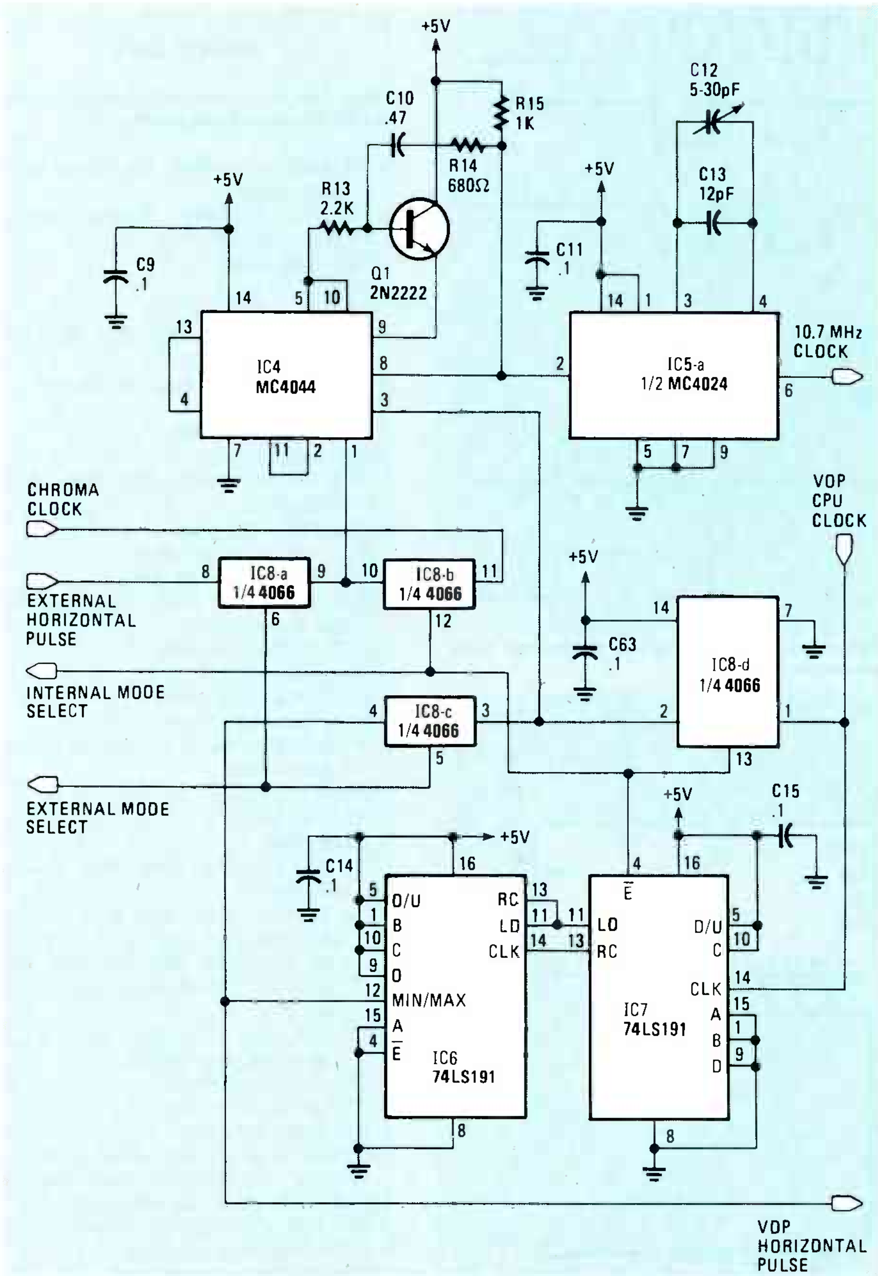


FIG. 8—THE CLOCK-GENERATOR section provides the titler's master 10.7-MHz system clock. IC4 and IC5-a make up a phase-locked loop.

CLOCK (free running at 3.58 MHz).

In the external mode, a pseudo VDP horizontal pulse is derived from the master clock using the VDP's CPU CLOCK output (pin 37). That signal is the master clock divided by 3. Two counters (IC6 and IC7) further divide the CPU clock by 228, which results in an output signal equal to the master clock divided by 684 (which is the equivalent to the horizontal timing inside the VDP). The PLL compares the falling edge of this pseudo VDP horizontal pulse to the falling edge of the EXTERNAL HORIZONTAL PULSE and adjusts the 10.7-MHz system clock in a way that minimizes the phase difference of the two signals.

The rest of the components in the clock-generator section provide the switching mechanism between external and internal modes. Four CMOS analog switches (IC8) determine which two signals are used by the PLL. The switches are controlled by two mode-select signals, which are generated in the video mixer/buffer section, and which we'll talk about shortly.

Video display processor

The VDP section is the heart of the titler's video generation circitry. Its schematic is shown in Fig. 10. Data is passed to and from the microcomputer section via a bidirectional data bus. The TMS9128 VDP (IC10) maintains its data lines in their high-impedance state until either control lines $\overline{CSW}$ or $\overline{CSR}$ go low, at which time the VDP reads from or writes to the data bus. The VDP's MODE line (pin 13, IC10) is tied to the low order address line (AØ) and it controls whether the data transferred is address, memory, or register data.

Data transfers will be discussed in more detail when we examine the software of the titler. All we'll say here is that you should note that all VDP data and address lines appear to be "backward." In other words, DØ = CD7, ADØ = A7, RD7 = DQØ. Texas Instrument's documentation on the VDP refers to all least significant data lines as XX7. The most significant lines are labeled XXØ.

A voltage-level adjustment for the RESET/SYNC input of the VDP is made up of C16, R17, R18, D2, and Q2. Two signals, the HYBRID VERTICAL RESET pulse and the MPU RESET are joined to generate a three-level signal.

On power-up, MPU RESET remains low for a few microseconds causing the VDP to reset. It then rises slowly to the 5-volt (inactive) level. In the internal mode, the HYBRID VERTICAL RESET pulse is not present. In the external mode, the pulse is AC-coupled to Q2, which inverts the signal and establishes its voltage swing between 5 and 12 volts.

As mentioned earlier, that 5- to 12-volt pulse maintains vertical synchronization between the VDP and the external video signal. It also maintains a constant phase relationship between the VDP's internal horizontal counters and the VDP horizontal pulse (generated outside the VDP) used by the PLL. The Zener diode, D2, is used to hold the MPU RESET line at, or below, 5.1 volts.

The VDP directly interfaces with two 4416, 16K × 4 bit dynamic RAM's (IC11 and IC12). The entire 16K × 8 video RAM is needed by the VDP to generate the titler's video images.

The chroma processor

The chroma processor performs a number of functions necessary to generate proper VDP color. Its schematic is shown in Fig. 11. Remember that superimposing graphics with stable colors requires that the VDP chrominance information be phased-locked to the external video colorburst signal.

We can accomplish that using RCA's CA3126 chroma processor (IC14). That IC generates a continuous 3.58-MHz sinewave that is phase-locked to the colorburst of the external video signal. The chrominance portion of the external video signal is extracted using highpass filter L1, C20, and C21. The BURST GATE signal, applied to pin 9, provides a window for extracting the colorburst signal.

In the external mode, the titler passes the external burst (as well as the external horizontal and vertical sync signals) directly to the VIDEO OUT jack, J6. The chroma filter phase-shifts the incoming colorburst in such a way that the resulting chrominance information contained in the

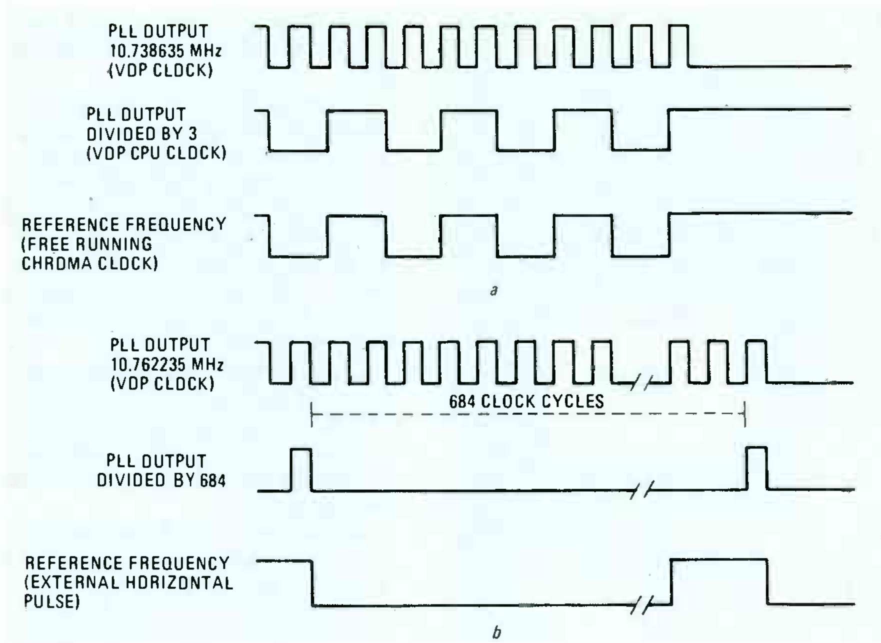


FIG. 9—SIGNALS ASSOCIATED WITH PLL FREQUENCY SYNTHESIS. Signals for the internal mode are shown in *a*, and signals for the external mode are shown in *b*.

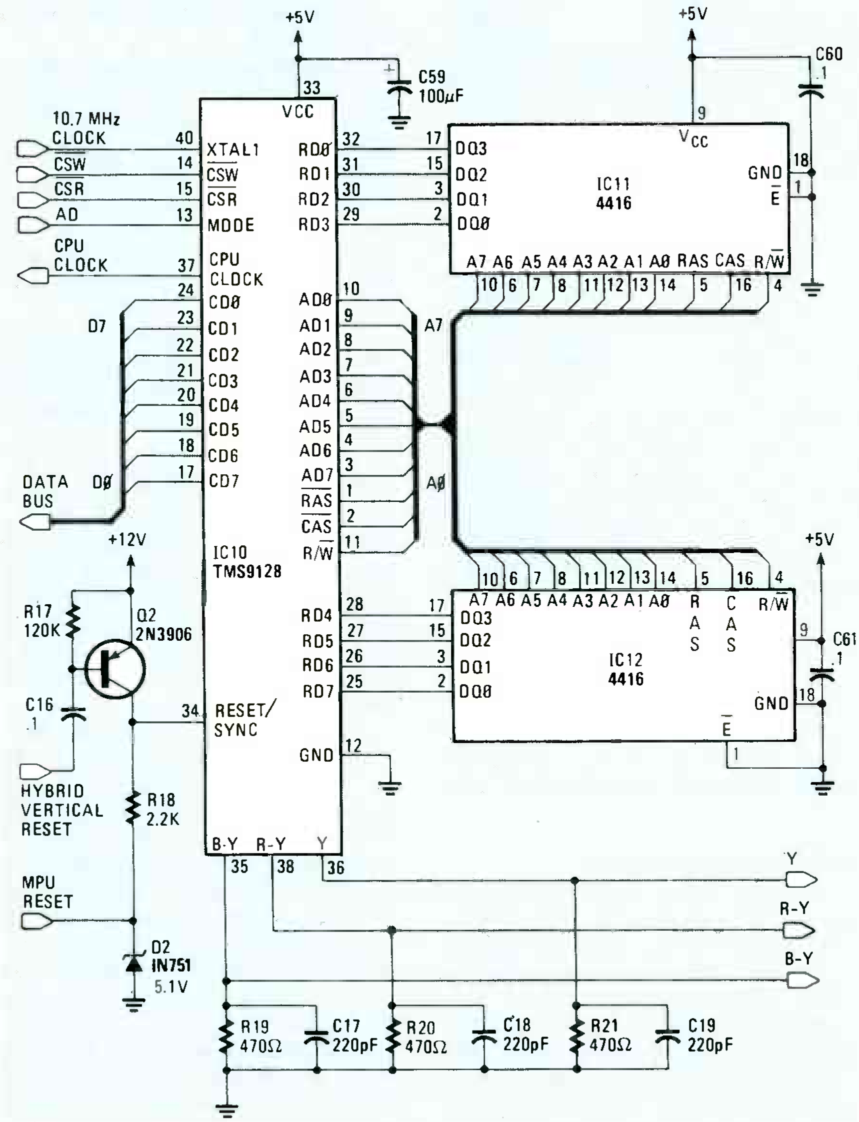


FIG. 10—THE VIDEO DISPLAY PROCESSOR section is the heart of the titler's video generator. The TMS9128 VDP (video display processor) directly interfaces to two 4416 16K × 4 dynamic RAM's.

PARTS LIST

Note: This is a corrected Parts List and supersedes that shown last month.

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

RN1—10,000 ohms × 9 resistor network
R1,R16—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, C45, 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
C56, C57—100 μF, 25 volts, electrolytic
C46, C52, C59, C67, C69, C71—47μF, 16 volts, electrolytic
C54—2200 μF, 25 volts, electrolytic
C55—4700 μF, 16 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 4K × 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—75L05 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.

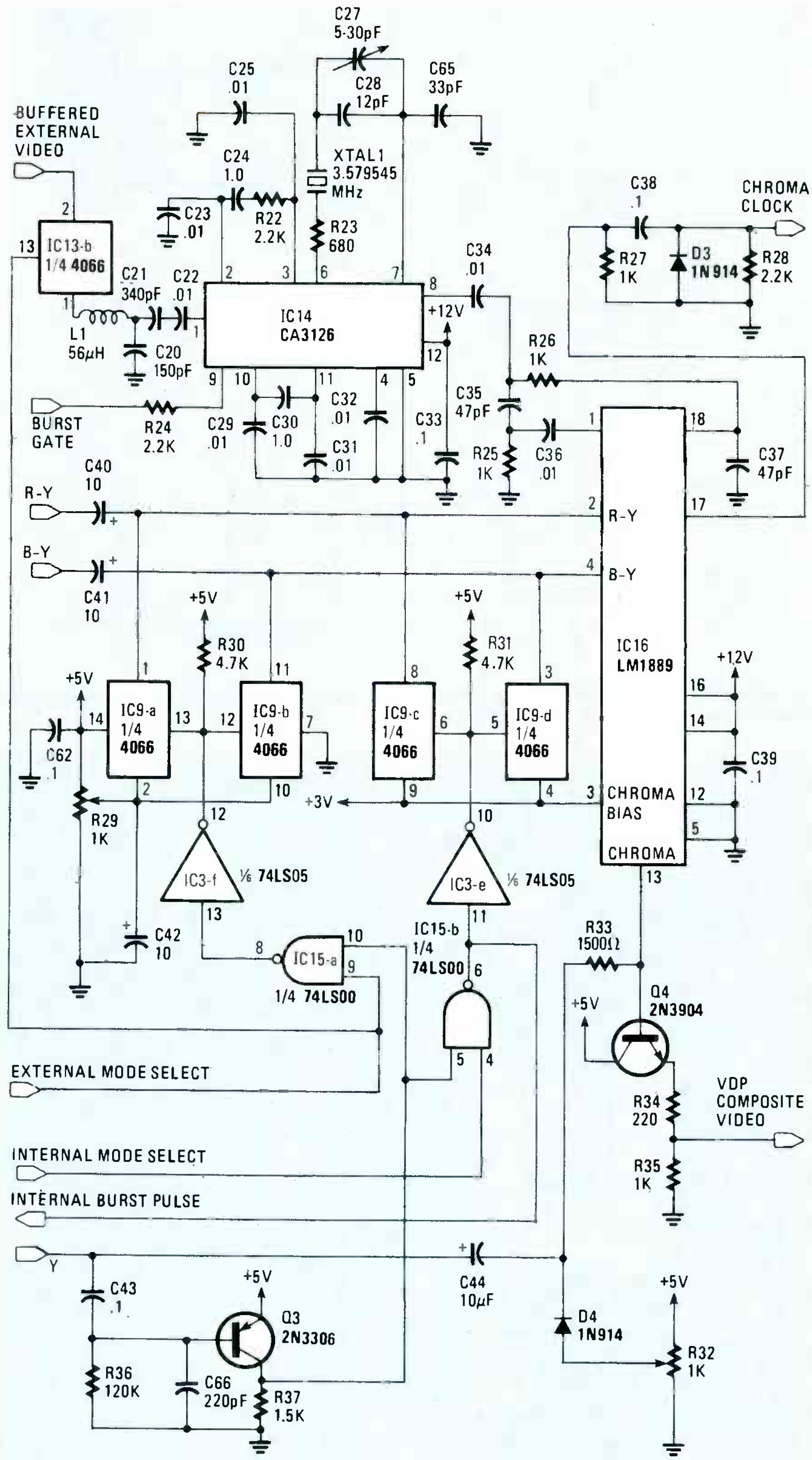


FIG. 11—THE CHROMA PROCESSING section is responsible for generating proper VDP color. IC14, a CA3126 chroma processor, generates a 3.58-MHz sinewave that is phase-locked to the external video signal's colorburst. That is necessary for proper VDP color.

titler's signal is in phase with the external colorburst.

In the internal mode, the crystal used by IC14 is allowed to free-run.

The VDP "Y" signal has no chrominance (or color) portion. In order to add color, the VDP has two color-difference signals: R − Y and B − Y.

Figure 12 is an illustration of the VDP video signals. The color-difference signals represent color information as positive or negative excursions from a center voltage (Fig. 12-a). The chroma modulator, LM1889 (IC16), converts the color-difference signals into a chrominance signal which modulates the VDP

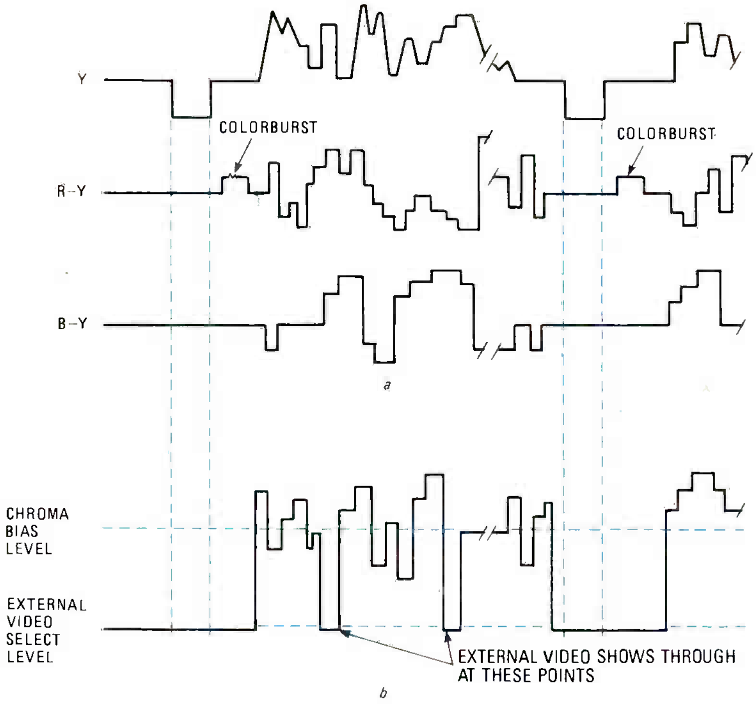


FIG. 12—VIDEO DISPLAY PROCESSOR SIGNALS. In *a*, we see the VDP signals in the internal mode, while *b* shows signals in the external mode.

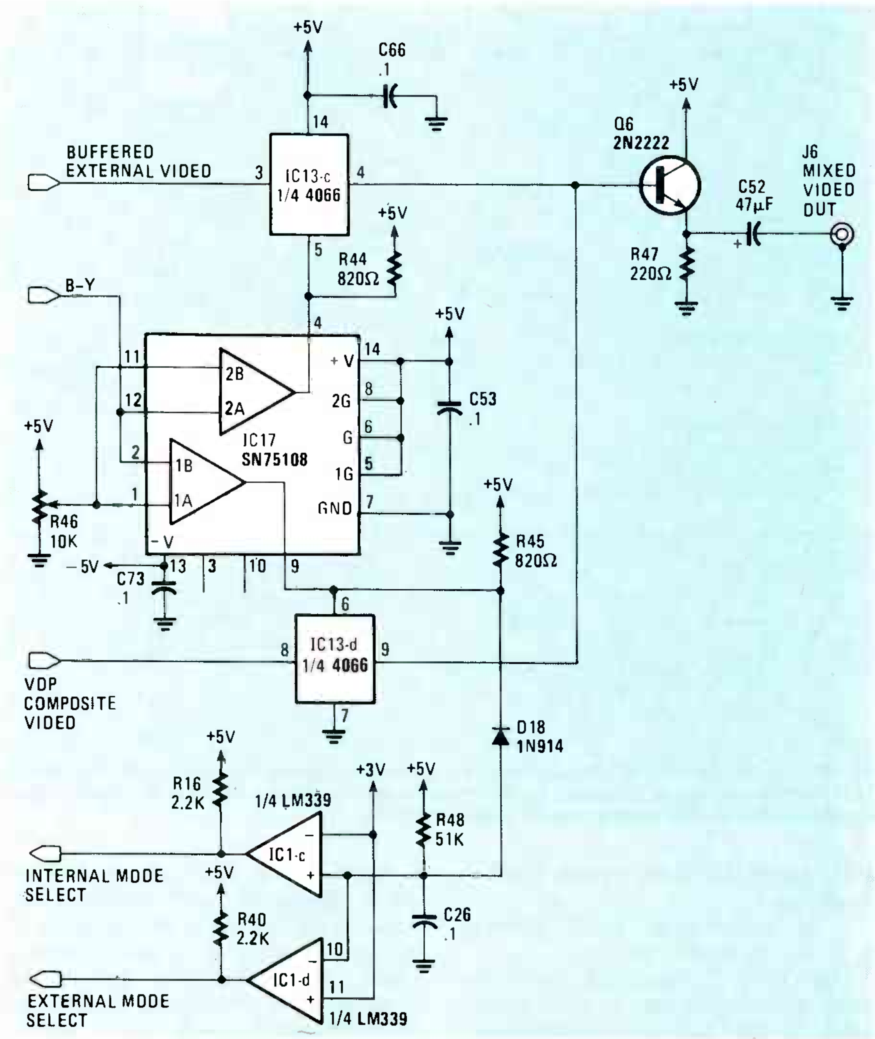


FIG. 13—THE VIDEO MIXER/BUFFER section of the video titler determines whether the VDP video or the external video signal is sent to the output.

"Y" signal through R33. One requirement of the LM1889 is that the center voltage of the color-difference signals must be stable. This stable reference is referred to as the *chroma bias* (pin 3, IC16).

The method used by the titler to DC-clamp the center voltage of the color-difference signals is to introduce the chroma bias voltage during the sync period when the signals are at the center voltage. That works fine while in the internal mode, but, the color-difference signals function differently in the external mode.

Figure 12-b shows how the color-difference signals fall to a special level to signify that the external video should be selected for display. As will be discussed later, the external video-select information is derived from the B – Y signal.

In order to establish a constant chroma bias during external mode, the titler introduces a different voltage to the AC-coupled color-difference signals. That voltage is adjustable via R29.

A positive-going VDP sync pulse is generated by Q3, C43, R36, C66, and R37. That pulse determines *when* the voltage is introduced, while the EXTERNAL MODE SELECT and the INTERNAL MODE SELECT signals are used to determine *which* voltage is introduced. Those two select-signals turn on the appropriate set of analog switches in IC9.

Other areas within the chroma-processing section include the VDP video level adjustment, which consists of C44, R32, and D4. That adjustment establishes the proper DC level of the VDP video before mixing with the external video signal. The chroma clock, a TTL-compatible 3.58-MHz signal, is used as a PLL reference during internal mode.

Video mixer/buffer

The video mixer/buffer determines whether the VDP video, or the external video signal, is fed to the titler's output. Its schematic is shown in Fig. 13. Using the B – Y signal, a high-speed comparator (IC17) switches on one of the two analog switches (IC13-c and IC13-d). R46 is used to adjust the level at which the switching will take place. The external video signal is buffered by Q5 and R43 (see Fig. 7), while Q6, R47, and C52 provide the necessary drive and impedance for the output signal.

The remaining two comparators (IC1-c and IC1-d) are used to generate 2 mode-select signals. In the external mode, C26 discharges through D18 and causes a high on pin 13 and a low on pin 2 of IC1-c. In the internal mode, D18 is reverse biased, which allows C26 to charge through R48. That reverses the outputs on pins 2 and 13.

We're out of room for now. When we pick up again, we'll look at the microcomputer section, build the titler, and take an indepth look at the titler's software. **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.

JOHN LENK

Part 2 THIS MONTH, WE'LL turn our attention to the features found on a typical CD player. But first, let's finish our look at how CD players work.

Constant linear velocity

The CD is scanned by the servo-controlled optical pickup at a constant linear velocity of 1.3 meters-per-second. To get that scan rate, the rotational speed of the disc is progressively changed from 500 rpm at start-up to 200 rpm at the outside edge of the disc. That allows the data stream of digital information to be taken from the disc at a constant rate.

The data from the disc is stored in a memory. That memory is allowed to fill to half-capacity, then data is taken from the memory at the same rate as the specified input rate. As long as those rates are actually equal, the memory's "half-full" condition is maintained. But if incoming data is received at too fast a rate, the memory exceeds the half-full condition, and an error signal is developed. That error signal is applied to the turntable motor, and disc speed is reduced until the memory returns to the half-full condition and remains there. The opposite occurs if data is received too slowly.

With that scheme, changes in disc rotational speed have no effect on the rate at which data is removed from memory. As a result, disc-speed changes are not detected in the reproduced sound.

CD player features

Keep in mind that the features described here are found on most, but not all CD players. There are subtle differences in operating features that you must consider. For example, the disc compartment of some players must be closed manually, while most others are automatic. That can be a problem, particularly when you first begin CD player service. There is nothing more frustrating than troubleshooting a failure symptom when the player is supposed to work that way. Study the service literature before beginning any repairs!

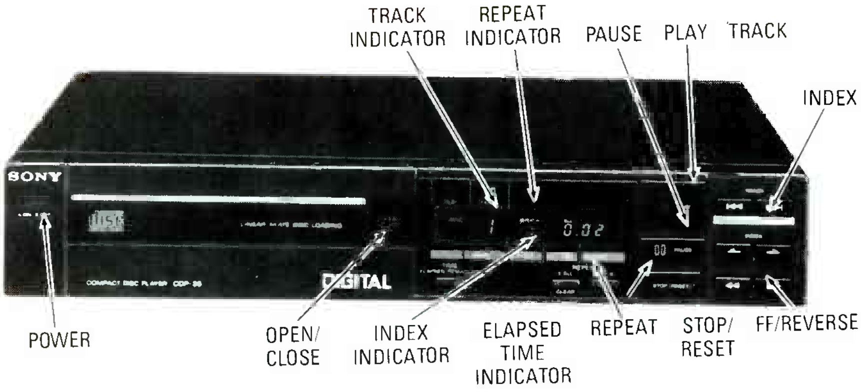


FIG. 7—FRONT PANEL of the Sony *CDP-30* compact disc player. This unit uses front loading.

CD players are available in both top-load and front-load models (see Fig. 7). The top-load models are best suited as stand-alone components, but can also be mounted as top-rack components in an audio system. On most top-load models, the disc compartment cover or lid is opened by a control (pushbutton), but must be closed by hand. Top-load CD players generally do not require a loading motor, and are thus mechanically simpler than front-load units.

Front-load units can be used as stand-alone components, or can be operated at any location in an audio system rack. With horizontal front-load units, you press a front-panel button to open a drawer or tray, insert the disc, and close the drawer (manually) or tray (with a control). With the tray version (the most popular type model) the tray is operated by a loading motor. One touch of an OPEN/CLOSE button moves the tray out to a position where the disc can be inserted (or removed). Another touch of the button causes the tray to be pulled in, and positions the disc over the turntable.

With the vertical front-load units, a loading motor opens and closes a vertical door (hinged at the bottom) so that the disc can be inserted and removed. On virtually all CD players, there are circuit breakers and safety switches (interlocks) that prevent operation of drive motors, and the laser, when the disc drawers/trays/covers are open.

The player normally plays from the beginning of the audio track to the end. If you wish, however, the *random-memory programming* feature allows you to preset up to 15 programs (individual selections on the disc) for playback in any order. That feature is made possible by the system-control microprocessor, which reads codes on the discs (transmitted along with the the audio) and causes the player to reproduce only the desired selections and in the desired sequence.

CD's are digitally-encoded at the beginning of the program material so the player will know the length of the audio track. Also encoded at the beginning of each selection is an individual code that identifies the location of the particular selection. That system of identification (sometimes called the disc directory) allows each selection of the disc to be accessed (by the system-control microprocessor) on command.

Random-memory programming features are easy to use. Typically, you enter the number of the desired programs by first pressing a PROGRAM button, and then use buttons marked 1 and 10. If the first program you want to hear is the third program on the disc, you press the PROGRAM button and enter the number 3 by pushing the 1-button three times. The program indicator displays the number 3 for confirmation. Pushing the PLAY button after the full sequence has been entered starts playback of the program sequence entered.

Self-program search lets you skip forward and backward to locate the beginning of each program on the disc. Typically, you press the FF (fast forward) control once, and the pickup advances to the beginning of the next program (and begins playing the disc at that point). When you press the REV (reverse) control once, the pickup moves back to the beginning of the current program to begin play. If you press the REV control twice, the pickup moves back to the beginning of the previous program to begin play.

In the *disc scanning* mode, brief samples of programming at various point in the disc are played. When activated that mode causes a brief sample of the current program to be played. Then the pickup advances to a point approximately 30 seconds ahead (or behind) in disc play time, and another brief sample is played. That process continues as long as the disc scanning mode is engaged.

With *memory stop* you can mark any point on the disc for instant location with the RECV control. In either play or pause modes, you mark the current disc location (the beginning of a favorite program, for example) by pushing the MEMORY STOP control. The point can then be returned to while in either play or pause by pushing the RECV control. The pickup moves back to the memory stop location, and the player automatically goes into the pause mode. You then push the PLAY control to start play from the memory stop point.

Play of the entire disc, or play of a random-memory programming sequence, can be repeated continuously on most CD players. For play of the entire disc, you push the REPEAT control at any point prior to or during play of the disc. After the full disc is played, the pickup returns to the beginning of the audio track and the disc is played again. Repeat play of a random memory programming sequence is generated in the same way.

Typically, there are indicators on the front panel that show such thing as total disc-playing time, elapsed playing time, number and total time of the programs entered, (via random memory programming), and possibly the track being played or the index numbers of the selections being played.

Transit screw

Most CD players have a transit or transport screw used to hold the pickup in place when the player is moved or shipped. Without such a screw, the rotating-arm or slide can move back and forth, causing possible damage to the delicate optics. Typically, the transit screw is accessible from the bottom of the player.

Make certain to remove or loosen the transit screw before using the player, and to install the screw when transporting or shipping the player. Typically, the transit screw can be installed only when the optical pickup is in one position (the at-rest or secured position). That usually means turning on the power, shutting the tray, and then tightening the screw. When transporting the player, always install a transit screw. After transport, be sure to remove that screw (otherwise the player will not work).

Connecting a CD player

External connections between the CD player and stereo amplifier are usually made at the back of the player. Generally the only connection needed is between the player's left and right outputs, and the corresponding inputs on the amplifier. That connection is made with a stereo patch cord terminated at both ends with RCA-type phono connectors. Sometimes the appropriate cord is supplied with the player. If not, you should have little trouble obtaining one from the usual sources.

Although the connections are very simple, certain precautions must be observed for all players. Always connect the player output to the amplifier's AUX or TAPE-PLAY input; some newer amplifiers may also have an input labeled CD. Never connect the player to the PHONO input. The player's output is about 2 volts. That voltage level could damage the amplifiers or speakers, and will overdrive the amplifier, if the CD player is connected via the PHONO inputs. Even on CD players with adjustable outputs, the output impedance (about 50 kilohms) is best matched to the AUX or TAPE inputs on an amplifier. As with any other audio components, always switch off the power before making or breaking connections between the player and amplifier.

General operating notes

The following notes are a supplement to (not a substitute for) the operating and installation sections of the player-service literature.

Check to be sure that the CD is set to operate at the appropriate voltage level. Many of the newer players are for worldwide use, and can be set to operate at 120 or 240 volts. Usually, there are special connections, or switch settings, required for dual-voltage players. Always check the service and/or operating literature for such connections or settings.

CD players produce strong magnetic fields. Do not place video or audio cassettes on or near the player.

If the player is brought directly from a cold to a warm location, or is placed in a very damp room, moisture may condense on the optical pickup lenses. The player will not operate properly (if at all) should the lenses become fogged. In such a case, remove the disc and leave the player turned on for about an hour to evaporate the moisture.

Although the compact discs are not delicate, and should last "forever," the discs should be handled with some care (hold discs by their edges, don't touch the surface of the disc, keep the disc clean, etc.).

Never use solvents such as benzene, thinner, commercially-available cleaners, or anti-static spray intended for LP records to clean the discs. Any of those can eat through the CD sealant, and destroy the disc. However, there are cleaners specifically designed for CD's; those are the only ones that should be used.

Some CD players cause interference to radio and TV reception. Any such RFI problems can be eliminated in the usual manner.

With CD players, special attention should be paid to the setting of the amplifier's volume controls. The dynamic range of a CD player is much greater (90 dB or better) than any LP system, and the peaks are recorded with high fidelity. Also, you get much greater S/N ratio (also 90 dB or greater) with a CD player. (Background noise is practically eliminated in most CD players.) If you turn up the volume while listening to a portion of the disc where no audio signals are recorded (or to very low-level audio), the speakers may be damaged when that portion of the disc with peak signals is played. Likewise, if you are listening with stereo headphones connected to the front-panel of the player, and set the player volume in an attempt to hear background noise, the effect during the audio peaks can be devastating.

Safety precautions

In addition to all the usual precautions that should be observed during electronics servicing, the laser used in CD players requires some special consideration. As with any very intense light source, direct exposure to a laser can cause permanent eye injury or skin burns. Also, the light beam produced by the laser diode is invisible (in contrast to the red light produced by the laser used in videodisc players). Since the light is invisible, you can't be sure if the beam is present.

CD players are designed so that the operator has no contact with the laser beam. They are also designed so that the servicer has no contact with the laser. But that design can be defeated. Overriding safety interlocks, removing protective shields, etc., can subject you to direct contact with the operating laser, and that is something that should be avoided. Always be on the alert for any laser warning labels during service.

Most CD player manufacturers recommend some means of checking the laser diode without direct exposure to the beam. Study the service literature to find out more about it.

Here are some additional tips on checking the laser. Even though the laser beam is invisible, the diffused laser beam is usually visible at the objective lens. (The lens appears to glow when the laser is on.) Also, when power is first applied to the optical circuits, the objective lens moves up and down two or three times to focus the beam on the disc. So, if you apply power and see the objective lens moving, it is reasonable to assume that the laser is on and producing enough power.

That brings up some obvious problems. First, on most players, if you open the disc compartment and gain access to the lens, you must override at least one interlock. Next, many players have some provision for shutting down the player optics if there is no disc in place, so you must also override that feature. Most important, *never, never look directly into the objective lens with power applied to the player.* Also, keep your eye at least 12 inches from the surface of the lens. The purpose of the lens is to focus the beam sharply onto the disc. Needless to say, the lens can also focus the beam sharply onto your eye!

Some manufacturers recommend that you not check the laser directly, but monitor the output of the photodiodes. If that output is normal, or can be adjusted so that it is normal, the laser must be functioning properly. Consult the manufacturer's service literature for more details.

While on the subject of the objective lens, keep in mind that the lens is a key part of a CD player. The lens surface must be clean and free of moisture. Try not to touch the lens surface, and keep the disc compartment closed, except when inserting and removing the disc. If too much dirt or dust accumulates on the lens, sound quality can be degraded. Dust can be removed with an air blower such as used to remove debris from a camera lens.

As with MOS/CMOS devices, the laser diode can suffer electrostatic breakdown. Treat the laser diode as you would a MOS/CMOS or any other electrostatically-sensitive part. That includes placing a conductive sheet on the workbench, using wriststraps, etc. Keep in mind that the laser diode is usually considered part of the optical system or pickup assembly, and that most player manufacturers recommend replacement of the complete assembly as a package (and often ship the replacement pickup in a bag made of conductive material to prevent static breakdown).

Test equipment and tools

The test equipment used in CD player service is basically the same as that used for servicing conventional audio equipment. However, one piece of equipment bears special mention.

That is a test disc (also known as a check disc, reference disc, or alignment disc). Those discs are available from some CD player manufacturers. A test disc is essentially a standard CD with several very useful signals recorded at the factory using very precise test equipment and signal sources. You play the test disc and note the player's response (or use the disc signals for adjustment). Of course, you can use any known-good disc for a final, after-service check of the player, but such a disc will not provide you with the necessary signals to perform the response tests and/or adjustments.

Some CD player manufacturers supply special tools for service; others do not. Always use the recommended tools. Keep in mind that most CD players are manufactured in Japan, and as such the hardware, etc., adheres to the metric standard. When we continue this article, we will describe some of the special tools used in CD service.

Now that we have gotten some of the preliminaries out of the way, it's time to turn our attention to some typical CD player circuits.

Typical circuits

Now that we know a little more about how CD players are supposed to operate

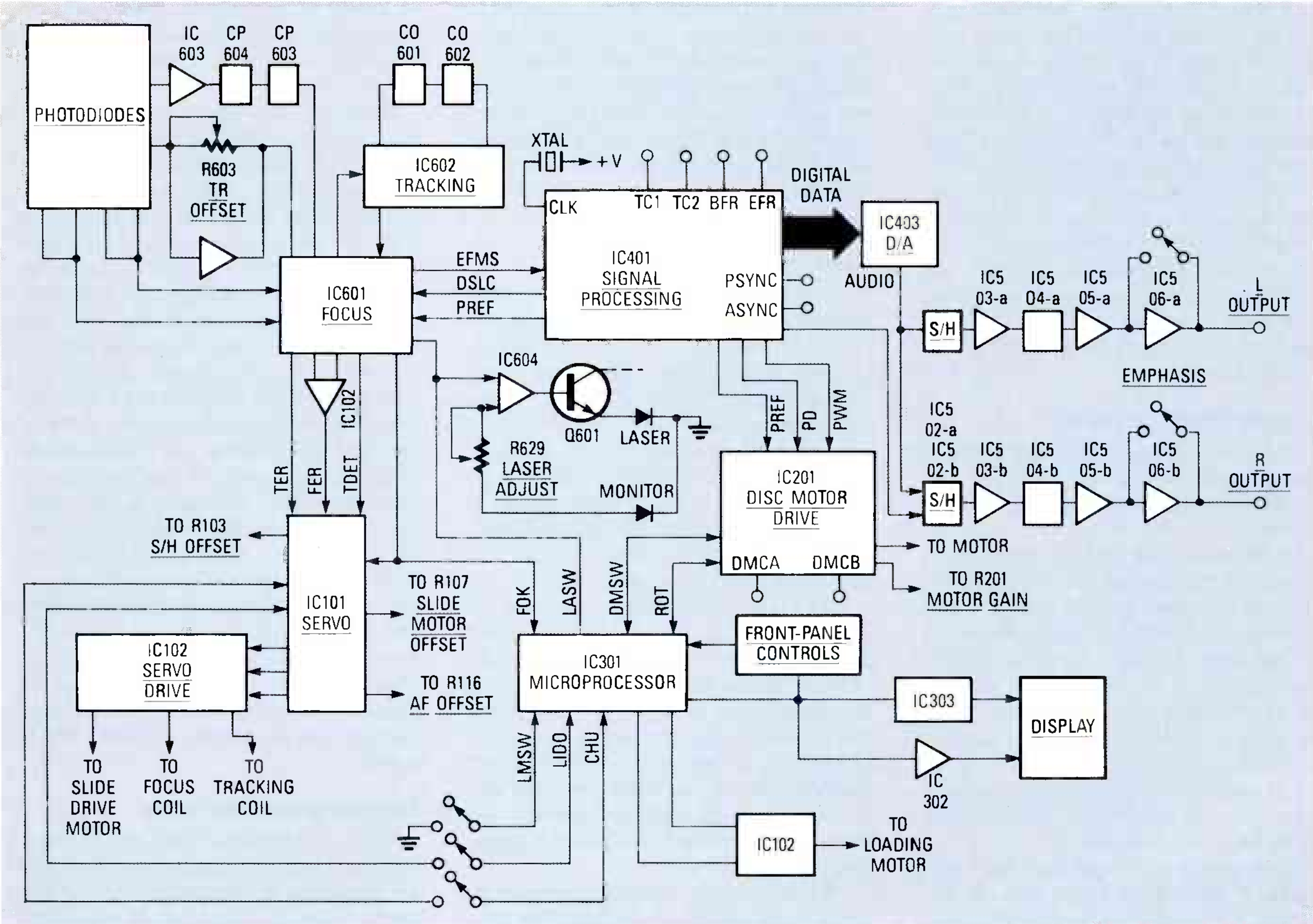


FIG. 8—THE MAJOR FUNCTIONS of a typical CD player are shown in this block diagram.

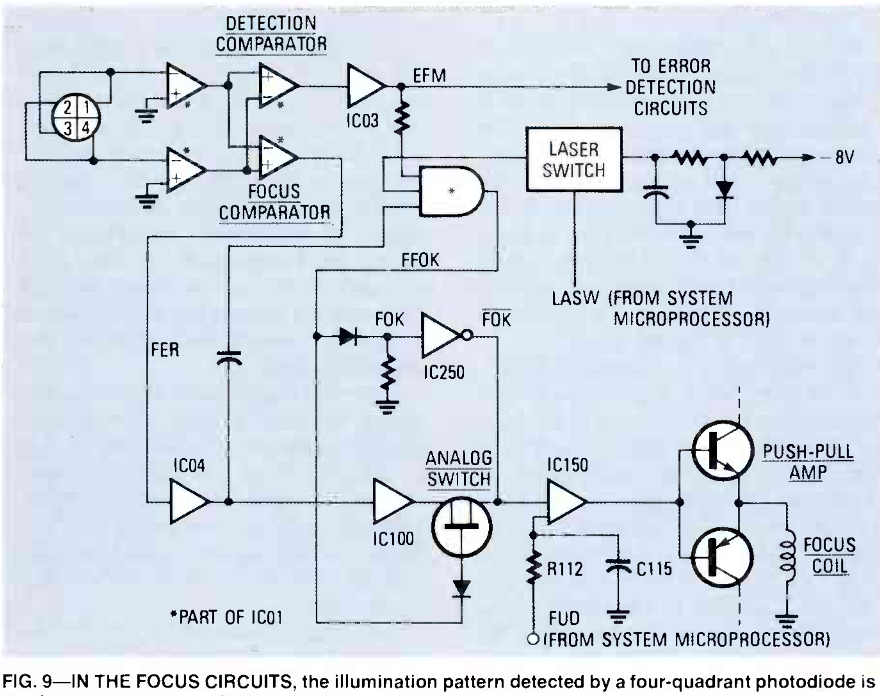


FIG. 9—IN THE FOCUS CIRCUITS, the illumination pattern detected by a four-quadrant photodiode is used to derive the focus information.

when everything is fine, it is time to take a look at the various circuits found in a unit and how they do their job. To keep things simple, we will concentrate on only one type of unit—front-loading players that use a slide or sled optical pickup system. Figure 8 is a block diagram of a popular player of that type. Note that most of the circuitry is contained on just a handful of IC's. Indeed, that is the case for many late-model units. But others, including most older models, feature a much lower degree of integration. Thus in the discussions of the individual circuits that follow, we will look at circuits that feature a much higher parts count; those circuits will be taken from a variety of players. Doing that will accomplish two things: First, it will familiarize us with some of the circuits we are likely to encounter in CD-player servicing; and second, it will help us learn more about how the various circuits function.

Figure 9 shows some typical focus circuits. As previously mentioned, a defraction grating is used to divide the main laser beam into three separate beams. The focus circuitry makes use of the center (brightest) beam. That center beam is focused on a a 4-quadrant photodiode. When properly focused by a cylindrical lens, the beam illuminates all four quadrants equally. If the beam is focused above the track, the lens causes the beam to illuminate the photodiodes in an elliptical pattern, with quadrants 2 and 4 receiving more light than quadrants 1 and 3. If the focal point is below the track, the photodiodes are still illuminated in an ellip-

THIS CD PLAYER features remote-control convenience and 19-step program capacity.

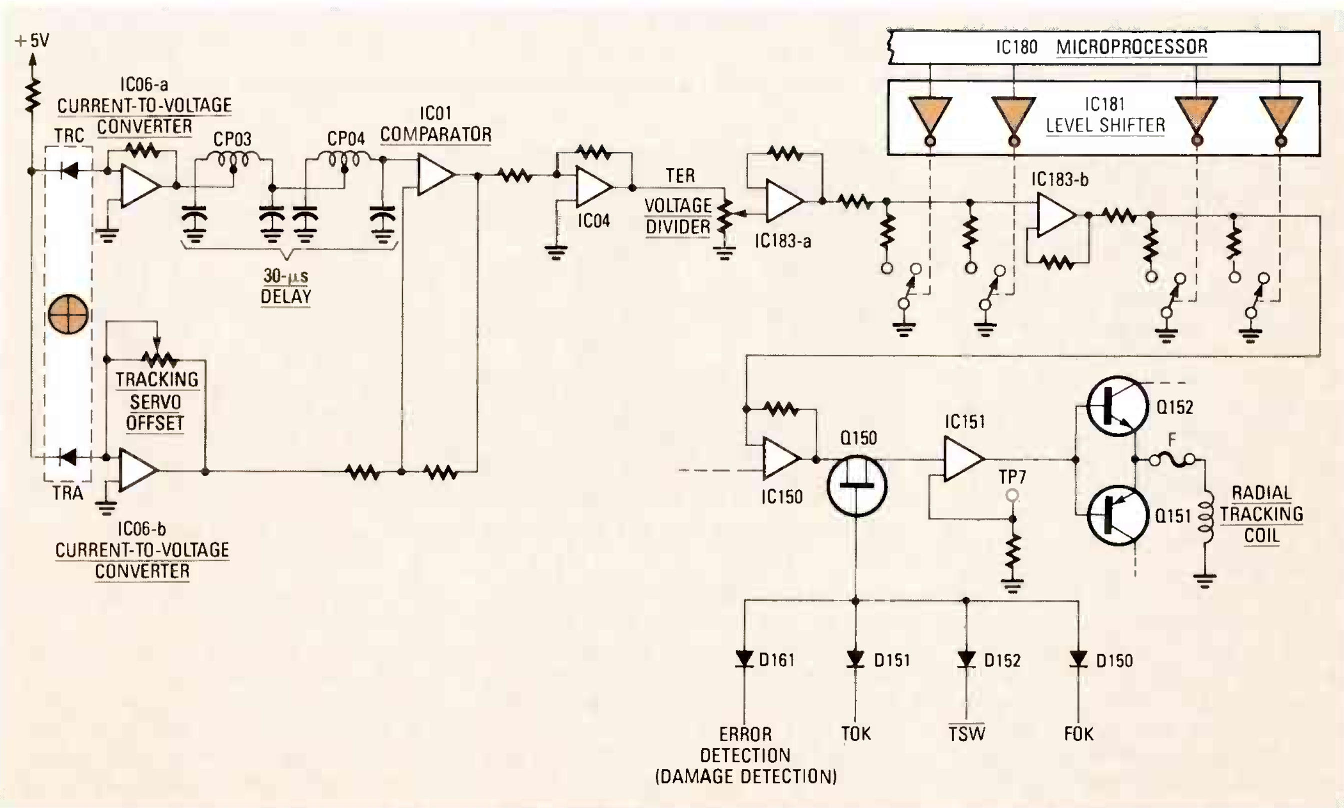


FIG. 10—THIS RADIAL-TRACKING CIRCUIT is used to make sure the laser beam correctly follows the track of pits and flats.

tical pattern, but quadrants 1 and 3 receive the greater amount of light. The focus circuits move the lens up or down to maintain good focus.

Let's see how the focus circuits work. The outputs from the two pairs of photodiodes are applied to the inverting inputs of two comparators. The outputs of the first pair of comparators are applied to the inputs of a second pair of comparators. One of those is for signal-detection; its output is used by the signal detection circuits (those will be discussed shortly). The other is the *focus comparator*. When in focus, the beam illuminates all quadrants equally, causing the inputs to the focus comparator to be equal. As a result, the output of the comparator is zero (or, more accurately, a fixed DC reference).

If the beam goes out of focus, either the even (2,4) or the odd (1,3) quadrants receive more light. The result is a time-varying positive or negative voltage deviation from the reference level at the output of the focus comparator. That deviation signal is called the *F*ocus *ER*ror signal, or FER. The FER signal is amplified by IC04 and IC100, and is applied through a FET-type analog switch to IC150. The FET is turned on by a high *F*ine-*F*ocus-*OK* or FFOK signal. The FFOK signal is produced by an AND gate in IC01. The AND gate produces a high FFOK output only when all three inputs (from the focus and signal detection comparators, and from the laser-monitor diode) are high. The output from IC150 is amplified and used to control the positioning of the cylindrical lens.

When a disc is first loaded, a rough focus is produced by the *F*ocus-*U*p/-*D*own, or FUD signal from the system microprocessor. The FUD signal consists of two 1-second squarewave pulses that are applied to IC150 through integrator R112 and C115. That causes the lens to move up and down two times. The first time the lens starts to move, the laser turns on. The lens stops when an $\overline{\text{FOK}}$ signal (derived from the FFOK signal) is applied through IC250 to IC150. If no disc is detected (no reflection) the first time, the lens moves toward the disc a second time (on the second FUD pulse). The system microprocessor shuts the system down if no disc is detected a second time.

Radial tracking

Figure 10 shows show some typical radial tracking circuits. If everything is working normally, the two tracking, or first-order beams, precede and follow the main beam as it sweeps along the track. Also, the tracking beams are slightly offset from the center beam. To be more specific, half of each tracking beam is focused on the pit, while the other half is focused on the reflective area between the pits. Each beam is detected by its own photodiode (TRA or TRC).

The output of photodiode TRA is applied to an op-amp that is configured as a current-to-voltage converter. The converter gain is set by the *tracking servo offset* control. The output of that converter is applied to one input of a comparator. The output of TRC is also connected to the comparator, but via a 30-μs delay (CP03 and CP04). The time delay is necessary because the tracking circuits require that the TRC and TRA beams sweep the same point on the disc and that the photodiode outputs that are generated as a result must reach the input of the comparator simultaneously.

With proper tracking, the outputs of TRA and TRC are equal, and the comparator output is zero. If the main beam drifts, the TRA and TRC outputs are different, and the comparator output varies above or below 0 volts. The comparator output is called the *T*racking *ER*ror, or TER; it is amplified and applied to IC183 through an adjustable voltage divider. IC183 provides a variable gain function. The amount of gain is varied by switching resistors into and out of the circuit. That switching is under control of the system microprocessor, via IC181. During the initial read of the disc, the gain is set to a predetermined level; that gain remains constant as long as the unit is in the play mode. When the player enters the jump or search modes, the gain is changed to a different predetermined value, called the *TYP* gain (about 0 dB). In most late-model CD players, the system microprocessor is programmed to compensate for variable signal levels from the disc.

From IC183, the TER signal is gated by Q150, and applied to the radial tracking coil through IC151 and Q151 and Q152. As shown in Fig. 10, FET Q150 is gated on by signals from four different sources. Four diodes (D150, D151, D152, D161) must all be reversed-biased by those sources to gate Q150 on. One source, $\overline{TSW}$ is generated by the system microprocessor. We have already discussed FOK. The other two sources, TOK (*T*racking *OK*) and error (damage) detection will be discussed later in this article.

Figure 11 shows the circuits used to detect and decode the information recorded on the disc. When a pit is present, the main beam is absorbed and no reflection occurs. When a pit is not present (a flat), the beam reflects back to the 4-quadrant diode. The diode outputs are processed by IC01 as previously discussed and then amplified by IC03. The output from that IC is called the EFM signal; it is sometimes also called the HF signal, the RF signal, or the eye pattern. In the EFM signal, sinewaves are used to represent digital information.

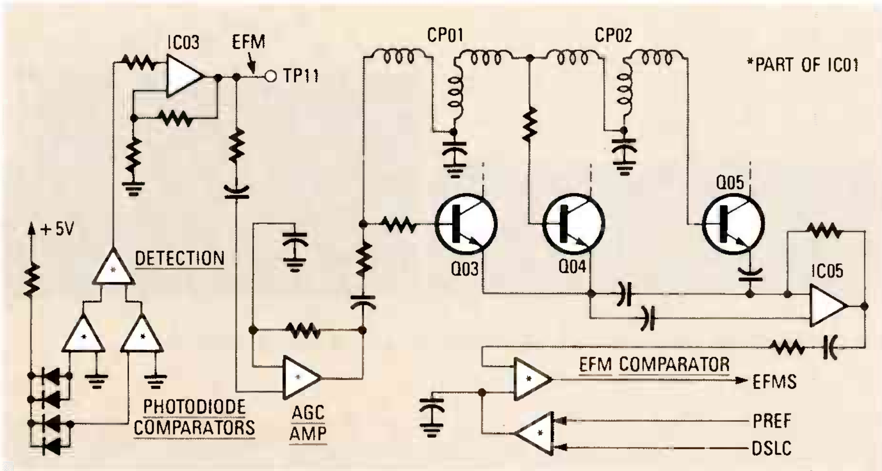


FIG. 11—THIS CIRCUIT is used to detect and decode the information stored on the disc.

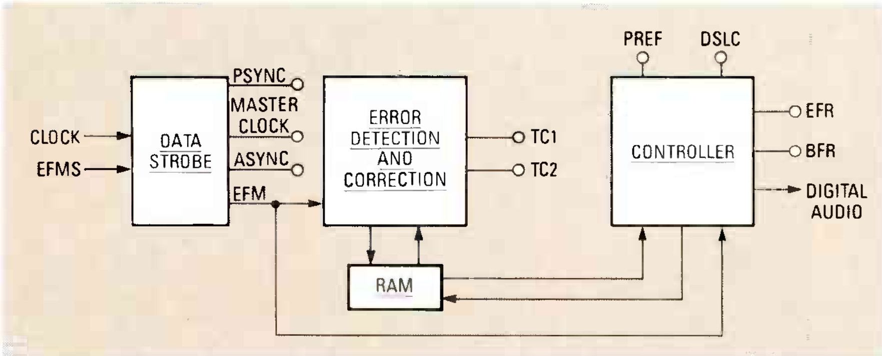


FIG. 12—THE SIGNAL-PROCESSING circuitry in a CD player can not be altered or adjusted.

The EFM signal is next fed to an AGC amplifier and then to an equalization network (actually a transverse filter) composed of Q03, Q04, Q05, CP01, CP02, and IC05). The transverse filter ensures that the high-frequency components of the EFM signal have the same amplitude as the low frequency components. The filter output is applied to a comparator called the *EFM comparator* (more on that in a moment) and then fed to the signal processing circuits (see Fig. 12). In the signal processing circuits, the signal is detected by the *data strobe* and then passed to the *controller*. The controller develops two squarewave signals—the *D*ata *S*lice *L*evel *C*ontrol, or DSLC, and the *PREF*erence pulse, or PREF. Those signals are fed back to IC01, where they are combined and used to form the threshold voltage for the EFM comparator. That comparator shapes the EFM signal into a squarewave. The resulting signal is called the EFMS signal and is the EFM signal in true digital form.

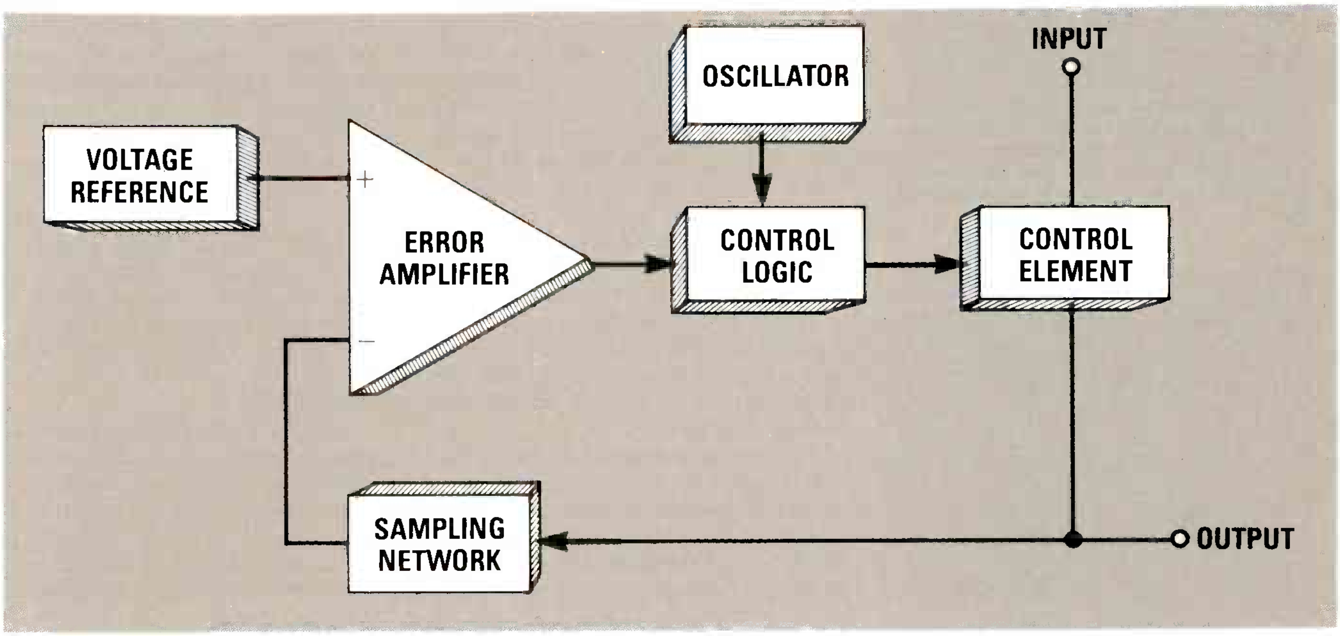
Next, let's look at the signal processing circuitry a little more closely. Those circuits, which are shown in Fig. 12, process the digital signal so that it can be applied to the D/A converter (where the digital information is converted to audio).

Typically, all of the signal processing circuitry is contained within one to four IC's; the following is a brief description of the major functions performed within those IC's. Keep in mind that the functions can not be altered, adjusted, or even checked, since the circuits are not accessible. At best, you can check inputs and outputs at the IC pins during troubleshooting. (We will show you how that is done later on in this article.)

The major function of the data strobe is to detect and generate sync pulses derived from the EFMS signal. The main function of the *error detection and correction* circuit is to demodulate the EFM signal, and restore the signal to its original 16-bit form (using processes known as C1 and C2 decoding). The error detection and correction circuit also has the task of processing control and data information. The controller governs many of the digital circuit functions, but its main function is to address memory locations in the RAM. The controller also has the responsibility of outputting the 16-bit digital audio signal to the D/A converter.

That's all we have room for this month. Next time, we'll finish up our look at CD-player circuits. After that, we'll begin to examine the mechanical systems in those devices. **R-E**

Switching Power Supplies



You too can design switching power supplies! In this article we present you with the theoretical background and several experimental circuits.

VAUGHN D. MARTIN

SWITCHING POWER-SUPPLY DESIGN HAS long been regarded as something of a black art practiced only by magicians and wizards. However, recent innovations in electronics have provided us with components that simplify such designs considerably: high-density IC's, high-permeability ferrite inductor cores, and high-power, high-speed switching transistors. We will review fundamental power-supply operation, discuss underlying switching-supply theory, and then present theoretical and practical information on how to design switching supplies using two popular LSI IC's. To simplify your design tasks, we include complete schematics, parts lists and PC artwork for several functional switching power supplies.

Regulator basics

Any regulated DC power supply—switching or linear—is governed by a feedback mechanism that senses changes in the output voltage and generates a control signal to compensate for those changes. As shown in Fig. 1, the basic *linear* voltage regulator has four major components:

- 1) A voltage reference
- 2) An error amplifier
- 3) A feedback mechanism
- 4) A control element

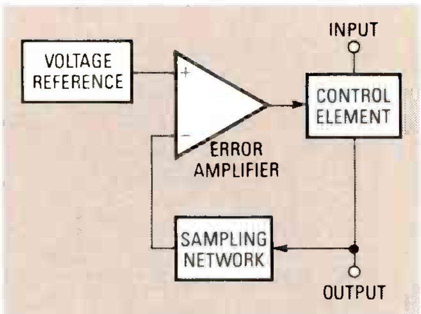


FIG. 1—THE FOUR BASIC COMPONENTS of a linear regulator are shown here. The control element is a transistor operated in the common-base mode.

The control element is usually a transistor operated in the common-base mode. Its base current determines the current flowing through its emitter-collector circuit, and thus, indirectly, the output voltage of the regulator. That base current is supplied by the error amplifier, usually an op-amp. The op-amp compares an internal reference voltage to a portion of the control element's output voltage. The op-amp's output is proportional to the difference between those voltages, and that is what controls the base current, and hence the collector current, of the control element.

Not shown in Fig. 1 is additional circuitry that protects the regulator from over-current and over-heat conditions. Like the error amplifier, the protection circuit samples a portion of the output voltage; the output of the protection circuit would be connected to the base of the series pass transistor, and would force the transistor into cutoff when it sensed an overload condition.

In a linear regulator the series-pass transistor operates in the linear region; that is, current flows through the transistor continuously as long as the input voltage exceeds the minimum necessary to keep the regulator working. (Output may also be cut off, as we discussed above, because of thermal or over-current shutdown.) But a regulator does not necessarily have to operate in such a fashion. It is possible for it to switch rapidly between saturation and cutoff, remaining in the linear region only for the short period of time required to perform the switching action. That is the basis of the *switching* regulator.

Fight or switch?

Although it might seem odd to operate a power supply in such a manner, with proper circuit design much greater efficiency can be obtained than with linear operation. Output voltage in the switch-

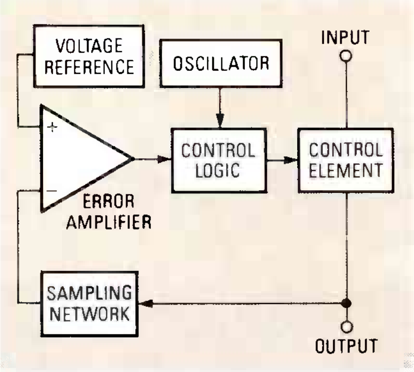


FIG. 2—**SWITCHING REGULATORS** differ from linear regulators by the addition of control logic and an oscillator; the latter allow control of frequency, duty cycle or both, and those parameters determine the regulator's final output voltage.

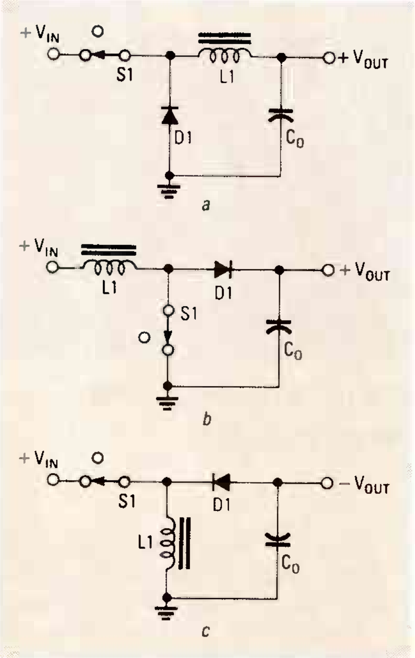


FIG. 3—**THREE BASIC** switching regulators are shown here. Step-down, step-up, and inverting regulators are shown at *a*, *b*, and *c*, respectively.

ing mode is controlled by varying the duty cycle, the frequency, or both, of the signal that turns the transistor on and off. As shown in Fig. 2, the switching regulator is conceptually similar to the linear regulator. The blocks labeled "control logic" and "oscillator" are what allow the duty cycle or frequency to be controlled.

Switching supplies allow greater efficiency than linear supplies, but that is not their only advantage. As shown in Fig. 3, by rearranging a few components, the same basic circuit can be made to step the input voltage down (*a*), to step it up (*b*), or to invert its polarity (*c*). And inversion may happen simultaneously with the step-up and step-down functions.

In each of the circuits shown in Fig. 3, S1 is represented as a mechanical switch, but in the circuits we will be concerned with, it is actually an electronic multivibrator whose duty cycle, frequency, or both may be varied by connecting appropriate components. In the past (that is, before the invention of high-voltage, high-power semiconductors, and LSI IC's), that switching action was performed by rotating machinery.

In Fig. 3-*a*, the coil-capacitor network may be thought of as an energy reservoir that is fed by the power source each time the switch is closed. The diode serves two functions. First, it provides a discharge path for the coil so that when the switch opens, there will be no arcing. Second, it also provides a path through which the current that is stored in the coil and the capacitor may flow while the switch is open. That helps smooth the rough sawtooth that is the normal product of such switching into a fairly "flat" triangle wave. Thus, less noise is generated, and the average DC value of the output voltage is higher than it would be without the return diode. That type of circuit is known as a *series* switching supply, because the switching device is in series with the input voltage source.

By contrast, the step-up circuit in Fig. 3-*b* is called a *shunt* switching supply, because the switching device is in parallel with the input voltage. When the switch opens, energy stored in the magnetic field of the coil is released as a large spike that serves to charge capacitor C_O. Diode D1 here serves to prevent the capacitor from discharging through the switch while it is closed.

The inverter scheme in Fig. 3-*c* combines elements of both the step-up and step-down circuits. Again the switching device is connected in series with the voltage source; the coil again dumps its stored energy to the capacitor when the switch is opened. Here the diode ensures that the discharged energy flows "backward" through the load.

Modern switching regulator IC's usually contain the voltage reference, switching mechanism, protection circuitry and a low- to medium-current series-pass element. The circuit designer usually supplies discrete components to set the oscillating frequency of the switching supply, an appropriate inductor, and additional series-pass elements to increase the circuit's current output.

The three most popular switching voltage regulator IC's today are probably Signetics' NE5560N, National's LM3524 and Fairchild's μA78S40. Robert Frostholm explained the Signetics IC in the February 1980 issue of **Radio-Electronics**, so for the remainder of this article, we will concentrate on the latter IC's.

The LM3524

A *P*ulse *W*idth *M*odulator (PWM) is a circuit that varies the duty cycle of a pulse train while keeping its frequency constant. The LM3524 has a built-in PWM that is used to vary the "on" time of the series-pass elements. As shown in Fig. 4, the output of the oscillator drives a flip-flop that in turn drives two NOR gates. Note that they are driven out of phase by the flip-flop's Q and $\bar{Q}$ outputs. Also note that the IC's output is disabled by the comparator whenever its output goes high. That will happen whenever the error amplifier determines that the internal ref-

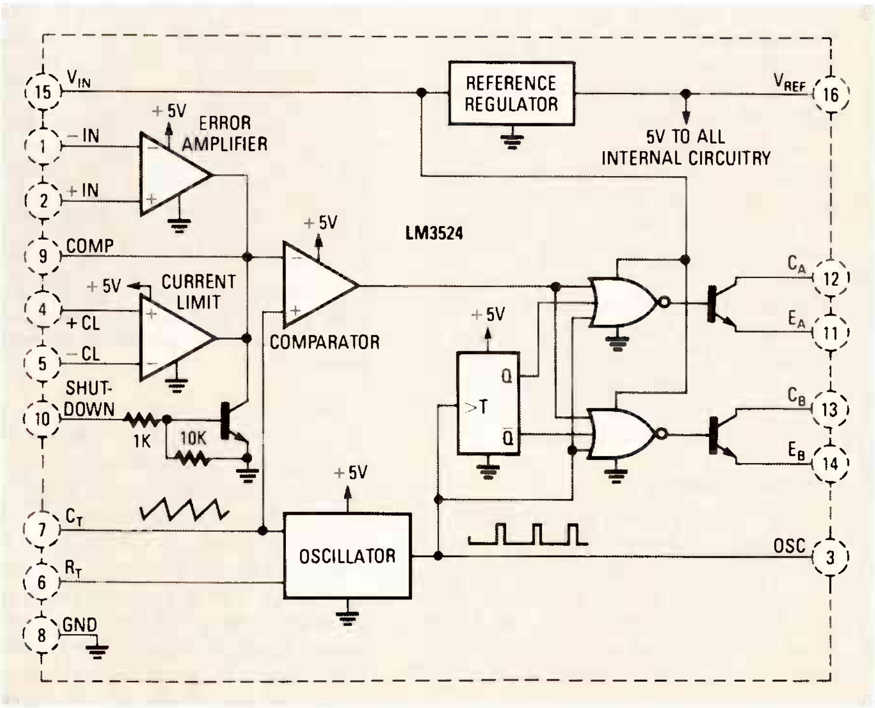


FIG. 4—**NATIONAL SEMICONDUCTOR'S LM3524** can tolerate a maximum input of forty volts, and can provide as much as 100 ma of output current.

erence voltage equals (or exceeds) the sampled portion of the output voltage. That will also happen whenever the current-limit amplifier senses an overload condition.

The LM3524 has a built in five-volt reference capable of supplying 50 mA to external circuitry. If V_{IN} applied to the regulator is less than eight volts, then the five-volt internal reference will not work properly, so pin 15 should be tied to pin 16. If more than six volts will be applied to the IC in that configuration, a pre-regulator should be used as shown in Fig. 5.

The frequency of the IC's internal oscillator is determined by external resistor R_T, and external capacitor C_T. The resistor should have a value between 1.8 K and 100 K: the capacitor should have of a value between 0.001µF to 0.1µF. A nomograph is presented in Fig. 6 that helps you select values for R_T and C_T, given a desired period of oscillation.

The error amplifier is a transconductance differential-input type with a nominal gain of about 80 dB; that gain may be set either by feedback or output loading, and loading does not necessarily have to be purely resistive. The output of the amplifier, which is also the input to the PWM, has an impedance of about 5 megohms, and that enables it to be overridden by a DC voltage, thereby forcing a desired duty cycle to appear at the output. The amplifier's inputs have a common-mode range of 1.8 to 3.4 volts, and the IC's on-chip regulator is typically used to bias the inputs to a value within that range.

The LM3524 performs its current limit-

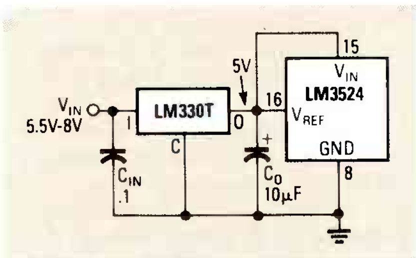


FIG. 5—PREREGULATION IS NECESSARY when using the LM3524 with input potentials between 5.5 and 8.0 volts.

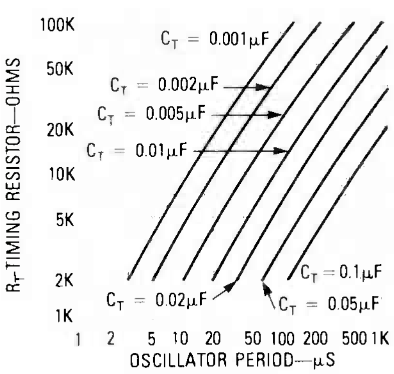


FIG. 6—TIMING COMPONENTS versus oscillator period are shown in this nomograph.

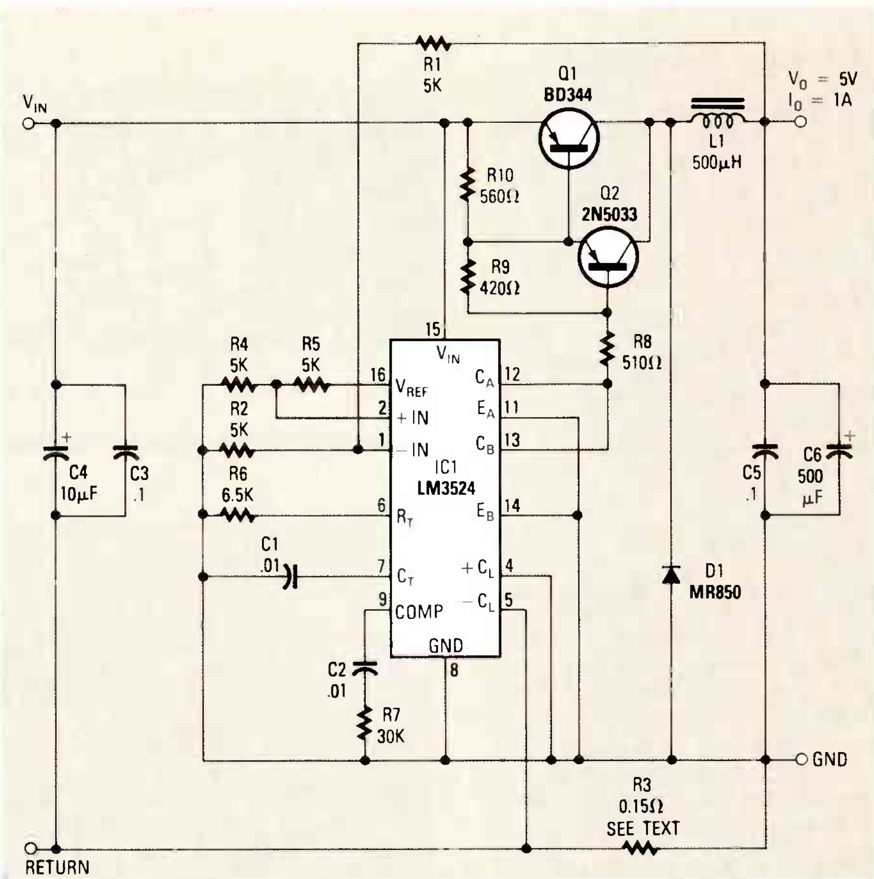


FIG. 7—A COMPLETE FIVE-VOLT, ONE-AMP SWITCHING REGULATOR may be built using the LM3524. Transistor Q1 should have a proper heatsink, such as the Staver No. V5-1.

TABLE 1—LM3524 SWITCHING REGULATOR CHARACTERISTICS

Parameter	Conditions	Characteristics
Output Voltage	V_{IN} = 10V, I_o = 1A	5V
Switching Frequency	V_{IN} = 10V, I_o = 1A	20 kHz
Short Circuit Current Limit	V_{IN} = 10V	1.3A
Load Regulation	V_{IN} = 10V, I_o = 0.2 − 1A	3 mV
Line Regulation	ΔV_{IN} = 10 − 20V, I_o = 1A	6 mV
Efficiency	V_{IN} = 10V, I_o = 1A	80%
Output Ripple	V_{IN} = 10V, I_o = 1A	10 mVp-p

ing by decreasing the width of its output pulses. The output duty cycle drops to about 25% when a potential of 200 mV is present between terminals +CL and −CL; 210 mV will reduce the duty cycle to 0%. The total potential difference between those two terminals must not exceed −0.7 to +1.0 volt.

The output stage of the LM3524 consists of two NPN transistors driven 180° out of phase with each other by the flip-flop. Each transistor is capable of supplying a current of 100 mA.

A practical regulator

A complete step-down switching voltage regulator is shown in Fig. 7. For proper operation, the input voltage should exceed eight volts. Transistor Q1 acts as the series control element; with proper heatsinking, it can provide a current of about 1 amp. Resistors R4 and R5 divide the IC's five-volt reference in half in order to bias the error amplifier's non-inverting

PARTS LIST—LM3524 CIRCUIT

All resistors ¼ watt, 5%
R1, R2, R4, R5—5000 ohms
R3—0.15 ohms see text
R6—6500 ohms
R7—30,000 ohms
R8—510 ohms
R9—420 ohms
R10—560 ohms
Capacitors
C1, C2—.01, ceramic disk
C3, C5—.1, ceramic disk
C4—10 µF, 35 volts, electrolytic
C6—500 µF, 10 volts, electrolytic
Semiconductors
IC1—LM3524, switching regulator
D1—MR850
Q1—BD344
Q2—2N5023
Other Components
L1—500 µH
Note: L1 is 40 turns of 22-gauge wire wound and evenly spaced on a Ferroxcube No. 502T300 toroid core, available from Permag Corporation , 400 Karin Lane, Hicksville, NY 11801; 516-822-3311.

PARTS LIST—µA78S40 STEP-DOWN CIRCUIT
All resistors ¼ watt, 5% unless otherwise noted
R1—1 ohm, 2 watts
R2—100 ohm trimmer potentiometer
R3—1300 ohms
R4—50,000 ohm trimmer potentiometer
R5—R7—not used
Capacitors
C1—100 µF, 35 volts, electrolytic
C2—.01, ceramic disk
C3, C4—1 µF, 50 volts, tantalum
C5—470 µF, 35 volts, electrolytic
Semiconductors
IC1—µA78S40, switching regulator
D1—1N4001
Other Components
J1, J2, J3—Banana jacks
L1—300 µH, Ferrite Potentiometer Core (Indiana General F1153-1-06-620); PC mounting bracket (Indiana General B662), and PC bobbin (Indiana General B657-12). See text.

PARTS LIST—µA78S40 STEP-UP CIRCUIT

Note—unless otherwise specified, all components are identical to components specified in the µA78S40 step-down circuit.

R5—180 ohms, ¼ watt, 5%
D1—not used

PARTS LIST—µA78S40 INVERTER CIRCUIT

Note—unless otherwise specified, all components are identical to components specified in the µA78S40 step-down circuit.

All resistors ¼ watt, 5%
R3—1000 ohms
R6—680 ohms
R7—100 ohms
Q1—2N6051

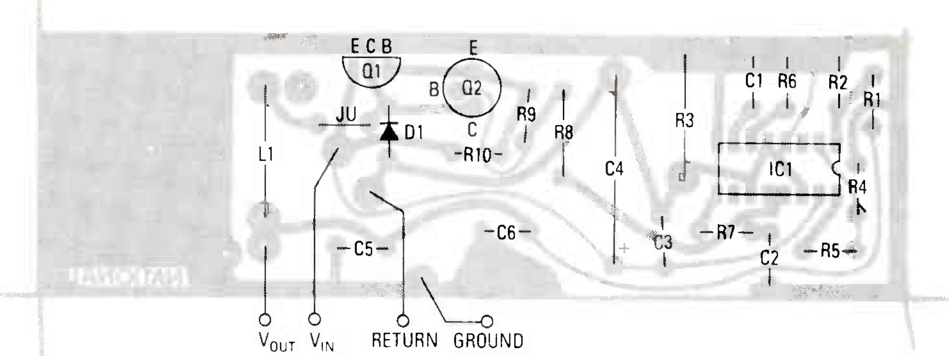


FIG. 8.—COMPONENT PLACEMENT DIAGRAM for the switching supply shown in Fig. 7.

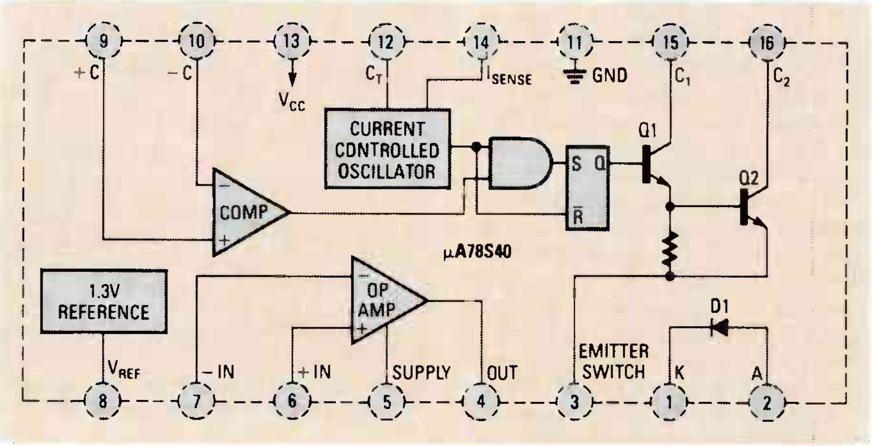


FIG. 9—FAIRCHILD'S µA78S40 is very similar to the LM3524. However, the Fairchild part also contains an uncommitted diode and an uncommitted op-amp that is similar to the popular 741.

input within its acceptable range. Each of the LM3524's output transistors is on for about 45% of the time, and they have been wired in parallel. That allows a duty cycle of as much as 90%, thus resulting in a lower input-voltage requirement, and greater overall efficiency. The output voltage is given by

$$V_O = V_{NI}(1 + R1/R2)$$

where V_{NI} is the voltage present at the error amplifier's non-inverting input (pin 2). The circuit's current limit is established by the value of R3 and is stated as: $I_L = 0.2\ V/R3$. In that case, $I_L = 0.2\ V/0.15\ \Omega = 1.3\ A$. Fabricate R3 by winding 1.45 feet of 30-gauge wire around a 100-ohm, ½-watt resistor.

Table 1 shows the characteristics of the power supply; and full-size artwork for a printed-circuit board may be found in the "PC Service" section of this magazine. A component-placement diagram is shown in Fig. 8.

The µA78S40

Whereas the LM3524 is a pulse width modulator, Fairchild's µA78S40 may be considered a variable pulse-width, variable frequency modulator. It is capable of operating from a supply as low as 2.4 volts, and it has a standby mode that draws only 2.4 mA at five volts. That is rather remarkable when you consider that the IC can handle 40 volts at 1.5 amps. Anyway, its low power requirements make the µA78S40 ideal for battery-powered operation.

A block diagram of the µA78S40 is shown in Fig. 9. The current-controlled oscillator (CCO) is probably the most important part of that IC. It's purpose is to generate the gating signal that turns output transistors Q1 and Q2 off and on. A single external capacitor controls the frequency of the CCO, which may vary from 100 Hz to 100 kHz. The duty cycle of the CCO is set internally to a ratio of 6:1, but that may be varied by manipulating the current-limiting circuitry attached to pin 14 (I_{SENSE}).

The µA78S40's manner of output-voltage control is somewhat more complex than that of the LM3524. The AND gate shown in the block diagram of Fig. 9 is fed by the CCO and a comparator. The comparator, as you have probably guessed, functions as the error amplifier we discussed above. The comparator is a high-gain differential type with a common-mode input range extending from ground to within 1.5 volts of V_{CC}. It functions to inhibit the µA78S40's "on" cycles. The comparator can inhibit several "on" cycles, one "on" cycle or any portion of an

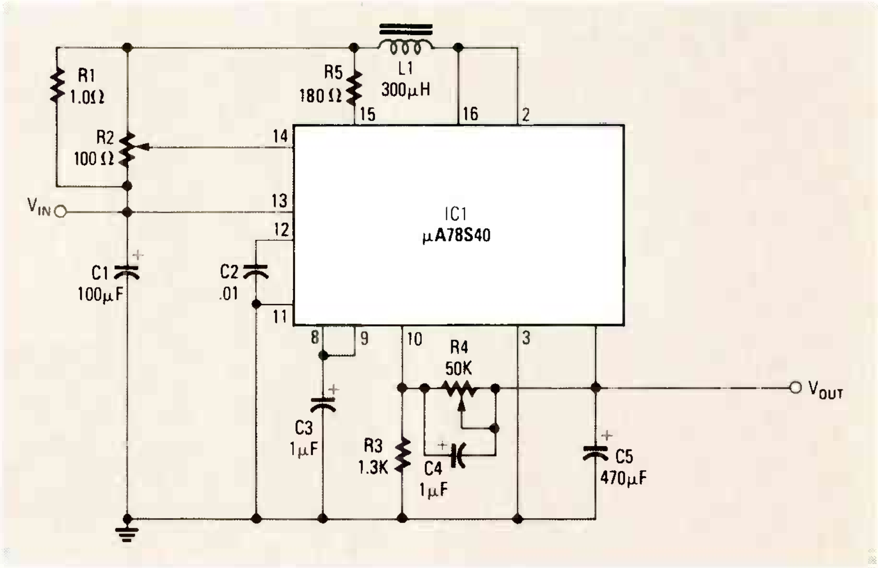


FIG. 11—THE μA78S40 USED IN A STEP-DOWN CONFIGURATION. Given a +25-volt input, the circuit provides +10 volts at 500 mA.

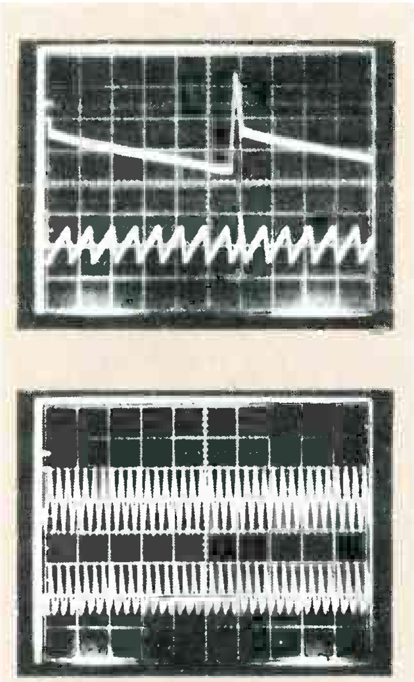


FIG. 10—KEY POINTS IN A μA78S40 circuit are shown in these scope photos. In both, the upper trace represents the output ripple, and the lower trace represents the voltage across the timing capacitor.

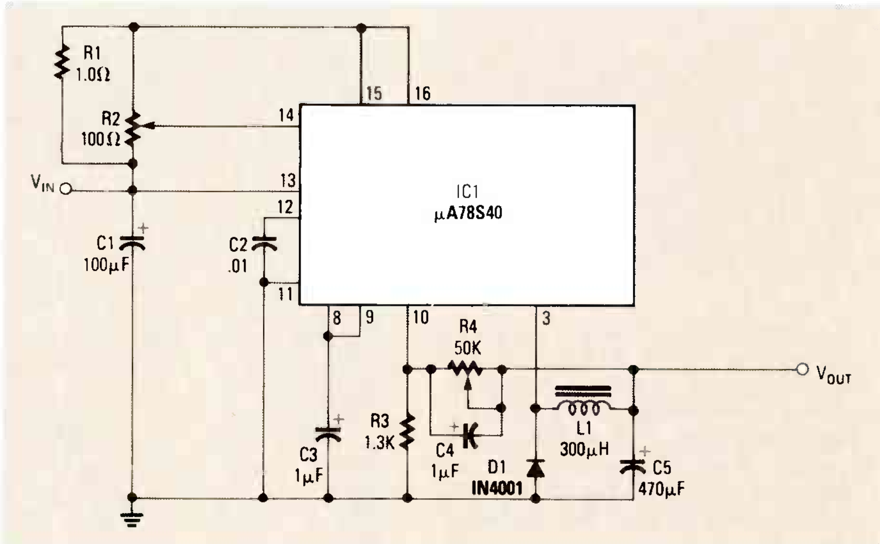


FIG. 12—THE μA78S40 USED IN A STEP-UP CONFIGURATION. Given a +10-volt input, the circuit provides 25 volts at 100 mA.

"on" cycle. After such a cycle has begun, the comparator cannot inhibit output until the beginning of the next "on" cycle.

The comparator samples a portion of the output voltage and compares it to the on-chip reference voltage. As long as the sampled portion of the output voltage is less than or equal to the reference voltage, the comparator remains high, so the flip-flop may be set and reset by the normal operation of the oscillator. If the output voltage exceeds the reference voltage, the comparator goes low. In that state, the AND gate cannot turn on, the flip-flop cannot be set, so the transistors will remain off.

The flip-flop is always reset during the negative-going ramp of the oscillator. And once the flip-flop is set, it will remain set until the negative-going ramp of the oscillator cycle. However, the current-limiting circuitry, which is temperature compensated, can speed up the reset action. The limiting circuit senses the output transistors' current across an external resistor. Current limiting is initiated when a 300 mV potential appears between pin 13 (V_{CC}) and pin 14 (I_{SENSE}).

Normally there is a steady current flow of about 50 μA into the timing capacitor, but when an overload condition is detected, that current is boosted to about 1 mA, and that causes the positive-going oscillator threshold to be attained more rapidly than it would without the additional current. Operation under such circumstances then causes a very short "on" time followed by the normal "off" time that is provided by the negative-going ramp of the oscillator.

The μA78S40's voltage reference is derived from an ultra-temperature-stable band-gap reference. A band-gap reference is a combination of several semiconductors that have both positive and negative temperature coefficients; they are arranged so as to exactly offset or cancel one another, and that results in a temperature coefficient of almost zero. In practical terms, that gives us a rock-steady reference voltage that is almost completely insensitive to temperature changes. The reference is capable of providing as much as 10 mA of current without additional circuitry.

Output transistors Q1 and Q2 are configured as a Darlington pair. That mode of DC coupling gives a very high gain that, as you recall, is the product of the betas of both transistors. For example, if each transistor has a beta of 250, then the overall gain will be beta^2, or 250 × 250 = 62,500. The collectors of both transistors are brought from the IC to the outside world separately, and their emitters are brought out together. They can handle as much as 1.5 A peak current at a collector-emitter potential of 40 volts, but still have excellent switching times ranging from 300 to 500 nanoseconds.

One special feature of this versatile IC is the inclusion of an uncommitted operational amplifier. It is a bipolar op-amp quite similar to the popular 741 type. However, its output capabilities have been boosted so that it can source 150 mA and sink 35 mA. Another improvement is that its common-mode input range includes ground.

The last major component of the

TABLE 2—JUMPER CONFIGURATION

Jumper	Down	Up	Invert
1	√		
2	√		
3	√		
4	√		
5	√	√	
6	√	√	
7	√		
8	√	√	
9	√		
10	√		
11		√	
12		√	
13		√	√
14		√	
15		√	
16		√	
17		√	
18		√	
19			√
20			√
21			√
22			√
23			√
24			√
25			√
26			√
27			√
28			√
29			√
30			√
31	√	√	√
32	√	√	√
33	√	√	√

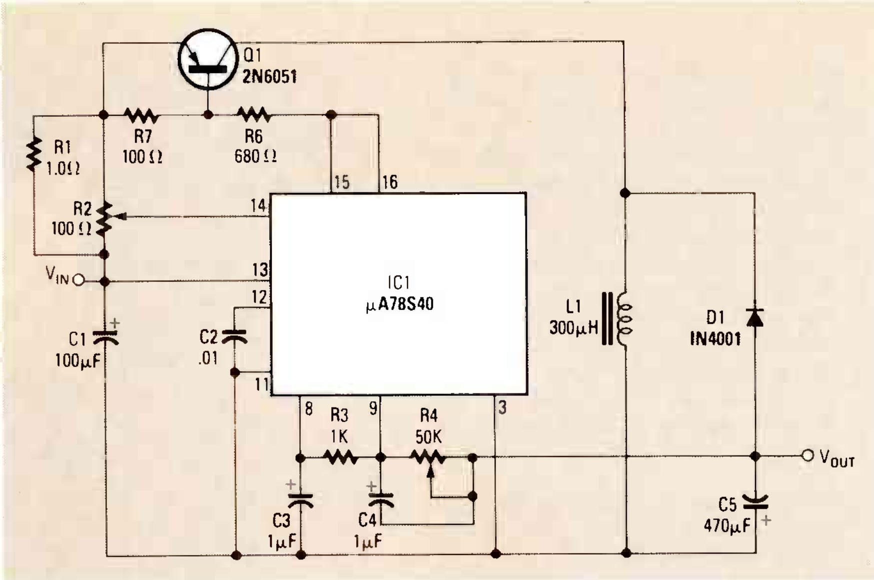


FIG. 13—THE μA78S40 USED IN AN INVERTING CONFIGURATION. Given a +12-volt input, the circuit provides −15 volts at 100 mA.

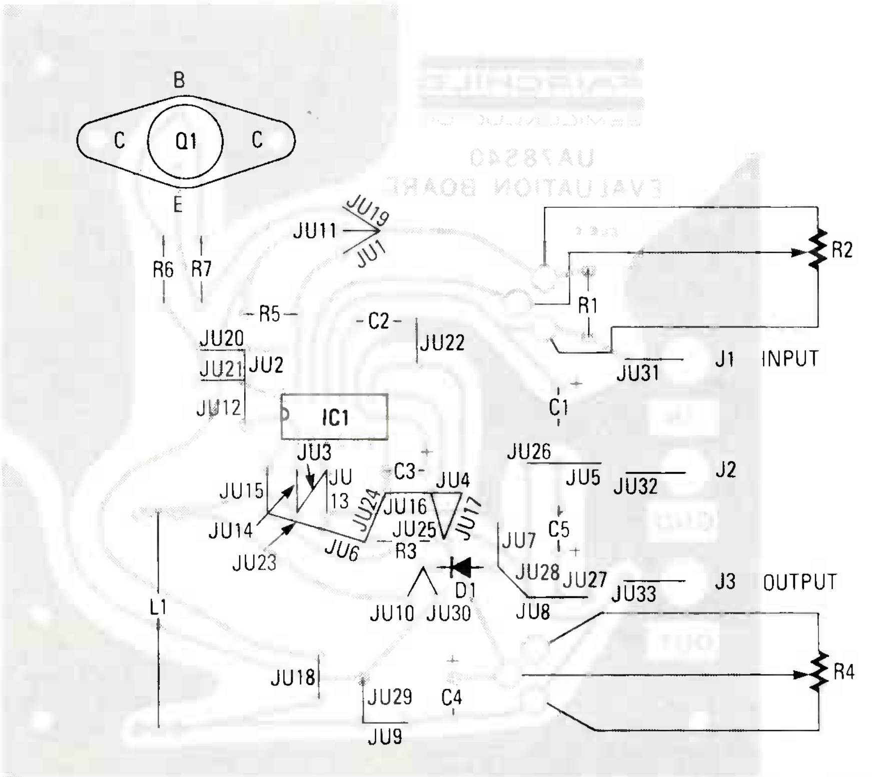


FIG. 14—COMPONENT PLACEMENT DIAGRAM for the switching circuits shown in Fig. 11–Fig. 13. See TABLE—2 for information on how to install the jumpers for the different circuit configurations.

μA78S40 is the uncommitted diode available at pins 1 and 2. That diode can be used as desired, provided that some precautions are followed. Since the IC's substrate is normally at ground potential, the cathode of the diode must not be subjected to a negative voltage; that precludes its use in step-down and inverting configurations. The diode's internal construction results in a current flow from the anode to the substrate amounting to about 10% of the normal anode/cathode current. Because of the high voltage usually present between the anode and ground in step-up regulators, power dissipation will probably limit the diode's usefulness in such applications. The diode is probably most useful protecting the output transistors from reverse-polarity voltage spikes.

The scope photos shown in Fig. 10-*a* and -*b* show the waveforms present at several key points in a step-down regulator circuit built from a μA78S40. In both cases the upper trace represents the output ripple and the lower trace represents the voltage across C_T. The photo in Fig. 10-*a* was taken at an output current of 22 mA, and the photo in Fig. 10-*b* was taken at 495 mA. In both photos the rising edge of the C_T wave represents "on" time and the falling edge represents "off" time. Notice that as the output current increases, the "off" time decreases to a minimum. Note also that the switching frequency increases with increased output current. In a PWM circuit, that frequency would remain constant; only the ratio of "on" time to the total period of the wave would change.

Sample circuits

Now we present circuits you can use for designing a step-down, a step-up or an inverting switching supply. The same PC board can be used for any one of those circuits; installation of various jumpers allows selection of the appropriate mode.

The step-down switching supply shown in Fig. 11 allows you to obtain 10 volts at 500 mA from a nominal 25-volt input, which may actually vary between 14 and 35 volts. Efficiency is typically 65% or better.

The step-up switching supply shown in
continued on page 110

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.

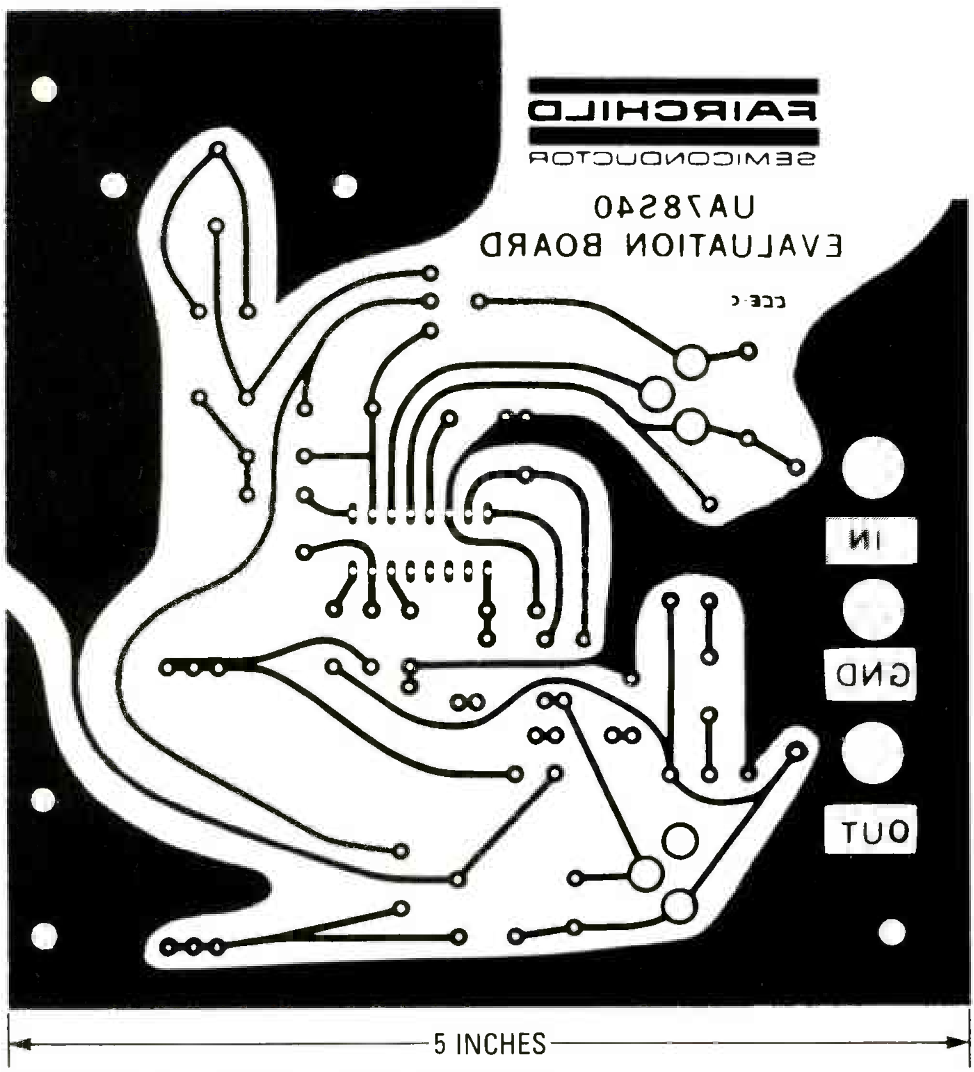
An optional step, once you're satisfied that the artwork is clean, is to take a little bit of mineral oil and carefully wipe it across the back of the artwork. That helps make the paper transluscent. Don't get any oil on the front side of the paper (the side with the pattern) because you'll contaminate 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:

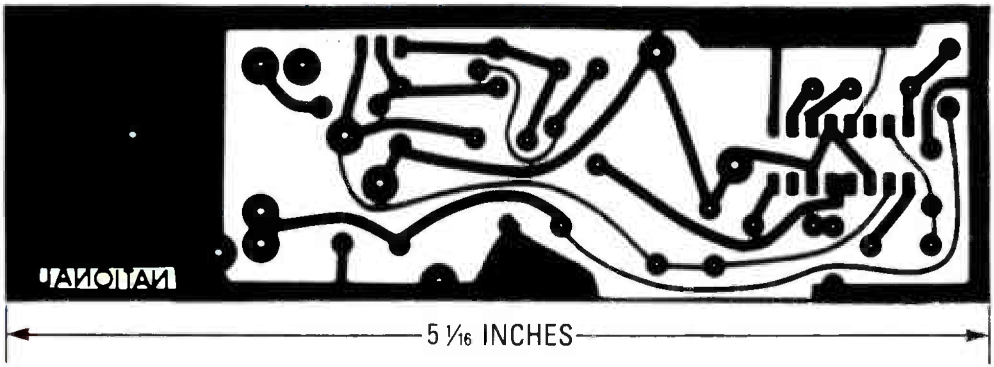
Radio-Electronics
Department PCB
200 Park Avenue South
New York, NY 10003

PC SERVICE



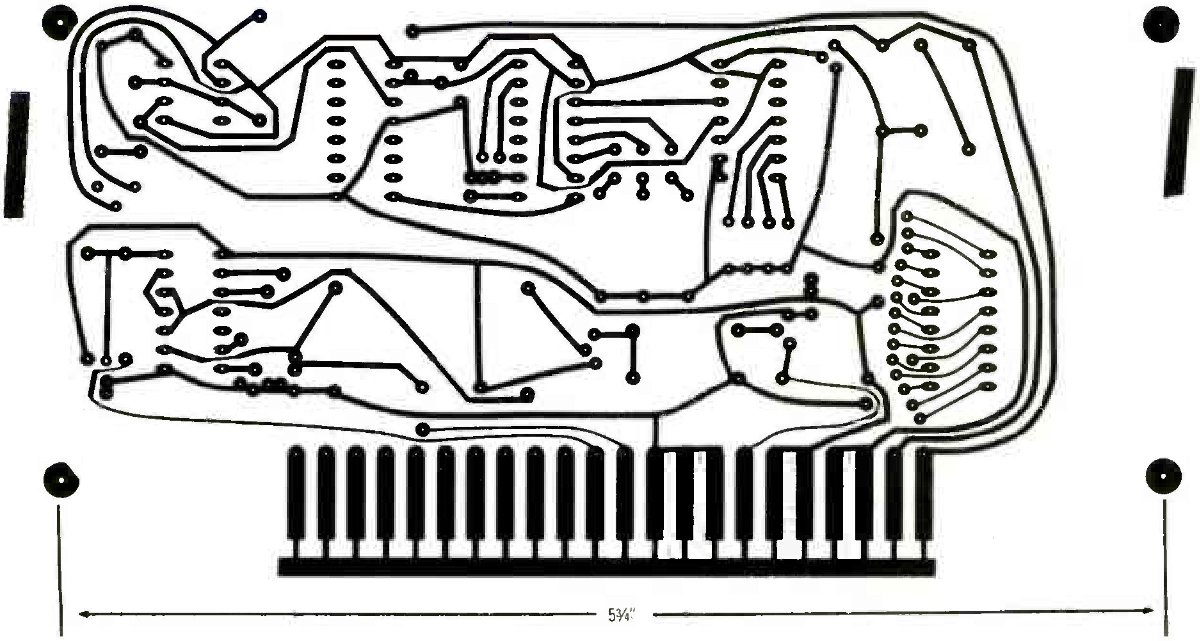
SOLDER SIDE of the μA78S40-based switching power-supply

PC SERVICE



SOLDER SIDE of the LM3524 5-volt switch power-supply PC-board. For more on switching power supplies, see the story on page 77.

PC SERVICE



TIMER BOARD for the home security alarm system. The solder side is shown here. The story begins on page 61.

Stocking Stuffer Specials on FLUKE® Hand Held Multimeters from Joseph electronics

- Analog/digital display
- Volts, ohms, 10A, diode test
- Autorange
- 0.7% basic dc accuracy
- 2000 + hour battery life
- 3-year warranty

Reg. $85.00
SPECIAL

FLUKE 73 — **$69.00**

- Analog/digital display
- Volts, ohms, 10A, mA, diode test
- Audible continuity
- Autorange/range hold
- 0.5% basic dc accuracy
- 2000 + hour battery life
- 3-year warranty

Reg. $99.00
SPECIAL

FLUKE 75 — **$85.00**

- Analog/digital display
- Volts, ohms, 10A, mA, diode test
- Audible continuity
- "Touch Hold" function
- Autorange/range hold
- 0.3% basic dc accuracy
- 2000 + hour battery life
- 3-year warranty
- Multipurpose holster

Reg. $129.00
SPECIAL

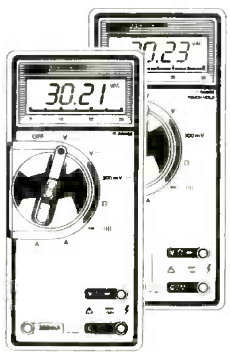
FLUKE 77 — **$110.00**

FLUKE 25 & 27

- Charcoal or yellow case color
- Analog/Digital display
- Touch Hold™ function
- −15°C to 55°C operation
- 0.1% basic accuracy
- 100 μV to 1000V ac and dc
- 0.1 μA to 10A, all fused
- Relative (difference) mode (27)
- MIN/MAX recording mode (27)
- Ruggedized, waterproof case
- Two-year warranty

Model 25 Reg. $229.00
SPECIAL $199.00

Model 27 Reg. $259.00
SPECIAL $229.00



FLUKE 21 & 23

- Yellow case color
- Analog/Digital display
- Touch Hold™ function (23)
- 0°C to 50°C operation
- 0.5% & 0.3% basic accuracy
- 100 μV to 1000V dc
- 1 mV to 750V ac
- 10 μA to 10A (23), all fused
- 10 μA to 320 mA (21), all fused
- Three-year warranty

Model 21 Reg. $99.00
SPECIAL $89.00

Model 23 Reg. $145.00
SPECIAL $129.00

AND MORE!

Model 8020B Reg. $199.00
SPECIAL $175.00

Model 8024B Reg. $249.00
SPECIAL $219.00

Model 8060A Reg. $349.00
SPECIAL $299.00

Model 8022B Reg. $154.00
SPECIAL $135.00

Model 8026B Reg. $199.00
SPECIAL $175.00

Model 8062A Reg. $295.00
SPECIAL $259.00

FOR SIMILAR SAVINGS ON THE COMPLETE FLUKE® LINE AND MORE THAN 100 OTHER MAJOR SUPPLIERS CALL

800-323-5925 In Illinois **312-297-4200**

ORDER HANDLING CHARGES	
VALUE	ADD
$0-499	$5.00
$500-999	$7.50
$1000-UP	$10.00

VISA MasterCard

Joseph electronics
8830 N. Milwaukee, Niles, Illinois 60648

ROBOTICS

Ultrasonic rangers and stepper motors

MARK J. ROBILLARD
ROBOTICS EDITOR

WE'VE DISCUSSED ULTRASONIC-RANGing and stepper-motor circuits the past several months; this month we'll mention several other ways to implement such circuits, and then go on to discuss how they may be used to map and navigate an arbitrary area.

We discussed the operation of a typical ultrasonic ranger in detail last month, but, to summarize briefly, a timing pulse is applied to a circuit that generates a burst of ultrasonic waves. A timing circuit begins counting at the same time, and, after an echo has been received, the time is divided by two, and the distance is calculated, based on the speed of sound in air. Normally you connect an ultrasonic ranging system to a microcomputer that is used to initiate ranging, do the calculations, and control the robot's stepper motor (or motors).

Last month we discussed Polaroid's ultrasonic ranging kit; another such kit is made by Texas Instruments. The SN28827 is available from the Micromint (25 Terrace Drive, Vernon, CT 06066) with a transducer for about $60. I recommend using a kit rather than a home-made system. That way you can get to the really difficult problems—like mapping and navigating—without spending time debugging standard circuits.

A stepper motor allows you to rotate the ranging circuitry (or the whole robot, if necessary) a precise amount, and then make, and record, a distance measurement. Steppers require a little more power than regular DC motors, but their position is much easier to control. The circuit in Fig. 1 shows how an LSI IC can be used to drive a four-phase stepper motor. A direction signal is applied to the MODE input, and then the CLOCK input is pulsed. The RESET input should normally be held high. Resistor R2 determines the base current of the IC's driver transistors, and it must be selected in accordance with the current requirements of the motor that will be used.

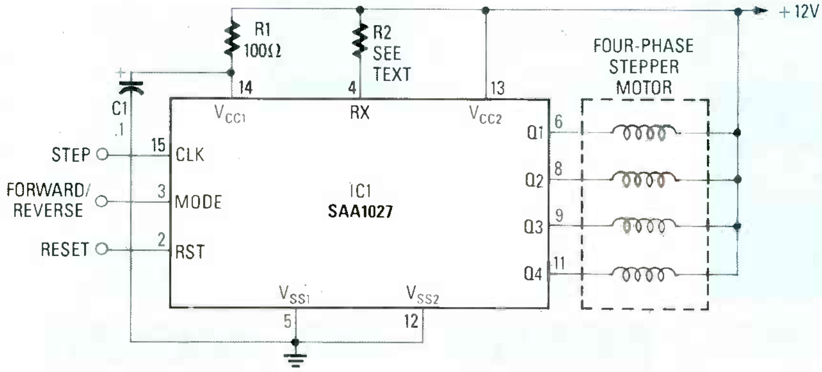


FIG. 1

The SAA1027 used in that circuit is made by Signetics; Sprague also manufactures stepper-motor drivers, the UCN-4202A and UCN-4203A, among others. Moreover, there are ways of controlling steppers without custom IC's. Let us know if you're interested; we could devote a column to that subject.

Robot mapping

With a stepper motor and an ultrasonic ranger we can make a rough map of an area by rotating the ultrasonic transducer while taking distance readings at periodic intervals. Using a computer to record those readings will allow a map of distances to be compiled. With a simple system such as that we're discussing, the resulting map barely resembles the space mapped; in early experiments, I could hardly recognize the area I had just mapped. The reasons for the discrepancies are many.

For example, assume we want our robot to navigate a room with a table and an open doorway. When we see a table, we have no trouble distinguishing it from a doorway. But the robot would see the legs as spikes and the in-between areas as caverns. The robot might try—mistakenly—to pass under those legs. As robot programmers, it is our job to interpret what the map actually represents, so that we could, for example, find the doorway without running into the table.

But let's assume that a trial-and-error method is necessary to move the robot out the doorway. At any arbitrary location, three readings might be taken: straight ahead, 90° right, and 90° left. Those readings will tell you whether it is safe to move in one of those directions. If the straight-ahead reading reveals that there is an obstacle within a

continued on page 113

ANTIQUE RADIOS

RICHARD D. FITCH
CONTRIBUTING EDITOR

Phonographs and antique radios.

PHONOGRAPHS ARE NOT NORMALLY considered relevant to the subject of antique radio, but many antiques have built-in phonos, or at least some provision for connecting an external phono. To the best of my knowledge, built-in phonos and phono adapters became common in the mid 1920's. And most phonos had their own volume controls mounted on the base, or even on the pick-up arm. As you can imagine, a phono with the volume control on the arm required a deft touch to adjust the volume while a record was playing!

The addition of an extra jack, switch, or both, to accommodate a phono can cause many service headaches. Many of those jacks and switches were never used; they were included in early radios mainly to impress the buyer.

There were several common methods of coupling the phonograph signal into the radio; phonographs often required their own volume controls because the signal was fed "downstream" from the radio's own volume control. For example, some sets had an arrangement whereby the detector tube could be used as an amplifier; and, as we have discussed in previous columns, volume controls were frequently part of the antenna/coil circuit. There was also an arrangement whereby an adapter could be plugged into the detector-tube socket to accommodate the phono's output. Some radios had no radio-phono switch, so the dial had to be tuned to an empty spot in the broadcast band in order to hear the output of the phonograph.

FIG. 1

The antique radio of the month

Our project this month, shown in Fig. 1, lacked any and all identifying marks. I assume that it is a Silvertone because many of its very old tubes are Silvertones. The most unusual feature of that radio/phono "combo" is the record changer under its lid. It's not just a record player, but a complete changer; and that is unusual for that era.

The turntable has a speed control, and it plays records of two sizes, but it is not a two- (or three-) speed changer in the modern sense of the term. There was a fad, in the post-WWII era, to replace those obsolete phonos with a complete three-speed changer. If your antique has one of the latter, you can bet that it's not original, no more so than if you find a stereo cartridge in the arm. If you want to keep your radio/phono in near-original condition, I wouldn't replace the phono with a modern three-speed, even if the original can't be repaired. It's better to leave it inoperative than to destroy the antique value of the entire set.

I was lucky with the receiver portion of that set; it came in good operating condition. The chassis has seven tubes, including the rectifier, a modern version of the workhorse 80. The chassis also has a four-gang tuning capacitor with a trimmer on top of each gang. The RF and detector tubes, as well as the tuner, are all well shielded, a very common feature of antique radios. It has a radio/phono switch that cuts off RF at the detector and substitutes the phono signal.

Troubleshooting

One nice thing about radio/phono combinations is that the components can be used to troubleshoot each other. For example, if the radio doesn't operate, but the phono does, you know that the audio amplifier works, and so does the speaker. Therefore, something must be wrong with the RF section.

On the other hand, if the radio operates but the phono doesn't, the trouble must be somewhere between the phono's needle (now called a stylus) and the input jack. The needle will always pick up something no matter how badly it

VOL. 2 NO. 12 December 1985

COMPUTERDIGEST

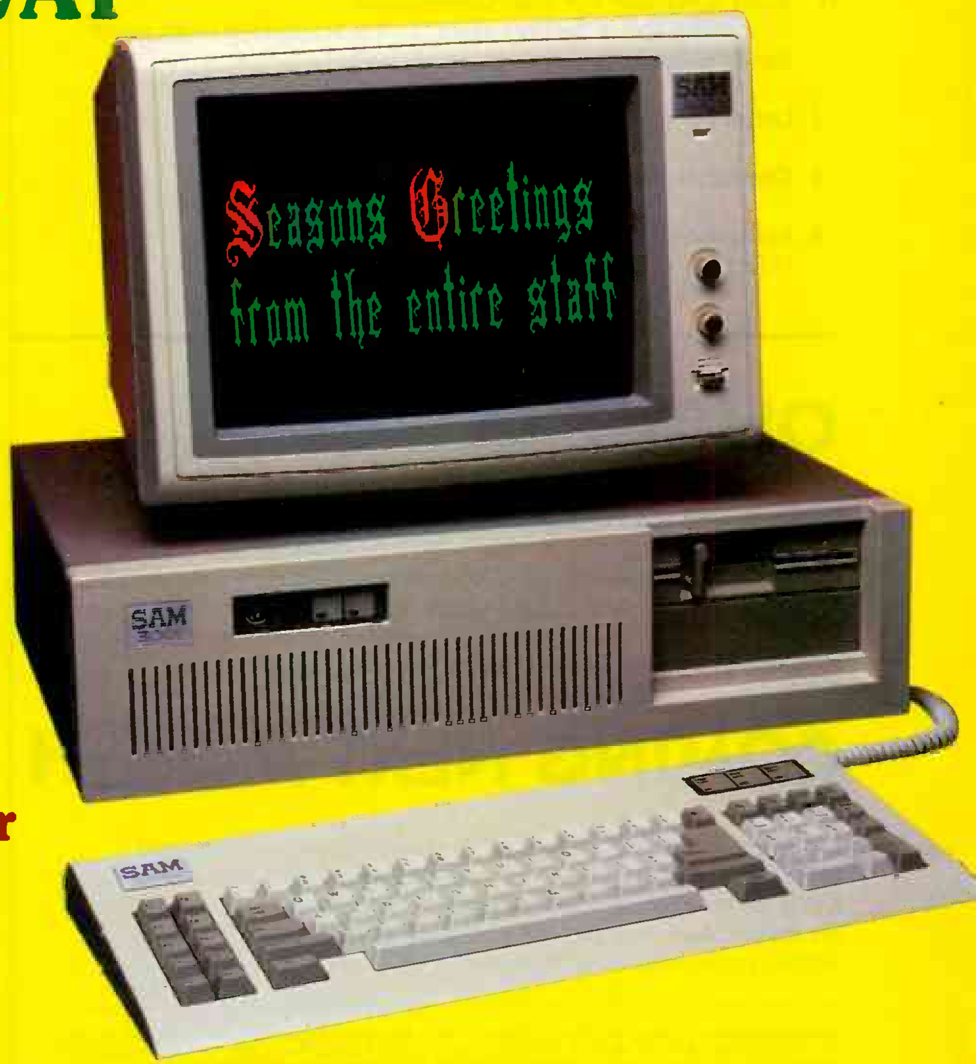
A NEW KIND OF MAGAZINE FOR ELECTRONICS PROFESSIONALS

ATTENUATORS AND MINIMUM LOSS PADS

Using your computer to simplify design problems.

DOUBLE DENSITY THE PERCOM WAY

Modifying your Model I double-density adapter



A GERNSBACK PUBLICATION

TUNING THE 1541

How to get your Commodore disk drive back on track

BUILDING A MODEM

Part II, the conclusion.

CONTENTS

Vol. 2 No. 12 December 1985

ON THE COVER

It's that time of year once again, and the message on our cover display was generated by Fontrix™. We'll be covering that, and other graphics software in an upcoming issue. The computer you see passing on our wishes for a happy holiday is the SAM 3001 from HiTech International. It's one of the first of the AT-compatibles to hit the market. For a review on the machine, turn to page 4.

COMING NEXT MONTH

We've got a great story lined up on everything you want or need to know about hard disks. Then we're going to begin a two-part article on how to use your computer to help design loudspeaker enclosures. And to round out a great issue, you'll get an in-depth article on the ubiquitous 555 timer. Don't miss it!

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.

COMPUTER DIGEST

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

Mor-On Hackers

I read your last letters section with great interest. It seems that people can always find a way to justify anything they do, can't they?—R.W., Denver, CO.

They can TRY to. But the wheel keeps right on turning, and wait until they get caught and have to stand before a judge and face the penalties. Suddenly the glamor and romance vanishes as they have to dig down and pay fines, court costs, lawyers fees, etc. The "proud parents" of what the newspapers labelled "Computer Wiz Kids" won't be so proud when they have to shuck out the big bucks. If only these people would think ahead!

"Ham" A Nasty Word?

How would you feel about not calling yourself a Ham Operator anymore if some amateurs were violating the FCC rules? That's why I want to keep calling myself a "Hacker!"—J. R., Tulsa, OK.

I am proud of my ham ticket but if the same sort of thing occurred, I'd go back to calling myself an "Amateur Radio Operator." Language keeps changing. "Gay" once meant "happy." If you felt happy, would you tell all your friends you were gay?

Everybody Does It!

I really don't see what the fuss is all about. Everybody hacks at one time or another, in one way or another. Maybe some more than others, but what's the big deal?—M. L., Cranbury, NJ.

First of all, everybody does **not** *do it! I don't do it; neither do a lot of other respectable computer experimenters that I know. And the "fuss" as you call it is twofold. For one thing it's illegal. The other point is that it's giving us all a bad name.*

Thank You!

Okay. It took two of your editorials to convince me, but I've seen the point and you're right. And it took guts on your part to stand up for that right. You are to be complimented. Now suppose you peer into your crystal ball and tell us what's liable to happen if things go on like this.—S.W., Fairbanks, AK.

Thank YOU, S. W. What I can foresee is a Government examination on the use of computers before you're allowed to use one. An examination that goes into the do's and don'ts so that if you elect to violate the law and get caught, you won't be able to say "Hey! I didn't know." And I can see much tighter controls on modems too, with Government agencies freely tapping in to monitor and dropping in on violators to confiscate their equipment.

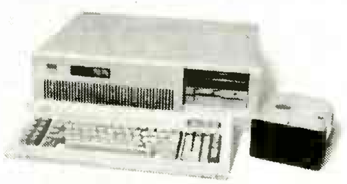
COMPUTER PRODUCTS

For more details use the free information card inside the back cover

DISK-DRIVE/TAPE BACKUP COMBINATION, consists of the model *AT HD* disk drive and the model *QIC-60 AT* tape backup unit.

The model *AT HD* is a Winchester hard disk drive for the IBM PC-AT with a formatted capacity of 20 megabytes. The model *QIC-60 AT*, an internal streaming tape-backup unit, provides increased security that data will not be lost through user error or mechanical failure.

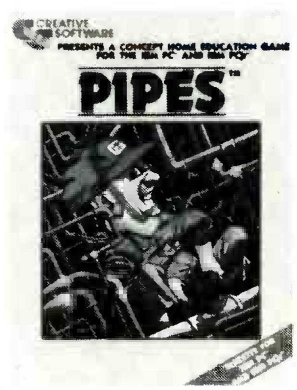
The model *AT HD* and *QIC-60 AT* sell for a combined suggested retail price of $3290.00.—*Tencar, Inc.*, 6225 Cochran Road, Solon (Cleveland), OH 44139-3377.



CIRCLE 11 ON FREE INFORMATION CARD

EDUCATIONAL GAME, *Pipes*, teaches children the concepts of spatial relationships and economics. The object of the game is to create a water network, using the least amount of pipe and money. The player must connect all the houses in town to the main water supply. After hooking up all the houses, the player turns on the water supply to make sure that there are no leaks. The VIC-20 version of *Pipes* was the 1983 CES Software Showcase award winner for "Best Home Education."

Pipes is available for the IBM/*PCjr* and Commodore *64* at a suggested retail price of $29.95. All versions are on disk.—*Creative Software*, 230 East Caribbean Drive, Sunnyvale, CA 94089.



CIRCLE 12 ON FREE INFORMATION CARD

HiTech's SAM 3001

PAT O'BRIAN

The AT-compatibles are coming! Here's a look at one of the first to hit the market.

■The IBM PC/AT received great critical acclaim when it was introduced a little over a year ago, mostly for its unmatched price/performance ratio. IBM's pricing policy was obviously intended to beat the clone competition even before it started.

The public, however, did not regard the AT as highly—at least if you believe the sales figures. The extra speed was impressive, but not enough to warrant buying a new machine. And then there was the hard-disk drive that created reliability problems. If not for the IBM Local Area Network, the machine could have headed the way of the Junior. The software writers also were—and still are—slow in taking advantage of the AT's impressive capabilities.

All that may change now, because the AT-compatibles are on the way. And that's sure to make even IBM's machine more popular than ever. We had the opportunity to examine one of the first AT-compatibles to hit the market: the Sam 3001 from HiTech International (1180 Miraloma Way, Sunnyvale, CA 94086 (408) 738-0601). You might remember HiTech as the manufacturer of the Sam 2001 XT-compatible computer kit that was featured in July's **Radio-Electronics.**

What the PC/AT offers

Before we look at what the SAM 3001 has to offer, let's see what IBM's machine does. The IBM PC/AT is not the fastest and most powerful computer you can buy, but it is the fastest and most powerful IBM personal computer. While it is compatible—for the most part—with the rest of the PC family, it is certainly an improved machine. For example, the AT uses the faster and more powerful 80286 microprocessor (which runs easily at 6 MHZ, has a true 16-bit data bus interface, can address 16MB of memory, and is upward compatible with the PC's 8086). The AT's system board can hold up to 512K of RAM and offers 8 expansion slots. The disk controller can support fixed- or floppy-disk drives, including the new higher capacity (1.2 megabyte) floppy-disk drives. A CMOS clock/calendar memory with battery backup was added to the main board. CMOS RAM on the clock chip—instead of on-board switches—holds most of the system-configuration information. The keyboard is much better than anything else IBM has offered. The AT's BIOS (*B*asic *I*nput/*O*utput *S*ystem) is 4 times bigger than the XT's. Some of the reasons for that is that it includes the hard-disk BIOS instead of relegating it to the controller card; the floppy-disk BIOS can handle various media and drive types, and multitasking-support functions were added.

Can a compatible be better?

You might expect the clone-makers to try to out-do IBM. And that's exactly what HiTech tried to do with the SAM 3001. And—as shown in the table below—for the most part, they succeeded.

The Motherboard (manufactured by Faraday Electronics of Sunnyvale, CA) comes standard with 640 KB of RAM and is expandable on-board to 1 MB. You'd have to tie up an expansion slot on the AT if you wanted 1 MB of RAM. Two serial ports and one parallel port are included on the main board, so they don't tie up any slots. What's more, each serial port can be configured for either the RS-232 or RS-422 standards.

The SAM 3001 runs PC-DOS 3.0, as well as MS-DOS 3.1 and XENIX. Of course, as with any other PC-compatible, the SAM 3001 does not support IBM BASIC, but it will run the similar GW-BASIC.

A hercules-type graphics card, which includes a parallel port, comes standard with the SAM 3001, as does a 20 MB hard-disk drive.

To sum up the SAM 3001, it's basically an AT with the added benefits of extra on-board memory and serial and parallel I/O ports, a monochrome/graphics card, and greater expandibility. We found the machine to be compatible with IBM's; it will even run IBM's advanced diagnostics program. We are not without complaints, however. We had problems with the board's power-on reset, and with the configuration-memory. A new set of ROM's cleared up the configuration-memory problem, and a call to HiTech cleared up the power—on reset problem. (It really wouldn't have been a much of a problem if the documentation supplied with the SAM 3001 was better—a change in the reset circuit was never documented.)

Another complaint was with the floppy-disk drive. It was extremely loud, and we were victimized by frequent data errors. HiTech has realized that problem, however, and has switched to Mitsubishi as its drive supplier. ◀CD▶

	Price	Microprocessor	RAM	On-board RAM (max)	Disk Drives	I/O Ports	Display Adapter	Empty Slots
IBM PC/AT	$3995	80286 (6 MHz)	256 KB	512 KB	1.2 MB Diskette	None	None	7
IBM PC/AT Enhanced	$5795	80286 (6 MHz)	512 KB	512 KB	1.2 MB Diskette 20 MB Fixed	1 Serial 1 Parallel	None	6
HITECH SAM 3001	$4395	80286 (6 MHz)	640 KB	1024 KB	1.2 MB Diskette 20 MB Fixed	2 Serial 2 Parallel	Hercules-type mono/graphics	7

ATTENUATORS AND MINIMUM-LOSS PADS

Larry Friedman

■"Attenuators" and "Minimum Loss Pads" is a program that quickly calculates the resistance values for H and T attenuators and the values for minimum-loss L-matching networks. Simply key in the input and output impedances and the desired amount of loss. The screen will display the actual pad configuration and the required resistance values. If you haven't the displayed resistor values on hand, you get a chance to recycle the program and make minor changes in loss or impedance until you come up with a pad using resistor values you happen to have.

To make the program truly universal, it is written in "Timeshare Basic," which means it should run on every computer without modification of any kind except perhaps for the CLS (CLEAR SCREEN) function. If your own computer uses something other than CLS for CLEAR SCREEN simply make the substitution. Otherwise, no further modification to the program should be required.

Because PRINT USING is not a universal BASIC function, resistance values are rounded off to their nearest integer value. For example, 144.3 ohms is displayed as 144; 144.6 ohms is displayed as 145 ohms. Rounding should have no practical effect on an attenuator. On the other hand, decibel loss is displayed in decimal values because that is the common and desired notation.

To make the screen and printer graphics universal, they are created from conventional ASCII symbols. Figures 1, 2 and 3 show how the three kinds of calculated pads are both printed and displayed. The negative (–) symbol in front of some of the resistor values in Figure 1 indicate that the impedance on that side of the circuit is less than on the opposite side. Note from the illustrations that two different ways are used to indicate input and output impedances. You can substitute either kind of labelling in the program since both employ universal characters.

Depending on the kind of computer used, the graphic display will either fill most of the screen or appear scrunched on the left. This is caused by writing the program so it will run on all computers regardless of the display's column width; also, screen dumps to a printer will print on every kind of printer used with personal computers, from conventional 80/100 column models to pocket printers which use narrow calculator-type tape.

```
LOSS =   10 DB
     261            -14
----XXXX--------XXXX----
           !
           !
           X
           X    211
           X
           !
           !
----XXXX--------XXXX----
     261            -14

 600 OHMS  IN     150 OHMS OUT

DO IT AGAIN? (Y OR N)?

LOSS =  3 DB
     474
----XXXX----------------
           !
           !
           X
           X    53
           X
           !
           !
------------------------

Z= 500 -->      <-- Z= 50

DO IT AGAIN? (Y OR N)? .
```

```
       103
----XXXX----------------
           !
           !
           X
           X    1703
           X
           !
           !
------------------------

Z= 600 -->      <-- Z= 600

DO IT AGAIN? (Y OR N)? .

LOSS IS  15.7948  DB
```

FIG. 1—THIS IS HOW the three types of pads are both printed and displayed. Please refer to the text for additional information.

```
10 REM ATTENUATOR PADS
20 REM     BY
30 REM LARRY FRIEDMAN
40 REM CALCULATES H,T,L PADS
50 REM  IN UNIVERSAL BASIC
60 CLS
70 PRINT TAB(10) "1 = H PAD"
80 PRINT TAB(10) "2 = T PAD"
90 PRINT TAB(10) "3 = L PAD"
100 INPUT "ENTER PAD TYPE (1, 2 OR 3) ";T
110 CLS
120 IF T=3 GOTO 3000
130 IF T>3 GOTO 60
140 INPUT "INPUT LOSS IN DB "; DB
150 N=EXP((DB)*0.230259)
160 INPUT "INPUT Z IN";Z1
170 INPUT "INPUT Z OUT";Z2
180 R3=(2*SQR(N*Z1*Z2))/(N-1)
190 R1=Z1*((N+1)/(N-1))-R3
200 R2=Z2*((N+1)/(N-1))-R3
210 CLS
220 IF T=1 GOTO 1000
230 IF T=2 GOTO 2000
240 CLS
250 INPUT "DO IT AGAIN? (Y OR N)";Q$
260 IF Q$="Y" GOTO 110
270 CLS
280 END
1000 PRINT "    "INT(R1/2+0.5) TAB(16);INT(R2/2+0.5)
1010 PRINT "----xxxx--------xxxx----"
1020 PRINT TAB(12)"!":PRINT TAB(12)"!"
1030 PRINT TAB(12)"X"
1040 PRINT TAB(12)"X   " ;INT(R3+0.5)
1050 PRINT TAB(12)"X"
1060 PRINT TAB(12)"!":PRINT TAB(12)"!"
1070 PRINT "----XXXX--------XXXX----"
1080 PRINT "    "INT(R1/2+0.5) TAB(16) INT(R2/2+0.5)
1090 PRINT
1100 PRINT Z1 "OHMS IN" TAB(14) Z2 "OHMS OUT"
1110 PRINT
1120 GOTO 250
2000 PRINT "     "INT(R1+0.5)
2010 PRINT "----XXXX----------------"
2020 PRINT TAB(12)"!":PRINT TAB(12)"!"
2030 PRINT TAB(12)"X"
2040 PRINT TAB(12)"X  "INT(R3+0.5)
2050 PRINT TAB(12)"X"
2060 PRINT TAB(12)"!":PRINT TAB(12)"!"
2070 PRINT "------------------------"
2080 PRINT
2090 PRINT "Z="Z1"-->" TAB(14) "<-- Z="Z2
2100 PRINT
2110 GOTO 250
3000 INPUT "INPUT LARGER Z";Z1
3010 INPUT "INPUT SMALLER Z";Z2
3020 IF Z2>Z1 PRINT "ERROR":GOTO 3000
3030 R1=SQR(Z1*(Z1-Z2))
3040 R2=(Z1*Z2)/R1
3050 R3=R2
3060 L=20*LOG(SQR(Z1/Z2)+SQR((Z1/Z2)-1))/2.30259
3070 CLS
3080 PRINT "LOSS IS ";L" DB"
3090 GOTO 2000
```

DOUBLE DENSITY THE PERCOM WAY

Can you modify your Model I Double Density Adapter? Sure you can!

GARY FOSTER

■If you bought the Radio Shack Model I Double Density Adapter Kit to increase disk storage on your old Model I you soon realized that you were all alone in the world. All your Model I owning friends had done the smart thing. They bought the PERCOM Doubler which let them use all the neat new operating systems on the market. You and I were stuck with Model I Double Density TRSDOS and little else. You may have decided to make the best of a bad deal and live with your double density (of a sort), but I spent a lot of time looking at my NEWDOS80 Version 2 manual with all those PDRIVE command options, references to "double density" and so forth.

Circuit descriptions

A comparison of the schematics showed me that the same double density disk controller chip was used on both adapter boards. The only differences between the two were the method of addressing the bit which selected single or double density and the method of enabling write precompensation. On the Radio Shack version, density selection is done by using the upper three (3) bits of data written to the sector write register at address 37EEH (AI is high and A0 is low). See figure 1 for the schematic of the circuit. A normal write to the sector-write register will contain zeroes in data bits D5-D7 (there are no sectors greater than 31). This inhibits the density select decoder (U10) by placing a logic high on the G2A input. A write to the sector write register with any of D5-D7 active (D5'-D7' low) will enable the select decoder (U10) and allow a density change to occur. Remember that all data lines on both adapter boards are present only in their inverted state. See Table 1 for the control functions of each combination of D5-D7. Notice that write precompensation is enabled by the software.

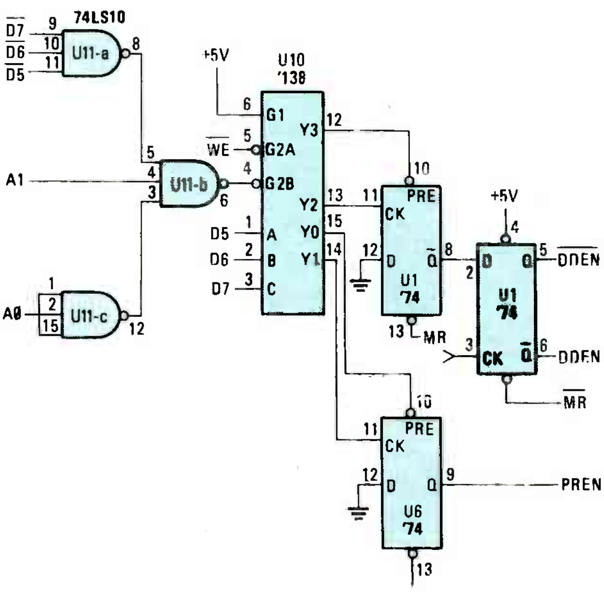


FIG. 1—SCHEMATIC DIAGRAM of the Radio Shack double-density adapter enable circuitry.

The PERCOM method of density selection is entirely different (as we already knew). This circuit, shown in figure 2, clocks a D-type flip-flop when address lines A1 and A0 are low (this forms address 37ECH when the disk controller write enable line is active) and data lines D3-D7 are high. Data line DO is then latched into the flip-flop to select single or double density. Address 37ECH is the address for the disk controller's command register. At first glance it appears that this method of addressing would cause the active controller to

D7	D6	D5	FUNCTION
0	0	0	No function
0	0	1	No function
0	1	0	Select drive side 0 N/A PERCOM
0	1	1	Select drive side 1 N/A PERCOM
1	0	0	Set double-density mode
1	0	1	Set single-density mode
1	1	0	Disable precompensation
1	1	1	Enable precompensation

TABLE 1—CONTROL FUNCTIONS of data lines for the Radio Shack Double-Density Adapter.

execute an unwanted (and possibly data-eating) instruction. A peek at the command summary for both controller chips quickly shows why this is not a problem: There is no instruction which corresponds to a high condition on datalines D3-D7. The active disk controller does not mind being given a meaningless command and we can safely swap active controller chips without fear. Write precompensation is always selected in double density with the PERCOM system.

At this point you might say that this is an interesting comparison of two relatively simple address decoding schemes, but where's my double density?

Because of an interesting quirk on the part of the designers of the 7400 TTL family I found a reliable solution to my problem. The Radio Shack circuit board uses a 74LS10 integrated circuit (U11) in the enable circuit for the select decoder. This chip is a collection of three NAND gates with three inputs each. I was able

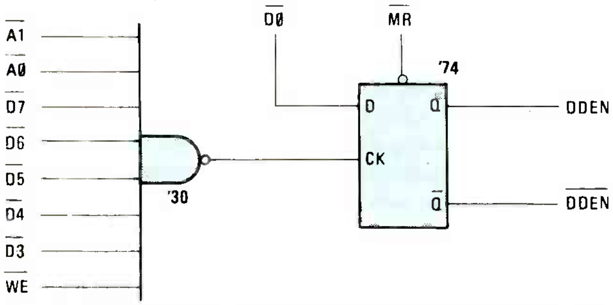


FIG. 2—REPRESENTATION OF PERCOM doubler enable circuitry.

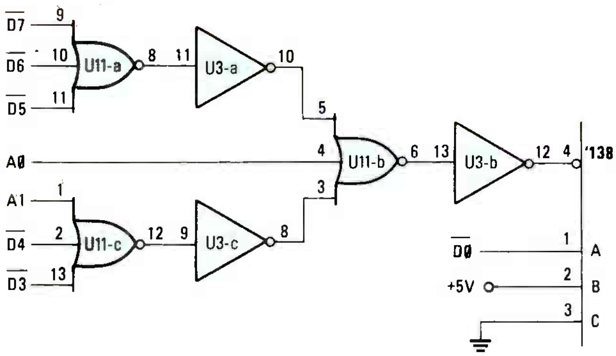


FIG. 3—RADIO SHACK'S double density adapter modified to perform as a Percom doubler.

to alter the address decoding scheme of the PERCOM Doubler to the circuit shown in figure 3 and then to figure 4. But this method requires three input NOR gates. By the grace of the 7400 TTL designers though we almost have our solution. There is a triple 3 input NOR gate chip (7427) that is pin compatible with its triple 3 input NAND gate cousin (7410). If we can replace our old 74LS10 chip with its NOR counterpart 74LS27 some of our work is already done by the PC board design. We will cut our expensive circuit board in fewer places! (See Fig. 5.)

While we are at it, we will change the circuit board to enable write precompensation any time double density is selected. We will also wire the interrupt lines from the controllers back into the circuit. This will make us fully compatible with the PERCOM Doubler. The best part is that the complete modification will only cost about $1.00 in parts and two hours in time.

As this will most assuredly void any warranty on your Radio Shack Double Density Adapter proceed with caution. We are going to remove your old Radio Shack Double Density board and, with a little static-free luck, turn it into a perfectly functional look-alike to a PERCOM Doubler. If you are not completely comfortable working on a $150 circuit board get a friend or pay someone to do this modification for you. You must remove an IC from your board, cut 10 traces, and connect jumpers in 14 places.

Modification procedure

First, take a hard look at everything you have stored in double density mode with your Radio Shack Double Density Adapter. Copy everything you want to keep onto single density TRSDOS diskettes. Once you modify your board you will no longer be able to read or write to your TRSDOS Double Density diskettes.

Next, assemble the following items:

1 74LS27 Integrated circuit
1 16 pin IC solder tail IC socket
1 Low heat soldering iron
1 Short length of 22 ga. solder or equivalent
24-in. of 28 ga. wirewrap wire or equivalent
1 Pair of small diagonal cutting pliers
1 Pair of small needle nose pliers or tweezers

Disassemble your expansion interface and locate the disk controller piggy-back board. It should be the only small circuit board you see. Carefully remove the circuit board without bending any pins. Be patient and rock it back and forth until it comes free from the socket. Hold the board with your fingers on the edges (don't touch the IC's any more than you can help). Turn the board so that the component side is facing you with the Tandy Corp. printing in the upper right hand corner. The IC on the very bottom (just below U3) labelled U11 is our target. Using soldering iron with a low heat element and an IC removing tip, desolder and remove U11. (See Fig. 6.) Another suitable method is to cut the IC loose from its pins and discard it. Then heat each solder pad in turn and, with a small pair of needle nose pliers or tweezers, remove the metal scraps from the hole. Carefully clean up your solder flux and clean out the holes, then solder an IC socket into the holes where the IC used to be. Using a very sharp razor blade, or an Exacto knife cut the following traces:

between U8 pin 9 and U6 pin 9
between socket header pin 39 and ground
between U11 pin 1 and U11 pin 13
between U11 pin 8 and U11 pin 5
between U11 pin 3 and U11 pin 12
between U11 pin II and U10 pin 1
between U11 pin 10 and U10 pin 2
between U11 pin 9 and U10 pin 3
between U11 pin 6 and U10 pin 4

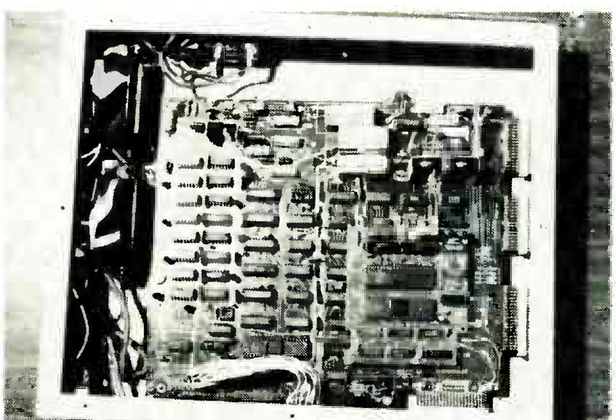


FIG. 4—THE RADIO SHACK double density adapter installed in the LNW System expansion board.

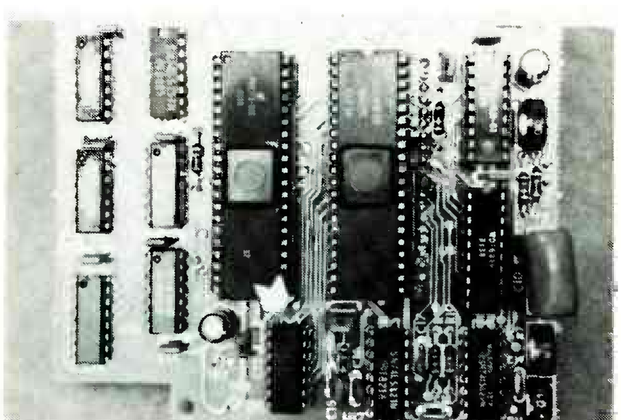


FIG. 5—CLOSE-UP VIEW of the Radio Shack double density adapter. Arrow points to U11, the IC we're going to replace.

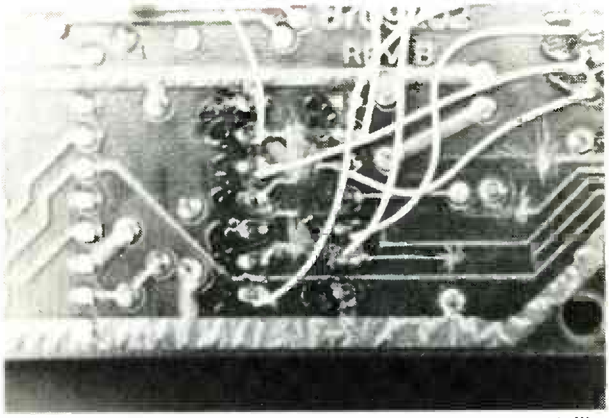


FIG. 6—WIRING MODIFICATIONS to U11. Notice that we deliberately make large gaps in the trace cuts to ensure a good cut.

With a soldering iron on low heat use #28 gage wire wrap wire to make the following jumper connections:

between U3 pin 39 and U4 pin 39
between U3 pin 39 and socket header pin 39
between U10 pin 2 and +5 volts
between U10 pin 3 and ground
between U10 pin 1 and U9 pin 6
between U9 pin 5 and U3 pin 7
between U11 pin 2 and U3 pin 11
between U11 pin 13 and U3 pin 10
between U11 pin 12 and U9 pin 9
between U9 pin 8 and U11 pin 3
between U11 pin 8 and U9 pin 11
between U9 pin 8 and U11 pin 5
between U11 pin 6 and U9 pin 13
between U9 pin 12 and U10 pin 4

Reassembly and testing

Carefully insert a 74LS27 IC in the socket you installed. Be sure that the notch in the IC package is oriented properly and that no pins are bent or broken (even though we have 16 on this one, we don't have any to spare). Just as cautiously as you removed it, install the double density board back in its socket on the expansion interface board. Be certain that you install the adapter board in the same orientation as it was before. (See Fig. 7.)

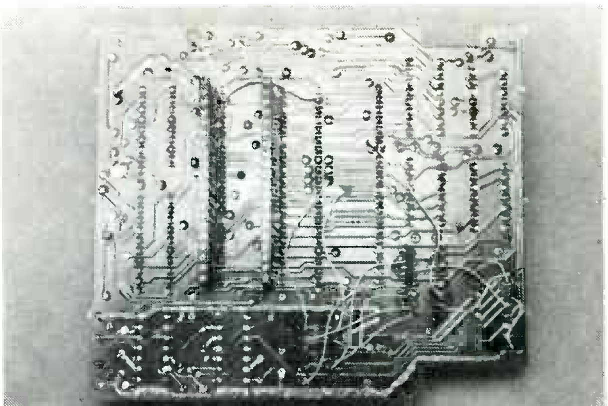


FIG. 7—THE COMPLETELY-MODIFIED BOARD. Use this illustration as a guide while working on your own board. Leave as little slack in jumper wires as possible.

Give your handiwork one last look for safety, then button it up and hook up your keyboard-EI cable. If at any time the computer does not behave normally quickly turn it off and find out what is wrong. Turn on your computer. If all seems well, boot up a single density diskette; you should still be able to boot up with any single density operating system. If this does not work then turn the computer off, disassemble your Expansion Interface and check your work. The most probable causes for problems at this point are wiring errors or a static-damaged single-density disk controller. If all is well up to this point follow the instructions for creating a double density operating system diskette. NEWDOS80 Version 2 will allow you to do this with the PDRIVE command. Your computer should now have written double density to a diskette and verified it correctly. If so, then you are through except for the rather pleasant task of copying everything in your software library onto your new double density diskettes. If it does not work in double density but appears to be okay in single density, you have probably damaged your double density

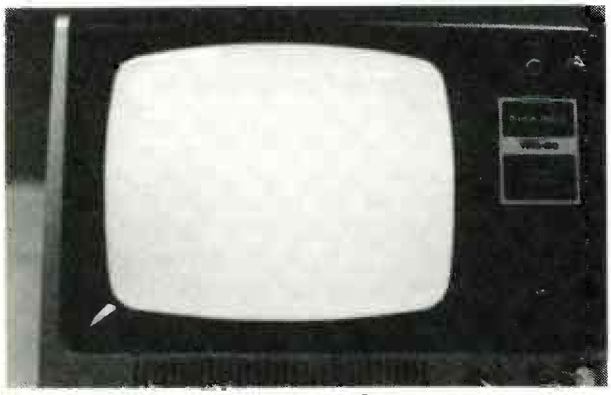


FIG. 8—A JOY TO BEHOLD! NEWDOS/80 with ever so much memory available for only the cost of a 29 cent IC!

controller chip. (See Fig. 8.)

If the wiring is okay after you have thoroughly rechecked it, try replacing this chip and try again.

Since this chip is easily subject to damage, and since its cost is so low, there should be little or no hesitation in suspecting it, and if necessary, switching it for a new one. It's certainly a small enough price to pay.

The Radio Shack Double Density Adapter is a nice addition to the TRS80 Model I. It is a well made circuit board and appears to be a reliable design. It is certainly capable of withstanding rigors of this modification. When Tandy released this device however they chose to make it incompatible with the popular operating systems produced by other companies. The great majority of good software for the TRS80 Model I is on non-TRSDOS operating systems. If you bought the Radio Shack and are not satisfied with the options available to you, then this modification is for you. I have used this modification on my system with NEWDOS80 Versions 1 and 2 for several months with no bad side effects; it should work equally well on any double density operating system which uses the PERCOM Doubler.

TUNING THE COMMODORE 1541

How to align and time the 1541

JIM STEPHENS

■While the Commodore 1541 disk drive is a marvel of electronic hardware, it has its flaws. Sooner or later it will require servicing. The following is a description of what you might try before sending it off on a long and expensive vacation.

One day my 1541 began to blink slightly while trying to load my favorite program and this led me to believe a problem might be brewing. Since the 1541 doesn't give up easily, it continued to re-read the data and finally load the required blocks from the disk. The blinks, which meant mis-read data bits, kept getting worse until one day, it gave up and refused to load those programs at all. Often, it would get completely through the load and reset itself back to the ready prompt screen.

On newly-written programs, where I had just formatted the diskette, there was no problem. The light stayed on continuously and the programs loaded fine. If I tried to load a piece of commercial software or a program from a friend's machine, things got really bad. After losing a complete database file disk from which I couldn't recover, I decided that now was the time to fix it. Fix what? I wasn't quite sure.

I found that there are three main mechanical malfunctions that could cause blinking lights and mis-read data. These are a dirty read head, a slow disk speed, and a misaligned head to the data track. Since these problems are mainly mechanical, they can be fixed by the average mechanical tinkerer. However, poking around inside a delicate piece of equipment such as the 1541 with a screwdriver does require some experience and is recommended only to those who feel capable and confident.

Case disassembly and head cleaning

Occasional program glitches and garbage on the screen without a blinking red light could mean a dirty read head. Rather than pay a small fortune for a head cleaning kit, use a cotton swab slightly dampened with alcohol. The only problem is getting at the head in order to clean it.

The drive case is formed of an upper and lower half. The top is held together by four screws through the bottom. Unplug the 1541 from the power cord and serial buss. Turn the drive over and remove the four screws. Then re-invert the drive carefully and remove the top cover. You will see part of the circuit board and some of the diskette guides. The rest is covered by a steel cover. This interior cover is attached by two small screws on the left side of the drive's metal frame. The right side is secured by two small detents that hold the cover in place. Remove this cover and you can view the rest of the circuit board and drive mechanics. Also, you can easily see the read head near the center below the circuit board.

The head is the small white square towards the bottom of the case that is recognizable by the black line that crosses it from left-to-right as shown in Figure 1. Most people think that the head is the gizmo that rides on top of the diskette. This is only a small piece of white felt that holds the diskette surface close to the head. The data is read from the bottom of the diskette, not the top.

Using a good-quality cotton swab which is slightly damp with alcohol, you can gently clean the surface of the head at this point. Make sure you don't soak the swab, or you may flood the head causing more problems. You'll be surprised to find a generous amount of grime on the swab if you have used your drive extensively. Many times, this cleaning is all that is required to get the drive back to normal operation. You may want to try a program or two before proceeding further. Always replace the metal cover and case top before powering up.

Speed adjustment

The 1541 is tolerant of variations in diskette speed. Several things can cause the speed to vary. Drag on the drive mechanics, aging in the electronic drive components and slipping in the drive hub, to name a few. If the drive makes a low, screeching sound, the bearing that holds the plastic centering guide may have become dry. This bearing is located in the center and on top of the diskette guide arm. A small washer holds the shaft in place and lifts the centering guide when the door is raised. This shaft is directly over the center hole of the diskette when the disk is locked in place. A small drop of light machine oil on the washer will oil the bearing further down this shaft. Be sure that only one drop is used and any excess is wiped from the top of the assembly.

To actually check the speed of the drive, Commodore has included a dynamic speed indicator

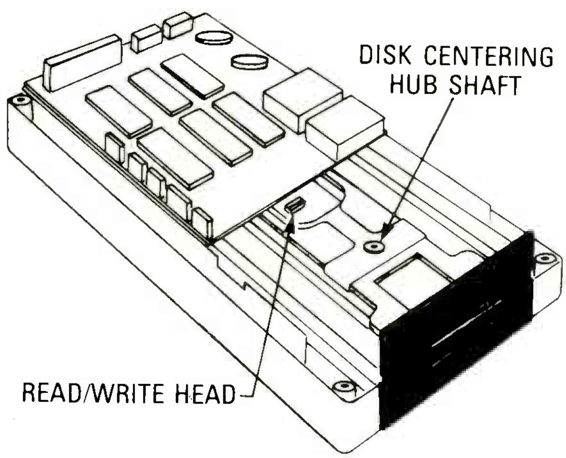


FIG. 1—LOCATING THE HEAD is easy if you follow the instructions and refer to the diagram above. Look for the small white square with the black line crossing it from left to right.

on the bottom of the diskette drive flywheel. To see this, it is necessary to remove the bottom of the plastic case.

You probably noticed that the drive is attached to the bottom of the case with six screws. After these are removed, the drive can be carefully turned on its side. The metal cover should be attached before this is done. The green indicator light is still attached to the case, so care should be used when the assembly is turned on its side in the case bottom.

Figure 2 shows the bottom of the drive assembly. The speed indicator is the pattern on the bottom of the drive flywheel. The pattern is used like the timing light on a car to set the correct rotation speed of the flywheel. The outside pattern is used for house wirings that operate on 60 Hz and the inside patern is for 50 Hz as found in England.

To check the speed of the drive, connect the drive to the computer and load a program while the assembly is on its side. Be careful since many components are exposed and should not be touched while the drive is operating. Shine a small fluorescent lamp on the flywheel with other lights in the room out. The outer pattern on the flywheel should appear stationary. While a small amount of movement can be tolerated, it should be corrected. If the pattern seems to be rotating rapidly, some adjustment to the speed control will be required.

The speed control is located under the metal case below a small access hole above and to the left of the flywheel. It is a small potentiometer with a screw that is held securely by a green glue. A small screwdriver inserted into this screw and turned will either speed up or slow down the pattern. Turn the screw until the pattern stops rotating and remains still. You may have to try several times. You should *not* have to turn the screw more than 1⁄16th inch in either direction. If you do, there may be other problems causing the incorrect speed. If you cannot get the pattern perfectly still, get as close as possible.

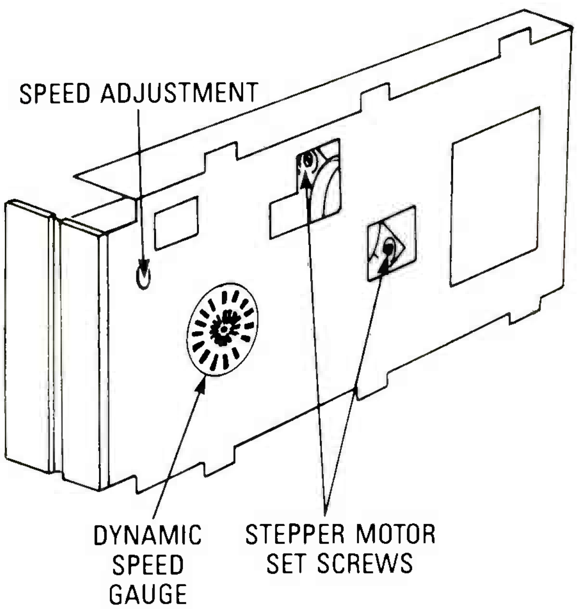


FIG. 2—BOTTOM OF THE DRIVE ASSEMBLY. The speed indicator is the stroboscopic pattern on the bottom of the drive flywheel. Outer pattern is for 60 Hz, inner is for 50 Hz.

Read-write head alignment

The last and most-probable cause of problems is a misaligned head. The head has a tendency to slip from the correct path over the disk track after awhile. Since the diskette has some 35 tracks and only about one inch of lateral space around the disk, each track can be no more than 1⁄32 inch wide. Any small deviation can make the head appear to be badly misadjusted. A deviation of even 1⁄64th inch and the head would be half way off the track.

The problem of course, is to get it back on track and this is no simple task without test equipment. There is a way however, It's called "trial and error." We can do it, but it may take several tries.

Figure 2 shows the bottom of the main drive assembly. Note that the flat stepper motor is to the right of the patterned flywheel that we just used. This stepper motor controls the position of the head. This motor was meant to be moved to correct any small error in head alignment. The motor is held by two screws. These fit through holes that are really channels. They are elongated so the motor can be positioned up to 1⁄4 inch forward or backward. We use this adjustment to correct head misalignment.

To correct head misalignment, load a commercial program disk. If your head is badly out of line, note that the red indicator blinks as the drive misses data and tries again. Use this disk to check the accuracy of adjustments. With the drive off, mark the position of the motor relative to the metal case. A small scratch or pencil mark on both sides of the motor will do. This is important, as you need to know how far you moved the motor and in what direction.

After marking the starting location, loosen the retaining screws slightly. You will have to scrape most of the green glue from around the washer. The washer will not rotate unless it is free.

By observing the location of the marks, rotate the motor clockwise, only slightly, no more than 1⁄32 inch. Move too far and you may overshoot the track completely. Tighten the retaining screws and try the blinking disk program again. If the blinking has been reduced, you moved in the right direction. If it has gotten worse, repeat but in the other direction.

Once the red light is steady, turn off the drive. Retighten the retaining screws and make a final test. Load a disk with error clatter and make sure the clatter doesn't crash the load. If it does, you'll need to adjust the stepper motor again. You should not have to move the motor more than 1⁄8 inch in any direction. If all else fails, move the motor back to the original starting point and adjust in even smaller increments.

This is not a job for the faint of heart, and you'd better believe it's better than sending eighty-five big ones to Commodore's repair-replace department. Tuning the 1541 is like tuning up a high-powered race car at the Indy 500. But with just a little effort, you can have your 1541 purring like a kitten. ◀CD▶

YOU CAN BUILD THIS MODEM FOR YOUR COMMODORE 64

PART II

JIM STEPHENS

Last month we began a two-part article on how to build this Modem for your Commodore 64. Here is the conclusion of that article.

Circuit adjustment

The most difficult part of the whole project is the adjustment of the circuit for proper operation.

The Commodore 64 can be made to handle many of the chores done by expensive testers and generators. The 64 has a sophisticated sound chip. which we use to set the frequency of our modulator and can use the small program in Listing 1 to check the output of the demodulator. It is not the best alignment method, but it works.

Do not connect the modem to the user port yet. Turn the variable resistors R13 and R14 to the center of their adjustment. These are the timing resistors of the modulator that set the pitch of the two modulator tones. Flip the toggle switch on the modem to ON and you should hear a high-pitched tone coming from the speaker. If not, adjust R11 of the modulator upward and readjust R16 until the volume increases. Keep the volume low or the tone will become distorted. If no amount of adjustment produces a tone, there is probably a wiring error and the circuit needs to be rechecked. Always check the power leads first with a volt meter.

If a tone is being produced, connect test jumper 1 from pin 9 of the 2206 to ground with a small jumper. Notice that the tone changes. Each time ground is touched, the tone shifts frequency. This is the keying input of the modulator and it is this pin that reads the ones and zeroes from the computer. Turn the modem off and connect the modem to the user port. Remember to orient the connector properly. Turn on the 64 and the READY prompt should appear. If it does not, turn the 64 off check all connections on the connector and the wiring of the modem. Always check the voltage levels and their connections first. If the prompt appears, enter the frequency set program shown in Listing 1 and save it. Note that the modem is still off.

LISTING 1

```
1 REM TEST TONE FOR 2225 HZ
2 REM F=1070 HZ DATA = 69 114 150
3 REM F=1270 DATA = 81 94 150
4 REM F=2025 DATA = 130,67,150
5 S=54272
10 FOR L=STOS+24:POKEL,0:NEXT
20 POKES+5,9:POKES+6,250
30 POKES+24,15
40 READHF,LF,DR
50 IF HF<0 THEN END
60 POKE S+1,HF: POKES,LF
70 POKE S+4,33
74 END
110 DATA 143,115,150
```

LISTING 1—TONE SETTING PROGRAM for the modulator. Data in line 110 is set to the numbers shown in lines 2 through 4 for the other frequencies as necessary. Data for a 2225 Hz tone is already shown in line 110.

The frequency set program is used to set the tones of the modulator. The small program is initially set up to produce a tone of 2225 Hz using the 64 sound chip. Line 2 through 4 of the program are REM statements that show the data statement changes necessary for the program to produce the other frequencies. Normally, the tones of the modulator will be set to 1070 Hz and 1270 Hz, but first, we must get the demodulator section working before these frequencies are finally set. The demodulator needs to be adjusted to respond to frequencies 2025 Hz and 2225 Hz. To do this, we need to set these frequencies into the modulator first since we will use the modulator section to feed the demodulator when we adjust it.

Run the frequency set program and a tone at 2225 Hz will sound through the TV/monitor speaker. Make sure jumper J1 is not connected to ground and turn on the modem. The tones from the two sources will be quite different. With each tone at about the same volume, adjust R13 (the one that connects to pin 7 of the 2066) until the tones are exactly the same. Listen to the pitch of each at the same time. As the tone of the modulator nears the same frequency of the TV/monitor, the sound will start to rapidly "chirp." This means that the tones are about the same frequency but not exact. Slightly turn variable resistor R13 until the chirps start to slow down to a slow "beat" like a wave of increasing and decreasing volume. The slower the wave, the closer the two tones are. If you have ever tuned a guitar using the fifth fret and listened to the beats, this will be no problem. If you find that all you can get is chirps, you may be tuning to a harmonic of the 2225 Hz frequency and the tone on the modulator should be raised or lowered. If no amount of adjustment brings the slow beat, you might be tone deaf and should get a friend to help or your variable resistor is too critical and may have to be changed to another with a more even or smoother taper. If you have one, a 10-turn potentiometer works well here. Of course there might be a wiring error. Get the beat as slow as possible and proceed to the next step.

Connect the jumper (J1) to ground. Notice that the tone changed. Turn off the modem with SW1 and the tone on the TV/montor by entering RUN and hitting RUN/STOP quickly. Change the data in line 110 to that shown in line 4 of the program. This is the data that will produce our 2025 Hz tone. Repeat the above procedure while adjusting R14 (the variable resistor that connects to pin 8). Once the slow beat is obtained, you have the modulator tuned as though it were an answering modem. Alternately connect and disconnect J1 from ground and listen to the tone alternate from 2225 to 2025 Hz. We can now use these tones to set the demodulator section.

Tuning the demodulator

Place the modulator speaker near the mike of the demodulator. With the modem on, disconnect J1 from ground. The modulator should be producing a low volume 2225 Hz tone. Place a voltmeter or logic probe on the collector of Q1. The logic level should be high or around five volts. R8 (the volume control on IC3) should be about in the center of rotation. Connect J1 to ground and the output at the collector of Q1 should drop to zero volts. If it does not, vary R7 slowly on the demodulator until it does drop from high to low when ground is touched by the J1 lead. If no amount of adjustment produces this change, readjust the volume control R8 either higher or lower until the modulator locks in with the above adjustment. Once it does, alternately connecting and disconnecting ground with J1 will produce a high and low reading at Q1's collector. A partial low or high on the collector of Q1 is not correct. It must swing all the way to ground and most all the way to five volts. Keep adjusting R8 and R7 until you get the proper swing in voltage level. Don't readjust the timing resistors on the modulator, however, unless you feel the first frequencies could be wrong and you want to start over. Too much volume on the speaker and it could distort the tone being heard by the demodulator. It should work even with the modulator volume quite low. If the level does not change correctly adjust R8 on the LM386 of the demodulator for more drive. If you have one of the modem programs mentioned earlier, you can run it and type into the computer and the response of the modem should print out your typing correctly on the screen. This is yet another method to test the response of the demodulator.

Once the demodulator is responding correctly to the 2225 Hz and 2025 Hz tones, you can reset the modulator (the speaker) to the correct frequencies at which it will operate (1070 Hz and 1270 Hz). This is done with the same procedure as you used in the above example except you change the data in the frequency set program to read as shown in line 2 and 3 of the program. Remember that these tones must be almost exact to work correctly. You could be off as much as twenty cycles and the modem would still work with most answering terminals.

LISTING 2

```
10 OPEN 5,2,3,CHR$(6)
20 GET#5,A$
30 PRINT A$;
40 GOTO 20
```

LISTING 2—SMALL PROGRAM which reads the user port and prints resulting data characters on the screen. There are no ASCII interpretation tables so many of the characters will appear as graphics.

Testing the modem

With the speaker still placed near the mike, enter the small test program shown in Listing 2. Save it and enter RUN. The screen should clear. Then, by rapidly connecting and disconnecting J1 to ground, several graphic and alpha characters should appear on the screen in response to the varying tones. If you have a small modem program, you could call up a friend with an answering modem, insert the phone into the coupler's cups, and have the answering modem type some communications which could be used to check the unit. You can even use the small program in listing 2 but a lot of the data will appear as graphics although some of it can be read with a letter missing here and there.

If you are receiving data over the phone line, it may be necessary to slightly adjust the volume controls and even R7 on the demodulator for the best response. Do not readjust the timing resistors on the modulator however unless you are doing it using the frequency set program as in the above example. The mike's LM386 is not too powerful and the tone on the phone can get quite low. The LM386 amp is at its maximum gain/quality level and a bad connection and low answering volume may not make it through.

If you find that the answering modem is responding correctly to your modulator when you enter data, but the demodulator is not responding to the tone coming in, you probably have too much or too little volume going from the phone to the 2211. Try readjusting the volume control on the mike's LM386 until the data is correctly printed on the screen. Occasional garbage on the screen usually means low volume to the 2211 from the mike's LM386.

If all else fails, an audio tape is available from Syntronics that has all of the tones recorded and a continuous data stream in the answering frequency which can be used to adjust and set your new modem with the use of an audio tape recorder. Details of how to order are given in the parts list.

Above all remember, if it fails to work the first time, you can learn a lot from finding the fault. The feeling of accomplishment you get when it does work correctly is worth more than all the expensive modems ever produced.

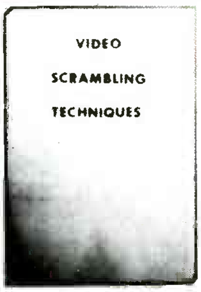
is worn. With power removed from your set, measure the continuity between the wires plugged into the cartridge and the input jack. The wires in the phono arm often come loose; they can cause noise merely by sagging and rubbing the record. Make sure that all contacts of the input jack are clean.

If you don't find an open anywhere, the cartridge is probably the source of the trouble. Cartridges can seldom be repaired; they must usually be replaced. Sometimes the phono arm has to be disassembled to remove the cartridge. If you have any problems, try laying a small mirror under the pick-up arm to see if there are any hidden screws that must be removed. It is usually easier to unplug the wires after you remove the cartridge from the arm. It will require some patience to get the tiny screws started in the new cartridge. Caution: If you have solder-clips on the wires that plug into the cartridge, don't solder them until they have been unplugged from the cartridge. You'll be sure to ruin it otherwise.

Loose (or open) connections and bad cartridges are the most common source of problems in phonos that use radios for amplifiers. But other problems can crop up. For example, a turntable motor that has been in disuse for many years may be "frozen" from its lubricants drying out. Try rotating the turntable by hand. Is the drive wheel or belt slipping? If everything seems OK, the motor may have to be replaced.

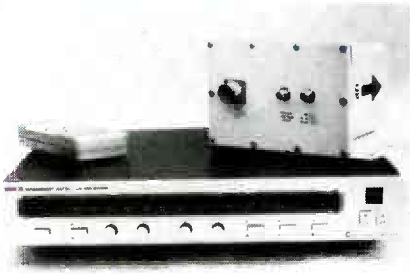
There are other reasons why a turntable might not turn. Radio/phono combinations, as well as separate turntables, usually have a separate AC plug for the turntable. Make sure that the phono is plugged in! With everything unplugged you might try making a continuity check across the turntable's AC plug. If you find an open, the line cord might be bad, or the motor might have an open coil. Another caution: An old turntable, like an old radio, may be shorted, so it thereby poses a dangerous shock hazard. If you haven't been trained in electronics, be sure to get help from a friend who *has* before even plugging your antique in. **R-E**

Radio-Electronics mini-ADS



SUBSCRIPTION TV MANUAL. This information packed book details the methods used by subscription TV companies to scramble and descramble video signals. Covers the Sinewave, Gated Pulse, SSAVI system, and the methods used by most cable companies. Includes circuit schematics, theory, and trouble shooting hints. **Only $12.95** plus **$2.00** first class P&H. **ELEPHANT ELECTRONICS INC., (formally Random Access) Box 41770-R, Phoenix, AZ 85080**

CIRCLE 120 ON FREE INFORMATION CARD

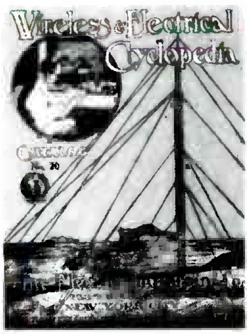


SATELLITE TELEVISION RECEIVER SEMIKIT with dual conversion downconverter. Features infrared remote control tuning, AFC, SAW filter, RF or video output, stereo output. Polorator controls. LED channel & tuning indicators. Install six factory assembled circuit boards to complete. **Semikit $400.00.** Completed downconverter add **$100.** Completed receiver and downconverter add **$150. JAMES WALTER SATELLITE RECEIVER, 2697 Nickel, San Pablo, CA 94806. Tel. 415-724-0587.**

CIRCLE 124 ON FREE INFORMATION CARD

THE LIGHT BRIGADE light chaser will control up to 2000W (4 channels) of your own 110VAC lighting. Create animated displays, fabulous Christmas trees, dazzling windows, etc. Fully programmable patterns, speed, direction. Kit includes PCB, all parts, plans for easy-build enclosure, **$34.95** postpaid. Add **$10.00** for A&T board. CA res. add 6.5%. Send check or M.O. to: **STARFLIGHT ELECTRONICS, P.O. Box 436, Oakville, CA 94562.**

CIRCLE 276 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.**

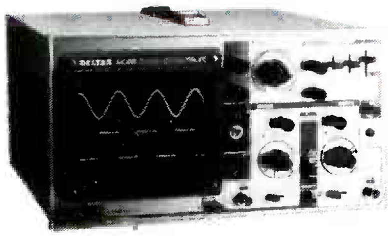
SPECIAL PRICE FOR RADIO ELECTRONICS SAVE **$300** ON 24" AND **$400** ON 30". New HD TRIOK SHEAR-BRAKE-ROLL multi-purpose sheet metal machine now w/6" male dies & removable female dies. Thousands used worldwide industry/government/education. R&D prototypes in-house at 1/3rd cost. **PACIFIC ONE CORP., Ste K51 (714) 645-5962, 513 Superior Ave. Newport Beach, CA 92663 TELEX 4996168 POC NPT**

CIRCLE 118 ON FREE INFORMATION CARD

NEW AUTOMATIC COMMERCIAL CUTTER. Automatically pauses VCR during commercials. Can also mute audio during commercials. WORKS WITH ALL VCR'S. Uses new CMOS LINEAR I.C. manufactured by National Semiconductor. C.O.D.'s accepted. **$179.00** (+ **$2.00** for C.O.D.) Dealer Inquiries Invited. CALL TOLL FREE (24 hrs) 1-800-268-1121. **WESTAR TECHNOLOGIES, 421 Center Street, Lewiston, New York 14092.**

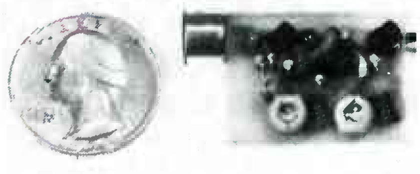
CIRCLE 288 ON FREE INFORMATION CAR

ONE MAN CRT FACTORY, easy operation. Rebuild CRT's for tv's, bus. machines, monitors, scopes, etc. Color, b&w, 20mm, foreign or domestic. 3×6 ft. space required. Profits??? Average CRT rebuilding costs—$5. Sell for $100 = $95 profit; × 5 CRT's = $475 daily; × 5 days = $2375 weekly profit. Higher profits overseas. Investigate this opportunity today. We service the entire world Contact: **CRT Factory, 1909 Louise St., Crystal Lake, Il. 60014, (815) 459-0666.**



DELTAX DUAL TRACE OSCILLOSCOPES WITH PROBES DX5020 20MHz **$379.95.** Built in component tester 5MV to 20V/DIV 0.2 microsec. to 0.5s/DIV. Risetime less than 17ns one year limited warranty. Also available DX5035 35MHz **$527.00** DX5045 45MHz **$789.95** DX5015S 15MHZ A/C D/C **$479.95.** CA. residents add 6.5% tax. Shipping $8.50. Money orders, checks accepted. **DELTAX DYNAMIC INC., 20955 E. Lycoming St., Walnut, Calif. 91789. Tel. (714) 594-7131. Telex: 503749 DELTAX.**

CIRCLE 252 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

SERVICE CLINIC

JACK DARR
SERVICE EDITOR

Wave propagation and antennas.

SOME TIME AGO (IN 1959), I WROTE A book about TV antennas. Before doing the actual writing, I did some reading on the subject (which is always a good idea), and found out that OTH (*O*ver *T*he *H*orizon) TV reception was impossible. However, I knew better! I lived in the mountains, and I could catch three or four stations that were well over the horizon just about any time I wanted. So I knew that the books were wrong, but I wanted to know how the signals *did* arrive. An answer came to me that may be questionable, but I wrote it up that way, and, so far, nobody has proved me wrong.

The traditional line-of-sight description of wave propagation is shown in Fig. 1. The signal is radiated from the transmitting antenna as if it were a bullet from a gun. In order for the "bullets" to reach the receiving antenna, nothing can obstruct the path they travel. Therefore, according to that explanation, OTH reception is impossible. Once the radiated waves passed beyond the receiving antenna, they would continue on out into space, lost forever.

I didn't see it that way. When a signal first leaves the transmitting antenna, if its field were plotted, it would resemble a doughnut. But soon the signal would appear as a series of wavefronts perpendicular to the ground. After a while, those waves would begin to tilt, as shown in Fig. 2, and lean forward at the top! The reason for the tilt is that the refractive index of the atmosphere decreases with height, so radio waves travel more slowly near the ground. That difference in speed causes the wave to tilt,

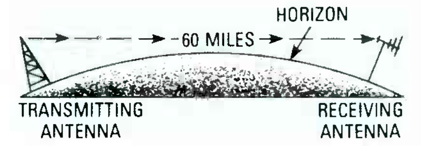


FIG. 1

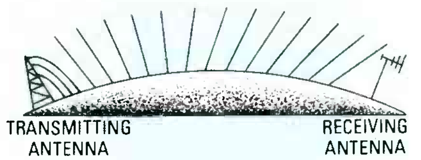


FIG. 2

and, I believe, gives it the ability to travel over the line-of-sight horizon of about 60 miles.

Of course there is another possible explanation for over-the-horizon reception. The upper portion of the signal, called the skywave, leaves the transmitting antenna and travels up into the ionosphere. The ionosphere is composed of several layers; the *E* layer is about 70 miles from the surface of the earth, and it is that layer that most commonly reflects high-frequency radio waves. Such skywave reflection is called *E-skip*, and that is another means by which OTH reception may occur.

However, *E-skip* is not at all reliable, due to the fact that the various layers of the ionosphere are constantly shifting. Of course, there are DX hounds who are constantly on the lookout for such things, and they have recorded some long distances. I think the record is held by someone on the east coast who watched the BBC for several days. Those DX'ers take photos of their TV screens to prove that they have actually received the stations they claim to have received. So E-skip can explain occasional occurrences of DX, but not the sort of daily OTH reception we experience here. Perhaps there's a better explanation than my "tilt theory," you have but I haven't heard one.

Myths about antenna height

It is a commonly-held fallacy that the higher the receiving antenna, the stronger the received signal will be. I have measured, with a field-strength meter, every antenna I ever put up, and I have found that, around this area, there is an optimum height: about 30 feet. Once I owned an extendible tower that would go as high as 40 feet (or 50 feet, if I added a 10-foot section of mast). I found that up to about 30 feet, signal strength increased with height. Above that, there was no perceptible difference, so I have been installing antennas at that height ever since with no complaints.

One last word about towers: Be sure that the mast is properly guyed. That means at least two sets of guys for a 30-foot antenna: one right under the antenna, and another halfway down the mast. For a higher tower, add more guys. My tower, a 65-footer, half of which I could have done without, has four sets, and it has withstood storms with winds clocked at over 100 mph. Two nearby 90-foot pines were blown over by the wind once, but my mast remained standing. Use sturdy cable, and fasten everything well.

Yagi antennas

Around here I usually install a

six-element Yagi antenna. Invented long ago by Dr. Hidetuge Yagi of Japan, the Yagi is probably the best all-around type for both gain and selectivity. Yagis typically have a dipole antenna cut to the desired channel or channels. Normally you choose a Yagi with several elements, each cut to one channel transmitting in your area.

Average gain, with three directors and one reflector, runs at least 12–14 dB. Antenna gain is almost always stated in comparison with a channel-cut dipole. Since a decibel is a ratio, an antenna with a gain of 12 dB means that it delivers signals that are 12 dB stronger than the standard would deliver if it were mounted in the same position.

One feature of the Yagi is its long, narrow "frontal lobe" that gives you a high degree of selectivity, and allows you to bring in signals without too much co-channel interference. The latter is what causes the blanking-bar from an undesired station to float across the picture, occasionally appearing as a negative image. That may also appear, at times, as closely-spaced horizontal bars. Co-channel interference can be caused by E-skip; if so, you just have to wait it out. It usually disappears in a few minutes, but sometimes takes an hour or more.

Since Yagis are so directional, you almost always have to add an antenna rotator to get the most gain from your system. Rotators are not too expensive, but they're an absolute necessity in rural areas like mine. R-E

SERVICE QUESTIONS

VCR KNOCKS OUT TV

My Zenith 19CC19 TV set blacks out after about one hour when used with my VCR. When that happens, the set remains inoperable for the next few hours. That doesn't occur when viewing over-the-air TV or using the VCR tuner. It only happens when I play a cassette. Could there be something in the TV set that charges up and knocks out the picture, and then takes a few hours to discharge?—H.B., Silver Springs, MD

The most essential thing required in service work is a good diagnosis. That sets the stage for all the troubleshooting steps that follow. Your preliminary diagnosis is a difficult one to accept; first that only playback kills the pictures, and second, that once gone, the set needs several hours to rid itself of some excess. My instincts tell me that you have jumped to a conclusion, and that further testing may show the picture blacking out in any mode of operation.

However, I've had enough surprises in this business to convince me to never say never. When the picture is gone, that's the time to act. Do you lose the high voltage? What happens to the kine socket voltages? Do the bias voltages change, cutting the tube off? Those questions must be resolved before you can make any progress.

NO BLUE IN RASTER

Can you help me with a model L-2556DE9 Zenith color TV? I have no blue in the raster. I've replaced the chroma-luminance module and checked the output transistors (including drivers) on the kine module. I suspect the blue gun in the picture tube, but since the set is only 4 years old, it's hard to believe it might be the CRT.—G.S., Phila., PA.

Check the DC voltages going to the kine, comparing those of the blue gun against either of the other two. If G1, G2 and K voltages all match, then chances are the blue gun is bad. On the other hand, if one of the voltages is short, trace it back.

NO SOUND

I really need your help on this one. I've had to change an AN-239 IC on a Quasar 19TS-955 chassis 3 times for loss of sound. Each time the set went bad, the voltage on pin 6 of the IC increased. All other voltage measurements look good. I hope you can help!—J.S., Independence, OH

The audio-output transistor has 124 volts on its collector, and its base is directly coupled into the sound IC. A momentary flash across the transistor junctions could destroy that IC. There can be no quick way to find out if that's what is actually happening, but changing the transistor couldn't hurt. R-E

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.

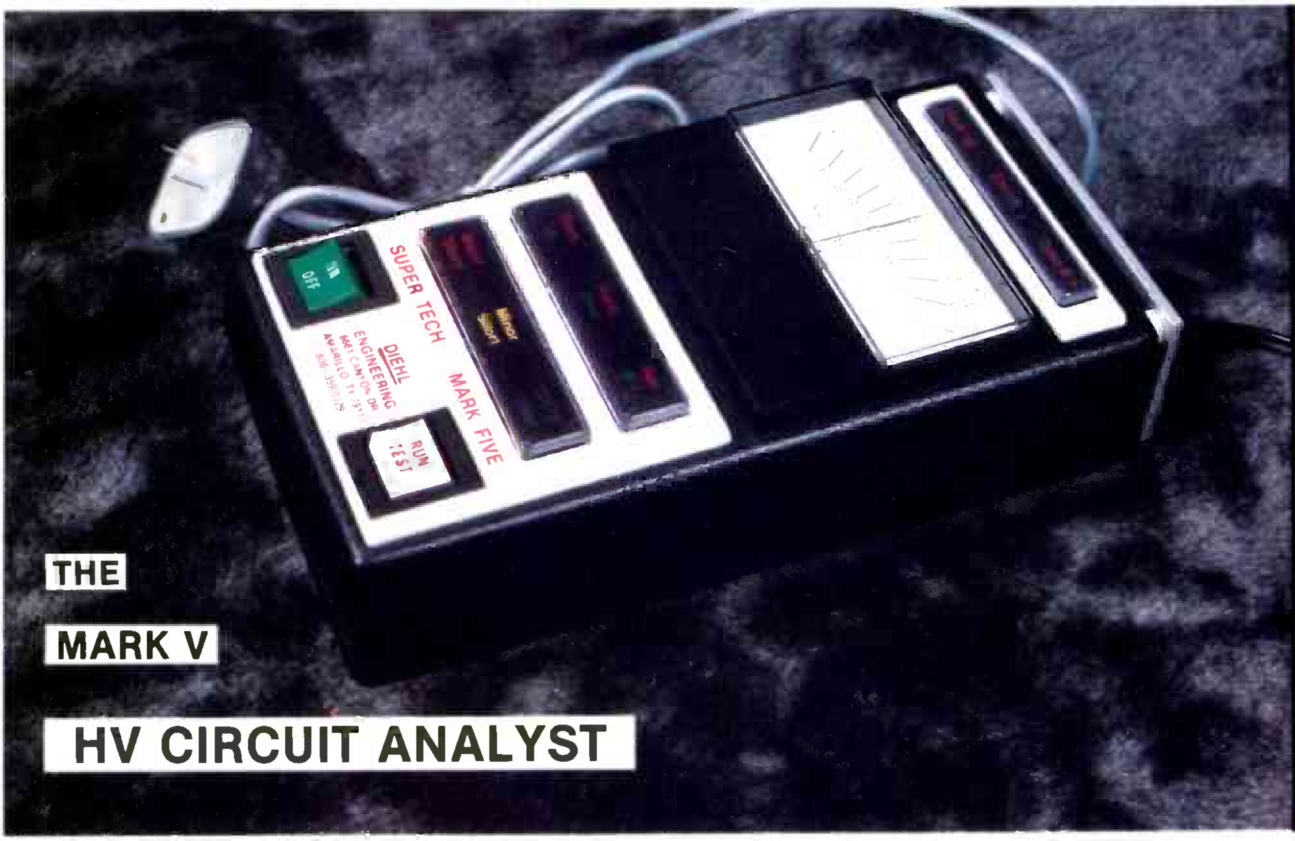
This means all circuits that are not shorted will have some 80% of their normal B+ voltage during the "test" phase. It also means that any shorted circuit will have zero DC volts on it. This feature makes any short easy to isolate.

The MARK III sells for only $595.00

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

Visa and Mastercharge Welcome !

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



THE MARK V HV CIRCUIT ANALYST

AMAZING

- ★ 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 $995^{00}

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

DRAWING BOARD

The world's simplest Z80 circuit.

ROBERT GROSSBLATT,
CIRCUITS EDITOR

I JUST WANTED TO SAY THANKS TO EVeryone—almost 200 of you—who sent a response to my question about hexadecimal display circuits. I wish there were some personal way to thank each and every one who wrote, but practicalities preclude my doing so. The subject of custom decoders and displays is obviously one that many of you want to read more about, so we'll get back to it in a few months. Let me know if you have any specific ideas you want to discuss so I can plan accordingly. But in the meantime, let's get back to microprocessors.

Enough theory!

We've had theory up to our ears by now, so let's do something practical. You'll recall, I said that we were going to build the world's simplest Z80 system. Well, let's see how simple such a system can be.

No matter what you want to do with a Z80, the first thing you must take account of is the system clock. Considering how powerful the Z80 actually is, it's surprisingly unfussy about its clock. The main requirement is that the clock be TTL level; the frequency of oscillation depends on which Z80 you'll use. The plain-vanilla Z80 has a maximum operating frequency of 2.5 MHz, but other versions of the IC, those with "A" and "B" suffixes, will run at maximum speeds of 4 and 6 MHz, respectively.

We don't need to run our circuit that fast; and, in order to keep the peripheral circuitry simple—and save a couple of bucks in the process—we'll use a plain Z80 with a 1-MHz clock. Other requirements of the clock (such as rise time and duty cycle) are easy to handle. As a matter of fact, if you have a TTL-level squarewave with a duty cycle of 50%, you can pretty much ignore those restrictions altogether. And since the Z80's clock input ap-

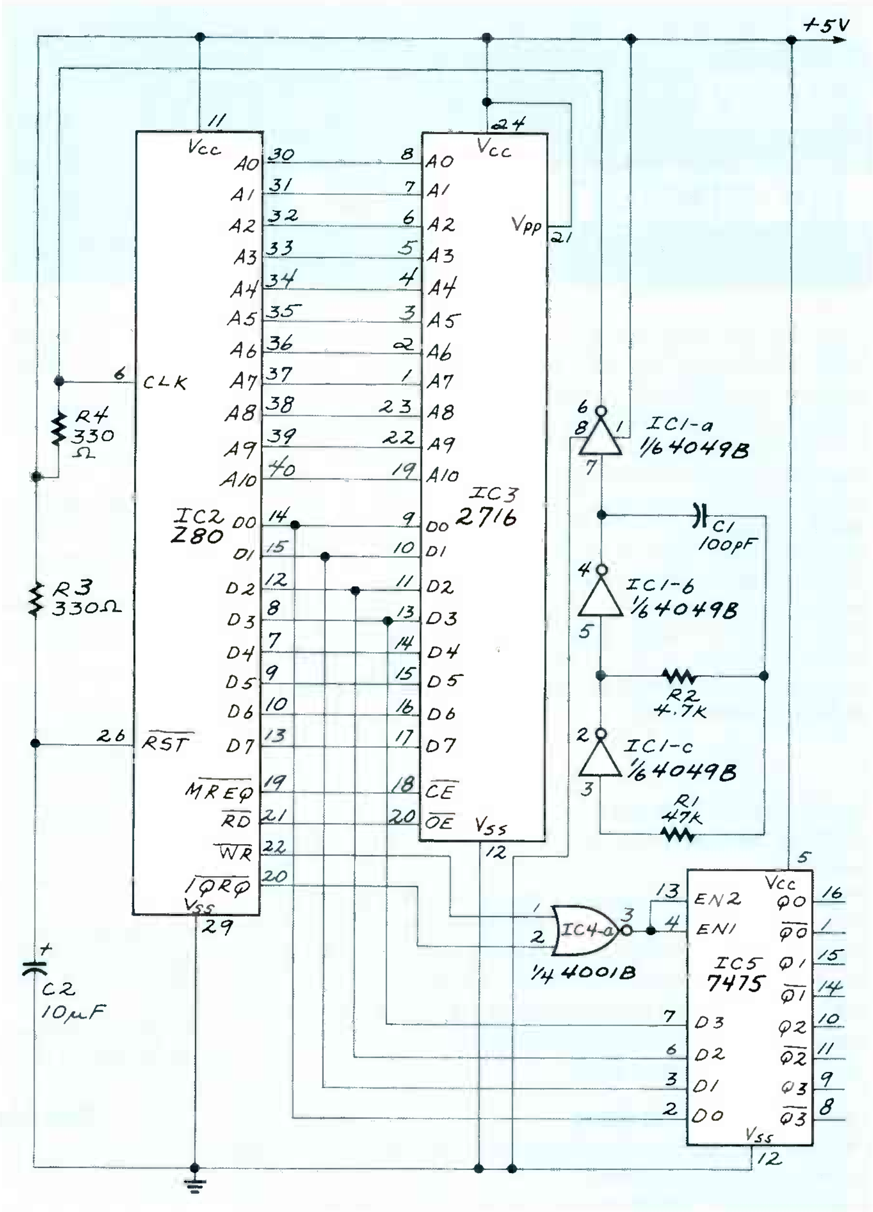


FIG. 1

pears as one TTL load, we can even drive it with a CMOS astable multivibrator.

The complete schematic for our Z80 circuit is shown in Fig. 1. The clock circuit shown there should look familiar. That's right; it's our handy-dandy, all-purpose CMOS clock circuit. You should be able to put one of those together in your sleep by now. The output frequency of that circuit is approximately equal to 1/(2.2 × R2 × C1), so the values shown should give us about 1 MHz. The additional gate is a buffer used to isolate the clock circuit from the Z80's clock input, because it needs a 330 ohm pull-up resistor.

Believe it or not, the only other control signal we have to generate for our bare-bones system is RESET. You'll notice in Fig. 1 that I generate that signal with R3 and C2. They take care of power-up reset; if you want to be able to generate RESET manually as well, all you need do is wire a momentary switch in parallel with C2.

Now that we've got a clock and a reset pulse, the next thing to talk about is memory. There has to be a place to store the software that drives the circuit, so we have to add some ROM. I chose a 2716 EPROM because, of all the permanent memory around, EPROM's are about the easiest to program, and 2716's are both cheap and available. Connecting the EPROM to the Z80 is simple. The address pins on the EPROM go to corresponding pins on the microprocessor; likewise with the data pins.

The only part of the memory circuit that needs to be explained is the 2716's chip-enable pins. You'll recall from our earlier discussions that when the Z80 wants to read something from memory, it puts a low on both the $\overline{\text{MREQ}}$ and $\overline{\text{RD}}$ lines. Those lines are connected to the enable pins of the 2716 so that a read request from the Z80 will enable the EPROM, thereby allowing data to be routed to the Z80.

So what about I/O? Well, in order to be consistent with our design goal of making this the world's simplest Z80 circuit, we'll connect a 7475 quad latch to the data bus. Whenever the Z80 wants to do an I/O operation, it puts a low on the $\overline{\text{IORQ}}$ line. The Z80 also brings $\overline{\text{WR}}$ or $\overline{\text{RD}}$ low depending on whether it wants to read from or write to an I/O port. So, by NORing the $\overline{\text{IORQ}}$ and $\overline{\text{WR}}$ lines from the Z80, we can send data to the latch by using an OUT instruction. Since the enable pin of the 7475 is active high, the Z80 will be able to store data in the latch.

If you've been following my earlier columns on the Z80, there should be one question uppermost in your mind: What about the RAM?

Where's the RAM?

Even a minimal Z80 system needs some temporary storage space. There is such space, of course: the Z80's internal registers. There's not much space, but a system like ours doesn't really need much. We can run simple programs without any additional RAM storage.

So there we have a complete Z80 system with a minimum of components. In fact, there are more parts in some light dimmers! With our circuit the Z80 can read data and program instructions from the EPROM; it can also output data to the real world through the 4-bit latch. Actually, our little circuit can do quite a few things such as playing music, storing and displaying tables of data, or working as a simple controller. All you have to do is tell it what you want it to do. And there, as Shakespeare said, is the rub: software.

In order to deal with software you need a good grounding in both logic and the Z80's instruction set. The point is that microprocessor circuits, unlike the circuits we usually talk about, require very little understanding of electronics *per se*. Volts, ohms, amps, and all the rest go out the window.

By the time we get together next month we'll have had time to digest that particularly distressing fact; we'll see then what we can do to get our little circuit to do something useful. In the meantime, spend the next couple of weeks reading up on the Z80 instruction set. But don't throw out your multimeter just yet—we'll get back to "pure" circuit design before you know it! **R-E**


$29.95 LCD Multimeter
SPECIFICATIONS
CATCH A LITTLE AUSSIE CHRISTMAS SUNSHINE!
You blokes may think Santa actually likes snow, but wait 'til y' see the bewty values he's come up with since he's let his hair down to celebrate the season with us downunda!
TELETEXT
Build This Low-Cost TELETEXT DECODER and SAVE A FORTUNE!
Look at these FEATURE
DSE Teletext
Cat No. K-6315
Headlines
ELECTRA
LATEST NEWS • NEWS FLASHES • BUSINESS HEADLINES • SPORTS SCORES • WEATHER • NYSE, AMES AND OTC STOCK PRICES • SPORTS QUIZ • STATISTICS • COMMODITY REPORTS
CIRCLE 95 ON FREE INFORMATION CARD
Portable Electronic Backgammon
The traveling backgammon game to beat them all. Has allthe right rules of play even the doubling cube - and it's a great aid to learning this exciting game, too. And the best part about it: you can actually beat the computer, it plays just like a person (not some super brain) so you aren't frustrated by losing all the time!
$34.95
Cat Y-1015
BONZA BARGAIN IN OUR XMAS MAILER— Got yo
© 1985 DICK SMITH ELECTRONICS

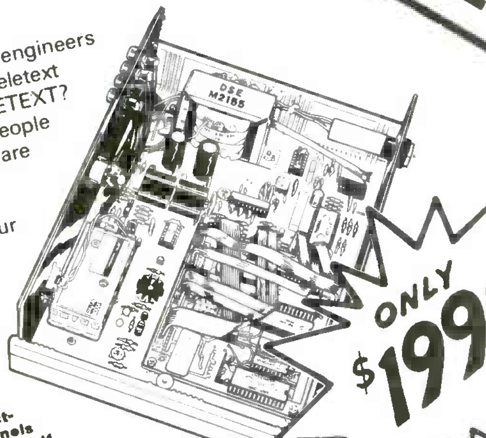
FAIR DINKUM VALUE!

IS HERE!

GET IT ALL THE TIME

It's finally here!

After long months of hard work our engineers have designed this easy-to-build teletext decoder. NEVER HEARD OF TELETEXT? You're not the only one. Many people don't know that text & graphics are being transmitted as digital data squeezed into the vertical blanking interval on your on your ordinary television set. There are literally hundreds of pages of information & graphics!



ONLY $199.00

Easy to build circuit board with screened overlay showing component layout for easy assembly. •Comes with pre-adjusted and pre-assembled decoder module. Requires very little adjustment. •Housed in attractive case with screened front and rear panels - You'll be proud to have it on your video shelf - Just wait until your friends ask what it is! •Comes complete with 21 button remote control. •Teletext services are FREE - no user fees, no scrambled signals •Watch regular TV, view Teletext pages, or see the text over the regular TV picture. •Decoder can be set to newsflash page warning you of hot news stories.

The largest teletext service is a general interest one called Electra. It is produced by Taft Broadcasting of Cincinnati, Ohio, and is available there on WKRC, Channel 12. It is also linked to the VBI of Superstation WTBS-Atlanta, and is thus available to some ,000 cable-TV systems with 32 million homes. It is also available to anyone with a TVRO dish on the Galaxy 1 satellite, transponder 18, and on the SPN channel of Satcom 3, transponder 6.

Along with Electra, the company that links WKRC with WTBS also produces a business "magazine" called Cabletext, which is 11 pages of 15-minute delayed NYSE, AMEX and OTC stock prices, along with a long "rolling page" of stock information and business headlines. (Cabletext is available simultaneously with Electra: Electra starts on page 100, Cabletext on page 201.)

Electra is a 100-page magazine with fast-breaking news, "soft news", business headlines and information, sports scores, headlines, and statistics, and features such as weather, trivia pages, and a daily sports quiz question whose answer appears at the press of a button (REVEAL)

Another very large teletext service is the agriculturally-oriented INFOTEXT service produced by the University of Wisconsin and available on television stations throughout that state. INFOTEXT provides general news, detailed weather, commodities reports and prices, and general market information.

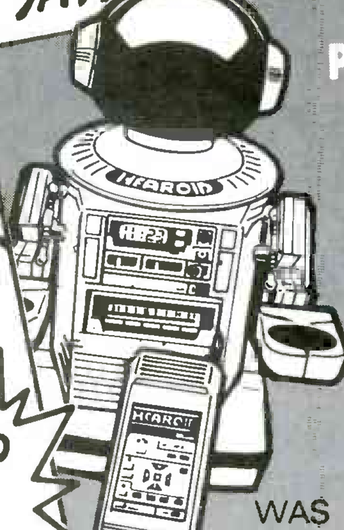
Two other services are KTTV — Los Angeles' Metrotext and WFLD — Chicago's Keyfax.

Teletext will be the hottest communications issue of the late 1980's and beyond!

NOTE: Requires pre-tuned composite video and audio outputs from your VCR (Beta or VHS), Satellite receiver, component-TV tuner, some cable-TV decoders, or some newer TV's with composite tuner outputs.

SAVE $100

The Incredible Voice-Programmable Hearoid



Hearoid is here! His brain is a sophisticated voice recognition computer that makes him respond to your spoken words. He understands 12 different commands in any language or accent; and that's all he needs to perform an infinite variety of actions. He's easily programmable and can learn complex programs up to 45 minutes long. With his tape and computer memory, you can keep a library of tasks for him to perform.

- By voice command, Herold can: Go forward, go back, turn left, turn right, stop, turn on his headlight eyes, turn off his headlight eyes, play & record on his built-in cassette deck & more!
- Carry objects with his grasping hand & carry objects with his removable tray.
- More than 18" tall; rechargeable built-in power cell with approved power pack included.
- Uses 1 '9V' and 2 'AA' batteries, not included; has a transmitter that can be used as a wireless microphone allowing user to talk through him; has a mouth display that lights in sync to his sounds.

WAS $399.00

NOW $299.00

12V Economy Solder Iron

$3.95

Cat T-1910

This little iron is superb-and very popular! It operates from 12 volts either AC or DC - so it's just as much at home in the car or on the workbench. Use it with any 12 volt battery supply or transformer

Take an armchair trip to Australia

Australians At Play

$29.95

Australians have always been fun and leisure oriented people and when criticisms are directed at us, they have invariably been about our inability to take life too seriously. This book applauds just that, in words and stunning color photos. You'll be taken to the topless beaches, experience a weekend, sailing the ocean, surfing the Barrier Reef, outback camping, cricket and much much more.

Cat B-9901

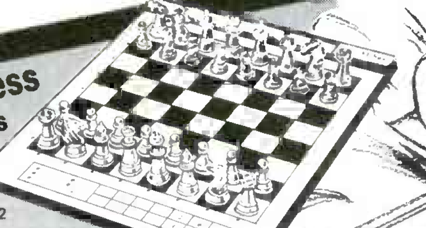
Table Top Chess

Ultra slim, 9 levels

$79.95

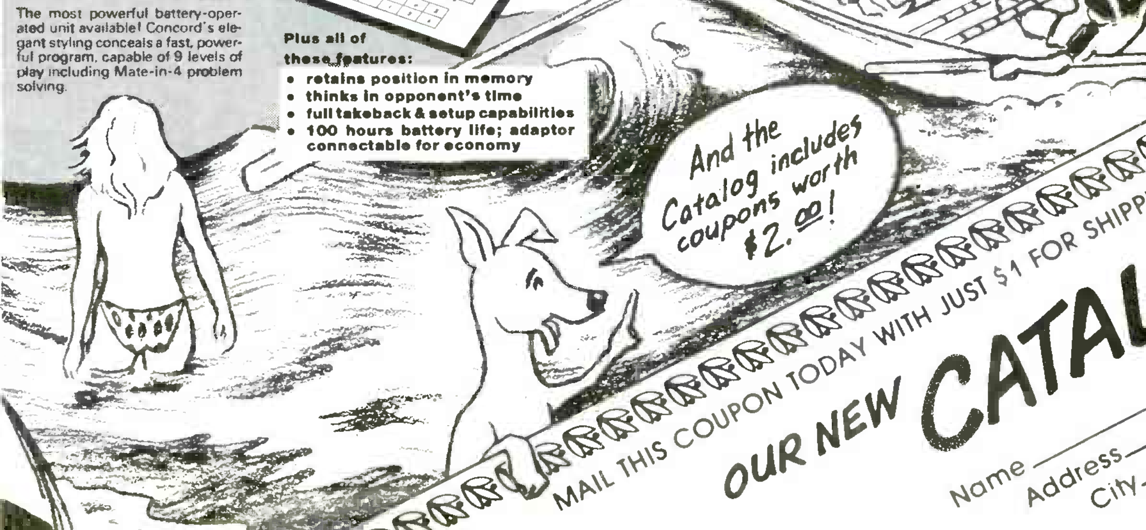
Cat Y-1262

The most powerful battery-operated unit available! Concord's elegant styling conceals a fast, powerful program, capable of 9 levels of play including Mate-in-4 problem solving.



Plus all of these features:

- **retains position in memory**
- **thinks in opponent's time**
- **full takeback & setup capabilities**
- **100 hours battery life; adaptor connectable for economy**



MAIL THIS COUPON TODAY WITH JUST $1 FOR SHIPPING AND WE'LL SEND

OUR NEW CATALOG!

Name ____
Address ____
City ____
State ____
Zip ____

PRICE/TECHNOLOGY BREAKTHROUGH!

SATELLITE RECEIVER KIT

$99.95* CAT K6316

YOUR CHANCE TO BREAK INTO A WHOLE NEW WORLD OF ELECTRONICS - THE WORLD OF SATELLITE TELEVISION - AT AN UNBELIEVABLE PRICE.

Unlock the world of television programming that you have never before experienced. The diversity of reception is phenomenal. From sports to international politics, to movies, to the major news at 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 you 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 Performance - Compare with receivers priced hundreds of dollars higher. Specifications like:

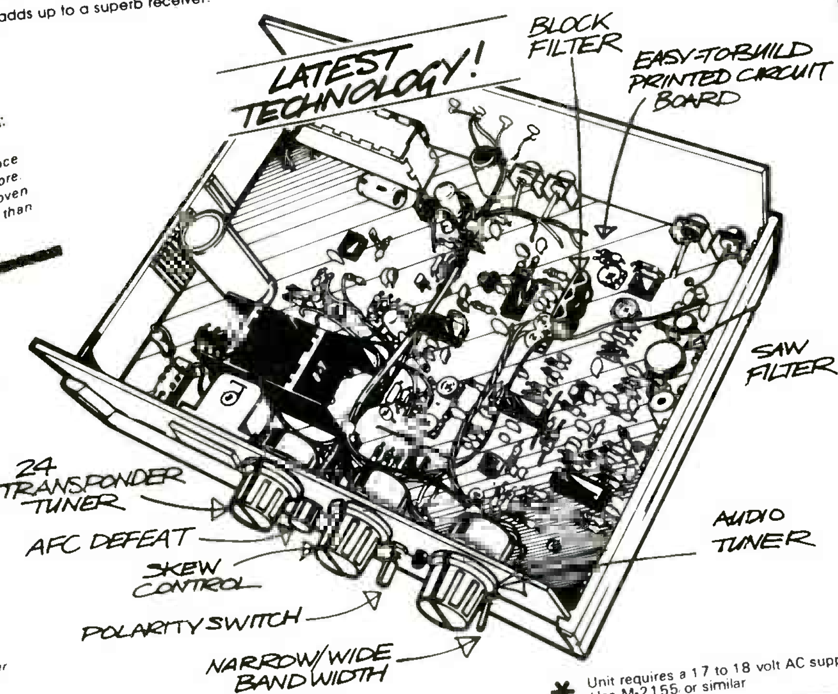
IF Input Frequency: 70mHz
IF Input Level: –35Bm to –5Bm
IF Input Impedance: 75 Ohms
IF Band Width: 26mHz standard 12mHz optional
Carrier to Noise Threshold: Less than 7dB
Video De-emphasis: CCIR 525 lines
Video Output Level: 1 volt (peak to peak)
Video Output Impedance: 75 Ohms
Video Polarity: Internally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

It all adds up to a superb receiver!

here's what Richard Maddox author of Tab books' "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. Building the Australis I in a few hours of your own time can save you money and think of what you'll learn about the new technology of satellite reception.*

* Unit requires a 17 to 18 volt AC supply. Use M-2155 or similar

CIRCLE 253 ON FREE INFORMATION CARD

SHOP EARLY!

Then you'll have time for a couple of tinnies!

DESIGNER'S NOTEBOOK

ROBERT GROSSBLATT,
CIRCUITS EDITOR

A handy low-voltage indicator

I KNOW IT'S HARD TO BELIEVE NOW, BUT once upon a time all electronics gear had to be powered from the AC lines. Batteries were put in flashlights, and nowhere else. Most other devices required much more power than a dry cell could deliver. These days, whenever I see someone walking down the street plugged into a tiny radio or cassette player, I think about companies like Webcor and get a bit nostalgic. Maybe some of you do too.

Anyway, more and more devices today use batteries for power, and that includes home-made devices as well. In the past we've presented several circuits that help keep batteries well-charged. We've also talked about nickel-cadmium cell charging and stand-by power supplies, but we've never shown how to keep an eye on batteries' energy reserves. And we all know (by Murphy's law) that batteries have a nasty habit of pooping out just when we need them most.

Well, I've used the little low-voltage indicator shown in Fig. 1 in almost every battery-powered device I ever built. The circuit has only five parts, and it pays for itself over and over in the amount of irritation it helps prevent.

FIG. 1

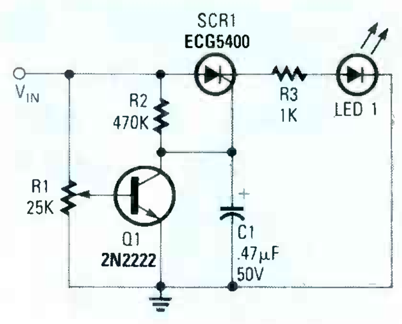


FIG. 2

How it works

Input terminal V_{IN} is connected to the +V line of the circuit the indicator is to monitor, and the grounds of both circuits are connected together. The position of potentiometer R1's wiper determines Q1's base voltage. As long as the transistor gets enough bias to remain on, the low voltage at the collector will keep the SCR from firing. As the battery voltage starts to fall, the transistor's base voltage will fall as well.

The magic moment comes when the base voltage drops too low to keep Q1 on. When Q1 turns off, the collector voltage goes up, and that provides enough gate drive to turn on the SCR. That provides enough power to turn on the LED, which could also be a buzzer or almost any other type warning device.

The circuit uses very little power. As a matter of fact, most current is drawn through the potentiometer, although some current flows through Q1 as long as it remains on. We've shown a value of 25 kilohms for R1, but you can use just about anything as long as you provide enough current to keep Q1 on. Of course, the larger the value of R1, the less wasted current there will be. Different 2N2222's will let you get away with larger potentiometers. As always, experiment. The capacitor is not strictly necessary; it's in the circuit to act as a "sponge" to prevent the SCR from firing when you change batteries.

The SCR

The last thing to discuss is the SCR. Remember that when the transistor turns off, the SCR is going to get its gate drive through the resistor. Not much current can flow through R2, so I've called for the most sensitive SCR I could find. If you need to drive something that draws more current than an LED, you'll have to adjust the back end of the circuit. There are many ways to do that: You could, for example, have the SCR trigger another SCR, or turn on a relay.

As it is, the circuit will work over a 25-volt range, and the potentiometer can be adjusted to make the circuit fire over most of that range. So, breadboard the circuit and try it out. I'm sure a bit of thought on your part will result in enhancements. Let me know what you come up with. **R-E**

KENWOOD

...pacesetter in Amateur radio

Scan the World

R-2000
All-mode receiver.

- Covers 150 kHz—30 MHz in 30 bands.
- All mode: USB, LSB, CW, AM, FM.
- Digital VFO's. 50-Hz, 500-Hz or 5-kHz steps. F. LOCK switch.
- Ten memories store frequency, band, and mode data. Each memory may be tuned as a VFO.
- Lithium batt. memory back-up.
- Memory scan.
- Programmable band scan.
- Fluorescent tube digital display of frequency (100 Hz resolution) or time.
- Dual 24-hour quartz clocks, with timer.
- Three built-in IF filters with NARROW/WIDE selector switch. (CW filter optional.)
- Squelch circuit, all mode, built-in.
- Noise blanker built-in.
- Large front mounted speaker.
- RF step attenuator. (0-10-20-30 dB.)
- AGC switch. (Slow-Fast.)
- "S" meter, with SINPO scale.
- High and low impedance antenna terminals.
- 100/120/220/240 VAC operation.
- RECORD output jack.
- Timer REMOTE output (not for AC power).
- Muting terminals.

R-1000 High performance receiver • 200 kHz-30 MHz in 30 bands • AM, CW, SSB • 3 IF filters • noise blanker • RF attenuator • S-meter • 120-240 VAC • muting terminals • built-in speaker • digital display/clock/timer

R-600 General coverage receiver • 150 kHz-30 MHz in 30 bands • AM, CW, SSB • IF filters • noise blanker • RF attenuator • S-meter with SINPO scale • front mounted speaker • 3 antenna inputs • 100-240 VAC operation • record jack • muting terminals • digital display

Optional accessories:

- VC-10 VHF converter for R-2000 covers 118-174 MHz
- YG-455C 500 Hz CW filter for R-2000
- HS-4 Headphones
- HS-5 Deluxe headphones
- HS-6 Lightweight headphones
- HS-7 Micro headphones
- DCK-1 DC cable kit for 13.8 VDC operation
- AL-2 Lightning and static arrester
- Service manuals are available for all receivers and most accessories.

Additional information on Kenwood all-band receivers is available from authorized dealers.

KENWOOD

TRIO-KENWOOD COMMUNICATIONS
1111 West Walnut Street
Compton, California 90220

Specifications and prices subject to change without notice or obligation.

CIRCLE 102 ON FREE INFORMATION CARD

STATE OF SOLID STATE

Analog IC's and new MOSFET's

ROBERT F. SCOTT
SEMICONDUCTOR EDITOR

MANY INTERESTING IC'S HAVE RECENTLY been developed for audio applications. For example, the MTA1537A is a precision AGC/Voltage-controlled attenuator developed by Aphex Systems. It is specially suited for high-speed precision control of signal level, dynamic range, and phase and amplitude equalization in applications such as high-quality audio controllers, analog computers, precision oscillators, robots, video-effects generators, servo controllers and precision phase detectors. The MTA1537A comes in a standard 14-pin DIP package; typical specifications are:

- 110-dB dynamic range
- 120-dB attenuation
- less than 0.05% THD
- 2-mv control-voltage feedthrough
- 200-MHz bandwidth

Figure 1 shows how the MTA1537A can be used as a stereo attenuator. Typical specifications for that circuit include maximum input and output levels of 7.75 volts rms, maximum attenuation of 100 dB over a frequency range of DC to 200 kHz, and a control voltage feedthrough of 5 mV at 100 dB attenuation. Note that at high frequencies, circuit layout will affect attenuation.

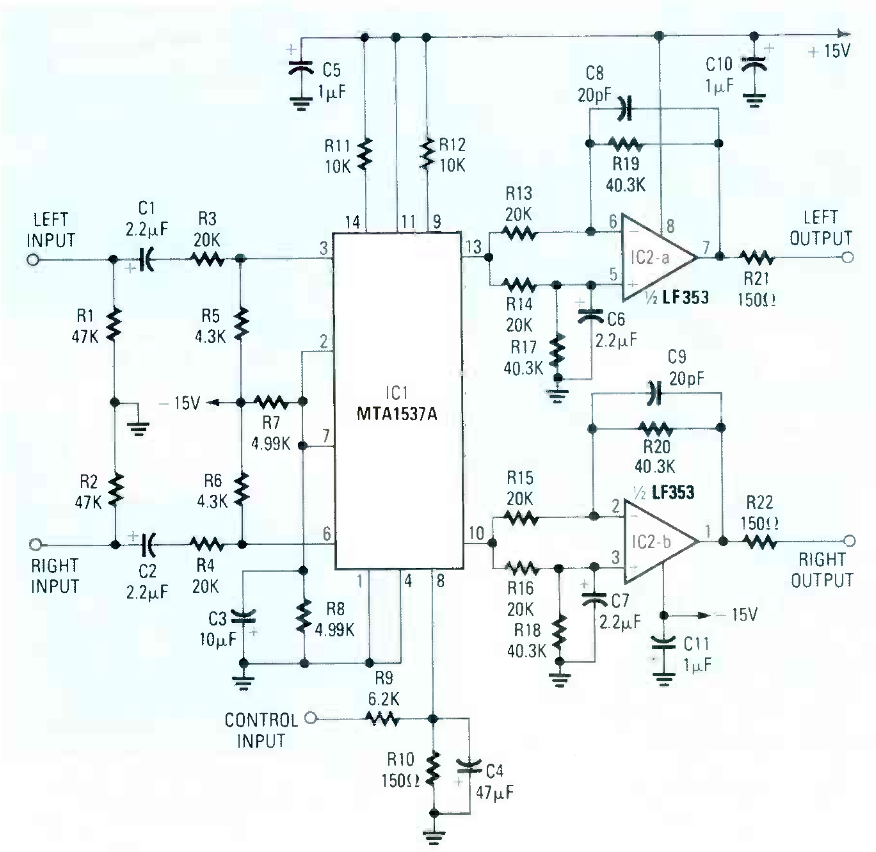


FIG. 1

The op-amps used in that circuit may be LF353's (or equivalents); NE5534's could be used for low-noise applications. The MTA1537's data sheets include basic circuit diagrams for applications such as a voltage-variable resistor, voltage-tunable high-pass filter, voltage-variable inductor, voltage-controlled band-reject filter, and a voltage-controlled graphic equalizer.

For two samples of the MTA1537A, and a copy of the data sheet, send $17.00 to the manufacturer.—**Aphex Systems Ltd.**, 13340 Saticoy St., North Hollywood, CA 91605

New JFET op-amp family

The MC34080 series is a new generation of JFET-input op-amps from Motorola. They are available in single, dual, and quad versions (both compensated and uncompensated), and they offer bandwidth and slew rates as much as four times greater than previously available types.

A combination of JFET and bipolar technologies, along with an all-NPN output stage, has yielded a fully-compensated op-amp family with a gain-bandwidth product of 8.0 MHz and slew rates in excess of 30 V/μs. For greater speed, uncompensated versions are offered with a gain-bandwidth product of 16 MHz and slew rates of 60 V/μs.

The all-NPN output stage provides a peak-to-peak output voltage swing that is 33% greater than standard op-amps that use NPN/PNP output stages. Other features include: input impedance of 10^{12} ohms, open-loop output impedance of 30 ohms at 1.0 MHz, THD of 0.01%, phase/gain margins of 55°/7.6 dB for fully compensated devices, and 30 nV/√Hz input noise voltage.

Prices range from $0.59 for the single op-amp MC34080 (uncompensated) and MC34081 (compensated) to $2.80 for quad versions. For data sheets and complete pricing information, contact **Motorola Semiconductor Products**, PO Box 20912, Phoenix, AZ 85036.

Low-power quad op-amps

National's LP124 family of quad op-amps is a pin-compatible, low-power version of that company's LM124 family. The new series consists of the LP124, LP2902 and LP324 high-gain, internally-compensated micropower op-amps. They are well suited for CMOS applications, battery-powered equipment and other circuits that require good DC performance and low supply current. The LP124 joins National's LP139 and LP165 low-power quad comparator families.

Maximum power consumption is 125 μA—one-tenth that of National's LM series, and lower than many CMOS amplifiers. In addition, input bias current has been reduced by a factor of ten to a maximum of only 4 nA. Available in 14-pin plastic and ceramic DIP's, the LP324N sells for $0.75 in quantities of 100 or greater. For more information, contact **National Semiconductor Corporation,** 2900 Semiconductor Drive, Santa Clara, CA 95051.

New temperature sensors

The LM34, LM34C, and LM34D make up a series of precision temperature sensors with output voltages linearly proportional to the Fahrenheit temperature scale. Those devices, from National Semiconductor, require no external calibration or trimming to provide typical accuracies of ½°F at room temperature and ±½°F over a full range of −50 to +300°F. Temperature stability is aided by the LM34's low self-heating, which is typically less than 0.2°F in still air.

Interfacing to readout or control circuits is easy. The output impedance is only 0.1 ohm at 2 mA and the output is linear at 10 mV/°F. It can be used with single power supplies or with split (plus and minus) supplies delivering from 5 to 30 volts and draws less than 60 mA. The LM34 can be glued or cemented to a surface and its temperature will be within 0.02°F of the surface reading.

The LM34 is rated from −50 to +300°F, the LM34C from −40 to +230°F, and the LM34D from +32 to +212°F. All are available in TO-46 packages. The LM34C and LM34D are also offered in the TO-92 packages. The LM34 is $1.55 each in 100 and up lots.—**National Semiconductor Corp.**, 2900 Semiconductor Drive, Santa Clara, CA 95051. **R-E**

COMMUNICATIONS CORNER

HERB FRIEDMAN,
COMMUNICATIONS EDITOR

Improving reception with an active antenna

IT WAS MOST LIKELY MARCONI WHO said, "If you can't hear 'em, you can't work 'em." And so for years, shortwave listeners put up the longest antenna possible in the belief that the longer the wire, the greater the RF signal induced in it, and therefore, the greater the chance of hearing the transmission.

In the early days of the wireless, it was not unusual to find receiving antennas that stretched well beyond the limits of one's property, and if a neighbor refused to give permission to string a wire over his "south forty," the wire could at least reach to your own property line.

Unfortunately, today's property line is often right outside one's living-room window. If you are an apartment dweller, just the stub of a wire hanging out the window is bound to produce at least five neighbors who've nothing better to do than spend the day staring at the sides of buildings to see if anyone has defaced the property with wire. As such, many SWL's (shortwave listeners) are limited to some form of indoor antenna, which are not known for efficiency when it comes to receiving RF signals.

Active antennas

Today, instead of using the bedspring as an indoor shortwave antenna, we can substitute an *active antenna*. An active antenna has a built-in preamplifier that compensates for some of the losses of an indoor antenna. One such device is the *Datong* active antenna from Gilfer Shortwave (52 Park Ave., Park Ridge, NJ 07656).

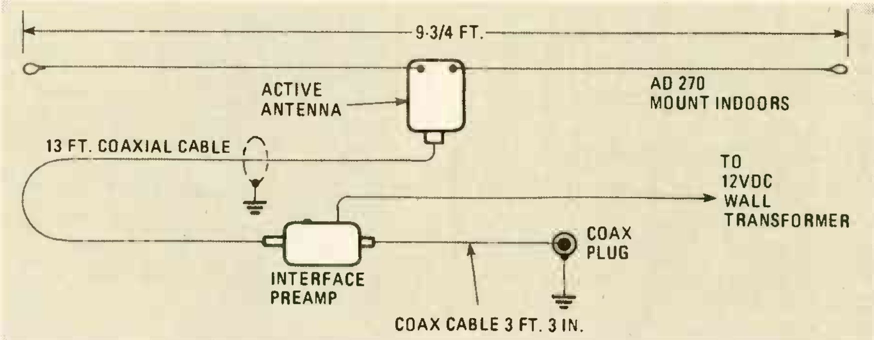


FIG. 1

Figure 1 shows how the *Datong* active antenna works. Although the operating frequency range is from 0.2 to 30 MHz, the antenna itself is only three meters long. At its center is a solid-state amplifier that's connected through 13 feet of coaxial cable to an interface preamplifier, which matches the active antenna to the low impedance of the receiver's antenna input.

The output of the amplifier is approximately 6 dB greater than that of a conventional dipole antenna. The interface device also has a 6 dB gain that is switch-selected by the user, so the total system gain is either 6 dB or 12 dB. The power source for the device is a common plug-in AC adapter.

Although the amplifier is enclosed in a small cabinet, the antenna itself is a flexible wire that can be placed under a carpet, draped around a window, concealed in an attic, or slipped under the bed. The only thing that you have to remember is that the amplifier will amplify all signals presented to its input. So, if the received signal is under atmospheric and man-made noise to start with, it's still going to be under the noise when amplified.

Squashing the QRM.

Even if you get the signal level up to the minimum level required by the receiver, there's still a reception problem because the VHF frequencies are jam-packed, and the interference is often stronger than the desired station. The usual way to reduce interference is to narrow the bandwidth of the IF amplifier through the use of filters.

Many shortwave receivers, even the less expensive models, have some form of user-selected IF filtering. But those factory-installed filters often don't cut the bandpass down to rock bottom. So some receivers have expansion sockets for user-installed upgrade IF filters. For some other units, there are more selective plug-in filters that can be purchased and installed by the user.

On the other hand, most of the less expensive receivers make no provision for extra IF selectivity. In such instances, the user can use an audio filter. While an audio filter is not as effective as an IF amplifier filter, it's a lot better than nothing at all.

An audio filter eliminates the interference "grind" heard in speakers or headphones. That is done by using an audio filter with a very sharp cut-off. Such a filter is found in the Laboelectron *SF-0330* (also available from Gilfer Shortwave), which connects between the receiver's audio output and the speaker or headphones. The *SF-0330* contains a 300–3300-Hz bandpass filter, a 500-Hz highpass filter, 1500- and 2200-Hz lowpass filters, and a small amplifier that drives the speaker or headphones.

The filters in the Laboelectron unit feature an unusually high degree of filtering. That degree of filtering is made possible through the use of active (amplified) rather than passive (inductive and capacitive) filters. The receiver's normal output signal is fed into one end of the special active filter, and the speaker/headphones are connected to the other.

If all filters are switched out, whatever normally comes out of the receiver is fed to the speaker and phones. But if the 300–3300 Hz filter is switched in, the overall receiver-system bandwidth is sharply limited to the voice-frequency range, generally attenuating the sputtering and hissing from stations on nearby frequencies.

If the interference is still severe, the bandwidth can be restricted even farther by switching in the individual filters. At maximum filtering, the bandpass is only 500–1500 Hz. Although it is not hi-fi, it can make the difference between getting some intelligence or hearing nothing but beeps and groans.

Of course, while few add-on gadgets are adequate substitutes for a high-performance receiver and an outdoor antenna, antenna gain and selectivity devices often are the only way to get any worthwhile audio—especially when you're using a budget receiver with a wire lying on the livingroom floor as an antenna. R-E

SWITCHING SUPPLIES

continued from page 82

Fig. 12 takes a nominal 10-volt input and converts it to 25 volts at 100 mA. Efficiency in that configuration is typically 60% or better.

The inverting converter shown in Fig. 13 takes a 12-volt input and delivers a −15 volt output at 100 mA; the circuit will actually operate over an input range of 10 to 20 volts. Efficiency in that configuration is typically 60% or better.

As we said, the same printed-circuit board may be used to experiment with the μA78S40 in any mode. Printed-circuit artwork is shown in the "PC Service" section of this magazine, and a component layout diagram is shown in Fig. 14. Follow standard construction practices and be careful installing the jumpers; Table 2 details the appropriate jumpers used in each circuit.

The only part that requires special attention is inductor L1, which must be assembled before it is mounted. First, evenly wind 20 to 25 turns of 18 gauge wire around the bobbin, leaving several inches of slack on either end. Next, insert the two black ferrite cores into the bobbin, and snap the assembly in the mounting bracket. The bracket can now be attached to the PC board with short screws. The pins on the bobbin should be inserted into the holes on the PC board and soldered. The slack ends of the coil should now be soldered to those pins.

Now the board must be calibrated; that involves setting the two potentiometers. The 100 ohm potentiometer R2 in parallel with one-ohm resistor R1 sets the short-circuit current limit; in the step-up and step-down modes they should have a composite value of 0.33 ohm, so R2 should be adjusted for a value of 33 ohms. For the inverter circuit the composite value is 0.28 ohm, so R2 should be adjusted for a value of 28 ohms. In either case the IC should be removed from its socket before calibration.

The second step of calibration involves setting 50 kilohm potentiometer R4. Connect a 1000-ohm resistor between the output terminal and ground, and then apply your input voltage. While monitoring the output with a voltmeter, adjust R4 for the desired voltage.

Beyond the basics

Designing a switching power supply is not just a matter of manipulating mathematical formulas; the actual components used to implement the circuit can have a great effect on that circuit's performance. In particular, the inductor, the switching transistors and the output capacitor must be carefully selected. Moreover, circuit layout must also be carefully thought out; switching power supplies are notorious generators of EMI (*E*lectro*M*agnetic *I*nterference), and a poor layout can cause excessive amounts of EMI to be generated.

Saturation of the inductor's core is a common problem with switching regulators. The inductor's current peaks should appear very sharp on an oscilloscope; there should be no cusping, rounding, or clipping. Further, the core's window must have a large enough diameter so that enough turns of the proper wire size may be wound through it. Otherwise DC losses at peak current may become excessive, power may be lost, and the output voltage may drop below the value the circuit was designed to maintain.

In linear voltage regulators the output transistors usually operate at a quiescent point so that a relatively constant current flows continuously. However, that is not the case with switching voltage regulators. The transistors must withstand the unique stresses caused by rapidly switching from completely on to completely off. So parameters such as switching times, saturation voltage, power dissipation and secondary breakdown ratings are now all crucial.

The last component to consider is the output capacitor. In general, such capacitors have large values (100 μF or more) and must operate at high frequencies (20 kHz or more). They require low ESR (*E*ffective *S*eries *R*esistance) and ESL (*E*ffective *S*eries *I*nductance). An excellent trade-off between cost and performance is the solid tantalum capacitor. Compared with aluminum electrolytic capacitors, solid tantalum capacitors have higher capacitance per unit volume, they are more stable, and they have hermetic seals to eliminate the effects of humidity.

Fighting EMI

EMI is primarily due to wiring inductance in the circuit. That inductance can cause rapid changes in current, which may thereby generate high-voltage spikes. Those spikes are proportional to both the rate at which the current changes and the wiring inductance. Here are some suggestions to help reduce EMI:

- Keep loop inductance to a minimum by using compact layouts.
- Keep loop area as small as possible, and keep lead lengths short.
- In the step-down mode, return the input capacitor directly to the diode. That helps reduce ground-loop noise.
- Select an external diode that can maintain peak recovery current as low as possible. That reduces the energy content of the voltage spikes.

Integrated circuits can greatly simplify the design of switching power supplies. And careful component selection and circuit layout can eliminate the disadvantages of switching supplies. **R-E**

NEW IDEAS

continued from page 38

mines the number of beats per measure.

Each time the 4017B is reset, its Q0 output goes high. That signal is fed to LED1 for a visual indication of the start of each measure. The Q0 signal is also fed to IC1-d, another buffer. The signal is also mixed with the astable's free-running output (after buffering by IC1-c). The mixed signal is what provides the extra "oomph" signalling a new measure.

There's not much else to the circuit. The network composed of C2 and R6 sharpens up the downbeat pulse, and the network composed of C3 and R7 sharpens up the free-running pulses. By making C2 larger than C3, the downbeat gets greater emphasis. You may vary the values of those two components to obtain different sound outputs.

The mixed signal is coupled by C4 and R10 to an outside amplifier. You may connect the metronome's output to any convenient amplifier; alternatively, the circuit shown in Fig. 1-b may be used for that purpose, and will provide a compact, portable metronome.

Construction

The metronome may be built in any convenient manner; just be sure to use sockets for all IC's. After mounting the components, check the board carefully for wiring errors, especially to the battery, a standard nine-volt unit. Use a small speaker, and mount everything in a small plastic case. Just check over your wiring before inserting the IC's in their sockets.

The metronome can be calibrated by marking off ten equally-spaced divisions on the front panel around R1. Attach a knob with a pointer to R1. Turn the metronome on, set R1 to point to the division, and count the number of beats in 20 seconds. Multiply that value by three and record the result. Do the same for each of the other nine divisions, and then transfer the results to the plastic case with rub-on lettering or labels from a labelmaking gun.—*C. R. Fischer*

NEW PRODUCTS

continued from page 42

closure. Accessories include: X-acto knife, masking tape, a red and blue pencil, general-purpose template, three pieces of 18" × 14" mylar, aluminum locators, three

CIRCLE 23 ON FREE INFORMATION CARD

pieces of 1/10 grid paper, IC pads, 12" steel ruler in 10ths, one roll each of .031-inch, .062-inch, .125-inch width black tape, vertical and horizontal locator straps, and two sets of donut pads.

The model *G5024PC* is priced at $299.95.—**PMC Industries**, Draftette Division, 9353 Activity Road, San Diego, CA 92126.

REUSABLE CABLE TIES, *FLEXLOC*, are ideal for bunching cables attached to computers and peripherals, home-entertainment systems, and electronics and electrical hardware.

Made from tough, flexible nylon (Type 66), *FLEXLOC* has a tensile strength of 50 pounds. Each 10-

CIRCLE 24 ON FREE INFORMATION CARD

inch fastening strap is self-locking with a ribbed backing that permits diameter adjustments up to 2¾ inches, and secures the bundle until release.

FLWXLOC cable ties are available in packages of 20 direct from the manufacturer for $7.00 (includes First Class postage and handling).—**Visual Departures, Ltd.**, 1641 Third Avenue, Suite 202, New York, NY 10128.

ROBOTICS

continued from page 88

given distance (one foot, for example), the robot should make a measurement to the right. If that direction isn't blocked, movement may proceed in that direction. If both the front and right are blocked, the left should be checked. If all three directions are blocked, the robot should back up and examine both the left and right sides for a possible escape route. The whole process would be repeated as necessary until the robot found the doorway and exited. If you think such a procedure is complicated, consider how complex an optical image-recognition system must be!

At this point you may be wondering if robotics is really a hardware or a software discipline. To tell the truth, it encompasses both fields, and others such as mechanical engineering. To get the most out of robotics, you've got to be expert in them all.

Miscellaneous news

Expect the industry leader in personal robotics to introduce a new high-performance product shortly. Unusually, rather than rush their new model to market, that company has been using the robots internally for almost a year. That *should* provide us with a well-debugged product when it does make it to market.

The Rhino Robot company has reduced the price of their Scorpion (reviewed here a few months ago) drastically. In an upcoming column I'll show you how to slave the Scorpion to a Heath HERO. We also have ideas for some other interesting HERO projects. Drop us a line if you're interested. **R-E**

"How's your new robot maid working?"

U.S. Postal Service
STATEMENT OF OWNERSHIP, MANAGEMENT AND CIRCULATION
Required by 39 U.S.C. 3685

1A. TITLE OF PUBLICATION: RADIO-ELECTRONICS
1B. PUBLICATION NO.: 0 0 3 3 7 8 6 2
2. DATE OF FILING: 9/11/85
3. FREQUENCY OF ISSUE: Monthly
3A. NO. OF ISSUES PUBLISHED ANNUALLY: 12
3B. ANNUAL SUBSCRIPTION PRICE: $15.97
4. COMPLETE MAILING ADDRESS OF KNOWN OFFICE OF PUBLICATION: 200 Park Avenue South, New York, NY 10003
5. COMPLETE MAILING ADDRESS OF THE HEADQUARTERS OF GENERAL BUSINESS OFFICES OF THE PUBLISHER: 200 Park Avenue South, New York, NY 10003
6. FULL NAMES AND COMPLETE MAILING ADDRESS OF PUBLISHER, EDITOR, AND MANAGING EDITOR
PUBLISHER: Larry Steckler, 200 Park Avenue South, New York, NY 10003
EDITOR: EDITOR IN CHIEF M. Harvey Gernsback, 200 Park Avenue South, New York, NY 10003
MANAGING EDITOR: Arthur Kleiman, 200 Park Avenue South, New York, NY 10003
7. OWNER

FULL NAME	COMPLETE MAILING ADDRESS
GERNSBACK PUBLICATIONS, INC.	200 Park Avenue South, NY, NY 10003
Lawrence Steckler	200 Park Avenue South, NY, NY 10003

8. KNOWN BONDHOLDERS, MORTGAGEES, AND OTHER SECURITY HOLDERS OWNING OR HOLDING 1 PERCENT OR MORE OF TOTAL AMOUNT OF BONDS, MORTGAGES OR OTHER SECURITIES: NONE

9. FOR COMPLETION BY NONPROFIT ORGANIZATIONS AUTHORIZED TO MAIL AT SPECIAL RATES
(1) HAS NOT CHANGED DURING PRECEDING 12 MONTHS (2) HAS CHANGED DURING PRECEDING 12 MONTHS

10. EXTENT AND NATURE OF CIRCULATION	AVERAGE NO. COPIES EACH ISSUE DURING PRECEDING 12 MONTHS	ACTUAL NO. COPIES OF SINGLE ISSUE PUBLISHED NEAREST TO FILING DATE
A. TOTAL NO. COPIES	321,625	324,419
B. PAID AND/OR REQUESTED CIRCULATION 1. Sales through dealers and carriers, street vendors and counter sales	71,714	66,978
2. Mail Subscription	149,694	157,588
C. TOTAL PAID AND/OR REQUESTED CIRCULATION	221,408	224,566
D. FREE DISTRIBUTION BY MAIL, CARRIER OR OTHER MEANS SAMPLES, COMPLIMENTARY, AND OTHER FREE COPIES	7,742	9,950
E. TOTAL DISTRIBUTION	229,150	234,516
F. COPIES NOT DISTRIBUTED 1. Office use, left over, unaccounted, spoiled after printing	5,672	9,408
2. Return from news agents	86,803	80,495
G. TOTAL	321,625	324,419

11. I certify that the statements made by me above are correct and complete — SIGNATURE AND TITLE OF EDITOR, PUBLISHER, BUSINESS MANAGER, OR OWNER

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.

ELECTRONIC fuel injection cars: Newly developed **anti-theft kit.** Proven effective—prevents your car from starting. $34.95 **INSIGHT A.T.S.**, P.O. Box 95516, Hoffman Estates, IL 60195.

TI-99/4A software/hardware bargains. Hard-to-find items. Huge selection. Fast service. Free catalog. **DYNA**, Box 690, Hicksville, NY 11801.

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.

EXOTIC European autos. Import a European auto for the price of a domestic—DOT & EPA guidelines. Directory of European dealers who will ship direct. Complete details $ 12.95. **AUTO CONNECTION** P.O. Box 640337, Kenner, LA 70064. VISA/MC/COD.

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.

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. High gain. 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.

TUNABLE notch filters, 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. $12.95-$17.95. S.A.S.E. Full details. **COMPUQUEST, INFORMATION DESK**, Box-492, St. Croix Falls, WI 54024.

ADAPT any CRT tester to test all CRT's. Complete unit w/manual $63.95. Free infrared transmitter tester. Our third year. Chargecards/COD's. **DANDY MANUFACTURING COMPANY,** 2323 Gibson, Muskogee, OK 74403. 1-800-331-9658.

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

NUTS & VOLTS
HAM GEAR • COMPUTERS • SOFTWARE • SCANNERS • OPTICS • TEST EQUIPMENT • MICROWAVE • SATELLITE • AUDIO VISUAL • NEW PRODUCTS • COMPONENTS • KITS • ANTIQUE ELECT. • PUBLICATIONS • PLANS • SERVICES

TUBES, name brands, new, 80% off list. **KIRBY**, 298 West Carmel Drive, Carmel, IN 46032.

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.

ELECTRONICS, exclusives, surplus and more. Send $1.00 (refundable) for our two discount catalogs. Great bargains! **JELKINS**, 311 Shirley Street, Boston, MA 02152.

FREE importer accessories catalog, video, audio, others. With business card write, **17 BANNER COURT,** East Brunswick, NJ 08816.

FREE: 60 pg. Electronic/Computer parts catalog; **HOSFELT ELECTRONICS,** 2610 Sunset, Steubenville, OH 43952. (614)264-6464.

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**, 68-12 110 St., Flushing, NY 11375.

TUBES: "oldies", latest. Supplies, components, schematics. Send S.A.S.E. for catalog. **STEINMETZ**, 7519 Maplewood RE, Hammond, IN 46324.

VCR test tape. Performance check or servicing. Specify BETA or VHS, 12 minutes, eight tests for $59.95. **VISTA,** 717 Front, Lisle, IL 60532. (312)969-3296.

BUST ghosts! Seen movie? Order novelty rad detector. Send $5.95. **SHEPHERD,** 8125 Sunset Ave., Suite 183, Fairoaks, CA 95628.

CRT rebuilding equipment. Two automatic ovens, lathe, de-lam oven, extra-backer pump, etc. All $1000.00. **MODERN ELECTRIC**, 111 Main Street, Watervllle, NY 13480.

MONEY making tips for running your electronic service shop. Based on 17 years experience. $7.95 **DMVR,** 3015 Nolensville Rd, Nashville, TN 37211.

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, Columbus, OH 43212.

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

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.

SATELLITE TV VIEWERS
Get the most complete weekly listings.
Send $1 for sample copy.
Satellite TV Week
P.O. Box 308E, Fortuna, California 95540
800-358-9997 (U.S.) • 800-556-8787 (Calif.)
707-725-2476 (all others)

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. 21V, 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-TV systems from $449.00 wholesale, retail $995.00, dealers wanted. (714)891-5479, **WHOLESALE**, P.O. Box 8040, Anaheim, CA 92802.

VCR amplifier kit—transmits VCR output to any TV in your house. FM transmitter. Kits are $24.95 each and include 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.

PAY TV and satellite descrambling. Schematics. All systems. Covers America and Canada. 54 pages $12.95. Microwave, satellite, stunguns, kits catalogue $2.00. SHOJIKI ELECTRONICS CORP., 1327 Niagara st., Niagara Falls, NY 14302. C.O.D.'s. (716)282-1001.

SATELLITE systems $495. Name brands. Quantity discounts. Information $1. **STARLINK, INC.**, 2603-16R Artie, Huntsville, AL, 35805.

WM. B. ALLEN SUPPLY COMPANY

OPEN SATURDAYS 8 A.M. TO 1 P.M. WITH 24 HOUR ANSWERING TO TAKE YOUR ORDER ANYTIME

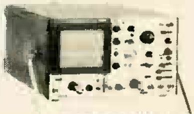
TEST EQUIPMENT SPECIALS

HITACHI OSCILLOSCOPES

V-650F
60MHz • Dual Trace
Delayed Sweep

Reg. $1195
$938
SAVE $257

V-1050F
100MHz • Quad Trace
Delayed Sweep



Reg. $1595
$1252
SAVE $343

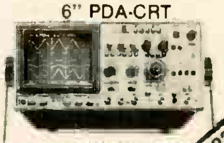
V-212
DC-20MHz • Dual Trace

Reg. $615
$451
SAVE $164

V-422
DC-40MHz • Dual Trace

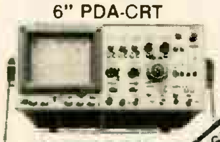
Reg. $925
$679
SAVE $246

V-1100
100MHz • Quad Trace
CRT Readout • 1mV
6" PDA-CRT



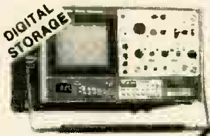
Reg. $2490
$2260
SAVE $230

V-1070
100MHz • Quad Trace
CRT Readout
6" PDA-CRT



Reg. $2295
$1532
SAVE $763

V-6041
40MHz/2 Channels • 4000 Words Per Channel
DIGITAL STORAGE



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

What's New at AMERICAN DESIGN COMPONENTS?

"The Source" of the electro-mechanical components for the hobbyist.

We warehouse 60,000 items at American Design Components — expensive, often hard-to-find components for sale at a fraction of their original cost!

You'll find every part you need — either brand new, or removed from equipment (RFE) in excellent condition. But quantities are limited. Order from this ad, or visit our retail showroom and find exactly what you need from the thousands of items on display.

Open Mon. – Sat., 9–5

THERE'S NO RISK.
With our full 90-day warranty, any purchase can be returned for any reason for full credit or refund.

5¼" DISK DRIVES

½ HT	Full HT
96 TPI	96 TPI
DS/Quad	DS/Quad
Tandon	Tandon
#TM55-4	#TM100-4
Item #1904	Item #1901
$79.50 ea.	$99.00 ea.

or 2 for $150.00

75-KEY MECHANICAL KEYBOARD

For computer upgrade . . . 21 user-defined keys, SPST mechanical switches, 21-pin ribbon cable connection. General instructions for replacement of membrane keyboards incl. Update computers such as the Timex Sinclair Z81/1000 Dim.: 13½"W x 1¾"H x 5"D.

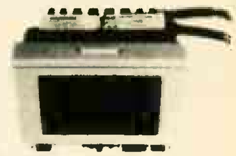
Item #6643M **$9.95** New

ASCII 75-KEY KEYBOARD

21 user-defined keys.
7-pin connection.
ASCII 8-bit serial output.
Originally designed for the Adam.
Dim.: 15"W x 2½"H x 6½" D

Item #6643 **$19.95** New

COMPUTER TAPE DRIVE



Serial format. Search 80IPS — Read/Write 20IPS. 12V motor, 5V logic, 8 & 9 pin connector cables. Originally designed for the Adam. Dim: 5"W x 3¾"H x 4" deep

Item #6641 **$9.95** New

COMPUTER & GAME CONTROLLERS (Set of 4)

12-digit keyboard and joystick. Originally used in computer and games. Includes coil cord with 9-pin connector.
Dim.: 6¼"L x 2¼"W x 2½"H.
Mfr — Coleco #78002

Item #7013 **$9.95** New

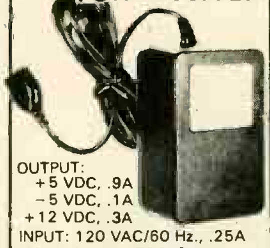
PRINTER MECHANISM

Originally designed for the Gavalin computer.

- Centronics interface
- 80 column width
- Friction drive (schematic incl.)

Item #5223 **$19.95** New

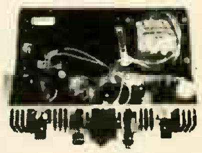
PLUG-IN POWER SUPPLY



OUTPUT:
+5 VDC, .9A
−5 VDC, .1A
+12 VDC, .3A
INPUT: 120 VAC/60 Hz., .25A
Mfr — Coleco #55416

Item #1882 **$6.95** New

DISK DRIVE LINEAR POWER SUPPLY



DC Output: −5V @ 200 ma.
+5V @ 3 amps
+12V @ 2.9 amps
+18V (inductive) @ 1 amp
Input: 115V/60 Hz.
Chassis Dim: 11"W x 4"H x 8"D

Item #6642 **$14.95** New

19" COLOR X-Y DISPLAY

Originally designed for use in Atari coin-operated games. Contains 3-gun color tube, focus and brightness controls. Requires external X-Y inputs, 250-0-24V transformer for power. May be used for oscilloscopes, reprogrammed for game use, or modified with the use of external vertical and horizontal oscillators to a rastor scan display or TV monitor for computer use. (IBM compatible.) Transformer supplied.

Item #5449 **$129.00** New

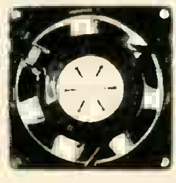
65 CFM WHISPER FAN

115 VAC. Super quiet! Sleeve bearing, metal body with 5 plastic blades.
Dim.: 4¾"sq. x 1½" deep.
Mfr — Rotron "Hi-Lo"

Item #5491 **$12.95** New

30 CFM MINI FANS

28VAC & 12VDC



Low noise level. Can be mounted for cooling or exhaust.
Dim.: 3⅛" sq. x 1½" deep
12VDC — Papst #8312
Item #7017 **$12.95** New
28VAC — IMC Peewee®
Item #7018 **$7.95** New

COMPONENTS PARTS KIT

Hundreds of components! Consisting of Heat Sinks, Capacitors, Trimpots, Resistors and MORE!

Item #7010 **$15.00** New

MAGNETIC RECORDING TAPE

Pre-recorded, bulk erased, by major manufacturers such as Ampex, 3M or Scotch. 7½" reels, 1500 ft. 1 mil.

Item #6710 26 reels **$9.95**

PUMPS COMPRESSORS BLOWERS MOTORS POTENTIOMETERS COUNTERS TIMERS RELAYS VOLTAGE REGULATORS POWER SUPPLIES

STEPPING MOTORS — for ROBOTICS

Precision steppers with increments from 1 to 7.5 degrees. Speeds up to 5,000 steps.

#5105

#5431

#5272

#6671

Item No.	Step Angle	DC Volts	Stall Torque oz/in	Dimensions H x W x D (in.) 1) Body 2) Shaft	Mfr. & Part No.	Price
5431	1	5	17*	1) 1⅞ x 1¾ x 1 2) 1⅛ x ½	N.A. Phillips A82310-M2	2/$ 9.95
5272	1.8	1.3	200	1) 4¼ dia x 4½ 2) ⅜ dia. x 1³⁄₁₆	Sigma 20-4247TD-200F1.3	2/ 59.50
5105	7.5	12	16	1) 2) 1⅞ x 1⅜ x ⅝	Airpax K82201-P2	2/ 14.95
6671	3.7	12	15*	1) 1⅝ sq x 1⁵⁄₁₆ 2) ³⁄₁₆ dia x ⁷⁄₁₆	Mitsubishi 42SH-32KCA	2/ 14.95

* Calculated

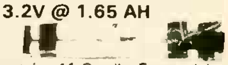
Rechargeable NICAD BATTERY BACKUPS

12V @ 450 ma

Contains 10 AA cells. Recharge rate: 45 ma. 16–18 hours. Case with tab output connections.
Dim.: 2⅛"H x 1¼"W x 2¹⁵⁄₁₆"L.
Mfr — GE 123233 or equiv.

Item #5443 **$5.95** RFE

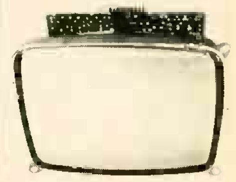
13.2V @ 1.65 AH



Contains 11 C cells. For model boats, toys, etc.
Mfr. GE #41B035BB00101

Item #5444 **$15.95** New

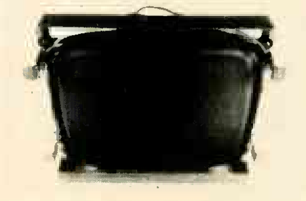
9" HI-RESOLUTION (TTL) VIDEO MONITOR



Green phosphor. Originally used in portable computers. 12 VDC.
Mfr — Clinton CE663Z9P31

Item #6811 **$19.95** New

12" GREEN PHOSPHOR COMPOSITE VIDEO MONITOR



40/80 column. 1000-line resolution. 18MHz bandwidth. Compatible with IBM, Apple, Commodore, and more. Includes external transformer for operation on 115 VAC & video cable. Mfr — Elston Elec. #DM30.

Item #6602 **$24.95** New

AMERICAN DESIGN COMPONENTS, 62 JOSEPH STREET, MOONACHIE, N.J. 07074

MINIMUM ORDER $15.

RE-125

YES! Please send me the following items:

Item No.	How Many?	Description	Price	Total

Total
Shipping & handling, we ship UPS unless otherwise specified. Add $3 plus 10% total. Canadian: $3 plus P.O. cost. Charge only.
Sales Tax (N.J. residents only, please add 6% of total)
ORDER TOTAL

FREE CATALOG of electro-mechanical devices sent with every order.

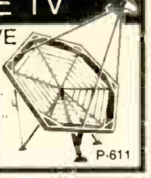
☐ My check or money order is enclosed.
☐ Charge my credit card.
☐ Visa ☐ Master Card ☐ Amex

Card No.
Exp. Date
Signature
Telephone: Area Code Number
Name
Address
City
State Zip

All inquiries and free catalog requests call 201-939-2710.

For all phone orders, call **TOLL-FREE 800-524-0809.** *In New Jersey, 201-939-2710.*

ENJOY SATELLITE TV



DO-IT-YOURSELF AND SAVE

Electronic Know-how not required.
Easy to build from our plans or kits.
Lowest prices on satellite electronics.
Send $1 for catalog or $8.95 for "Consumer Guide to Satellite Television."

Mail today to: **GFI-D14, Box 9108 Missoula, MT 59807**

P-611

SATELLITE equipment at discount prices. All major brands available. Send for free price list. **GALAXY SATELLITE SYSTEMS**, P.O. Box 970499, Miami, FL 33197.

BUY BONDS

BUSINESS OPPORTUNITIES

US $8.00 including disk, thousand name brand programs for Apple, IBM-PC, details U.S. $1.00, **RELIANT**, P.O. Box 33610, Sheungwan, Hong Kong.

MECHANICALLY inclined individuals desiring ownership of small electronics manufacturing business— without investment. Write: **BUSINESSES**, 92-R, Brighton 11th, Brooklyn, NY 11235.

BURGLAR alarms—booming business. Get started now. Information package $2.00. **DYNAMIC SECURITY** P.O. Box 1456-TW, Grand Rapids, MI 49501.

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

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.

MEXICO, obtain almost all technical books advertised in this magazine in pesos and in Mexico from Ing. **SAMUEL THOMAS**, Tel. 533-1833 clave 2754.

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

INVENTIONS, ideas, new products wanted! Industry presentation/national exposition free. Call free (1-800) 528-6050. Arizona (1-800) 352-0450. X831.

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.

PRINTED—CIRCUIT BOARDS

TORCCC Electronics will print any schematic, 6" by 9" maximum, on a circuit board. Send $1.50 and schematic to **TORCCC** 2161 North California, Chicago, Il 60647.

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.

PLANS AND KITS

CATALOG: Hobby, radio broadcasting, CB, lowfers. Transmitters, linears, active antennas, converters, scramblers, bugging devices, more! **PANAXIS**, Box 130-F12, Paradise, CA 95969.

DESCRAMBLER plans. New design decodes gated sync suppressed signals—newest pilotless method. Circuit boards, most parts from Radio Shack. Detailed theory, drawings, schematics, instructions $14.95 plus $2.00 shipping. **DIRIJO CORP.**, Box 212, Lowell, NC 28098.

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.

MOBILE telephone using your 2-way radio, plans $9.95, with PC/boards $19.95. Parts available. **CURRENT DEVELOPEMNT CORP.**, Box 384, Westmoreland, NY 13490.

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.

FREE catalog 99-cent kits—audio, video, **TV** computer parts. **ALLKIT,** 434 W. 4th St., West Islip, NY 11795.

PC/XT compatible mother board, fully loaded w/ bios, 256K, 8I/O slots, $199. **NRPC.** (713)484-9575, 104G S. Friendswood, Friendswood, TX. 77546.

CIRCUIT boards and kits for QST articles. Write or call for information. **A & A ENGINEERING** 7970 Orchid Dr., Buena Park, CA 90620. (714)521-4160.

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
Miniature Speaker, 2", 8 OHM .... .50
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
UCN4116B-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 Op Amp (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 Olspiay 1-1/2" X 2" 7X5 (35 Total) Red LED Matrix/Specs-4.95
11 LEO Bar Graph Oisplay-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
Mini Audio Transformers 10/1.00
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"X1)-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-S2) ... 7/10.00
Mot Det (IC Only-ULN2232A) 3/$2-20/10.00
Project Box/Lid For Detector 1.95
Miniature Speaker For Detector .... .25
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
34 Pin Connector (For Drives) W/Hood .... .75
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

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

$51.95

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 283 ON FREE INFORMATION CARD

CPU's & SUPPORT CHIPS

Z80A CPU	2.50	8155-2	7.50
Z80B CPU	8.00	8202	19.95
Z80A CTC	2.75	8212	1.80
Z80A DART	5.95	8214	4.50
Z80A P10	3.75	8216	1.75
Z80A S10	10.95	8224	4.00
82C43	4.25	8226	3.50
AMD2901	8.95	8237	8.00
6502	2.75	8238	3.95
6800	2.50	8250	10.95
6802	4.50	8251	4.40
6803L	8.00	8253	6.00
6809	8.00	8255A-5	5.00
6810	4.00	8257	6.00
6821	2.75	8259	6.00
6845	8.00	8272A	14.00
6850	3.25	8275	14.50
6875	4.50	8279-5	6.95
D7220-1	12.00	8288	9.00
8035	5.50	8355	12.95
8080A	3.75	8748	10.00
8085A	4.75	TMS9927NL	9.95
8086	8.00	68000L8	10.00
8088	7.50		

INTERFACE & DRIVERS

AY5-1013A	3.75
AY3-1015D	5.75
1488	.65
1489	.65
TR1602B	3.95
BR1941L	8.95
AY5-3600PRO	9.95
CRT5037	18.95
MM5307	7.95
MM5369	2.50
8610	2.00
8830	2.50
8833	2.50
8834	2.00
8837	2.00

SHIFT REGISTERS

MM1402	1.75
MM1403	1.75
MM1404	1.75
MM5013	2.50
MM5055	2.50
MM5056	2.50
MM5057	2.50
MM5058	2.50
MM5060	2.50

DISC Controllers

D765C	10.00	1793	17.00
1771	5.95	1795	17.00
1791	14.00	1797	17.00

ROM's

TPB18S42	3.50
82S126	1.95
82S130	1.95
82S131	1.50
TPB28S166	9.50
82S181	6.95
74S474	3.95
2708	3.75
2716 + 5V	3.75
2732A	4.00
2764	4.50
3341A	2.95
3628A-3	3.00
6331	1.95
8256-5	1.25
AM9214C	2.95
27128	7.50

RAM's

2016	3.00
21L02-3	.90
2101A-4	1.50
2111A	1.75
2112-1	1.95
2114-2	1.00
2118-4	2.50
2147-3	2.50
3242	6.00
TMS3409	1.75
MK4027-3	1.75
TMS4050NL	2.95
MK4096-11	1.25
4108-3	1.50
4116-2	1.00
4118-4	4.00
MK4802	5.95
Z6104-4	2.50
6116-3	3.75
8118-12	4.95
6167P-3	7.00

NO. 30 WIRE WRAP WIRE SINGLE STRAND 100' ... $1.40

CRYSTALS

1.843	6.000
2.000	6.144
3.000	8.000
3.579	10.000
4.000	18.000
5.000	18.432
	20.000

2.75 ea.

EPOXY GLASS VECTOR BOARD

1/16" thick with 1/10" spacing
4½" x 6½" $2.40

SCR's / TRIAC's

SCR	1.5A	6A	35A	110A	TRIAC PRV	1A	10A	25A
100	.35	.40	1.40		100	.35	.60	1.40
200	.40	.50	1.80		200	.50	.80	1.90
400	.60	.70	2.40	12.00	400	.70	1.00	2.60
600	.80	1.00	3.60	15.00	600	1.00	1.20	3.60

C/MOS

74C00	.35	74C915	1.10	4027	.45	4076	.80
74C02	.35	74C921	3.50	4028	.65	4077	.50
74C04	.35	4001	.25	4029	.75	4081	.28
74C08	.35	4002	.25	4030	.40	4082	.30
74C10	.35	4006	.85	4034	1.75	4093	.45
74C14	.55	4007	.30	4035	.85	4099	1.75
74C20	.35	4008	.90	4040	.75	4501	.95
74C32	.35	4009	.40	4041	.75	4503	.65
74C42	1.20	4010	.45	4042	.65	4506	.75
74C74	.80	4011	.30	4043	.85	4510	1.20
74C76	.60	4012	.30	4044	.80	4511	.85
74C83	1.20	4013	.35	4046	.85	4512	.85
74C85	1.25	4014	.75	4047	.95	4514	1.20
74C86	.40	4015	.35	4049	.35	4515	1.60
74C93	1.00	4016	.35	4050	.35	4516	1.50
74C154	3.00	4017	.75	4051	.75	4518	.85
74C161	1.10	4018	.75	4052	1.00	4520	.80
74C174	1.10	4019	.40	4053	.75	4528	1.10
74C175	1.10	4020	.75	4060	.70	4529	1.40
74C193	1.40	4021	.75	4066	.40	4538	1.50
74C245	1.75	4022	.75	4068	.40	4539	1.80
74C901	.40	4023	.28	4069	.28	4541B	1.75
74C902	.40	4024	.65	4070	.35	4553	1.75
74C903	.80	4025	.30	4071	.28	4583	.90
74C907	.90	4026	1.25	4072	.30	4586	.75

74S SERIES

74S00	.30	74S74	.50	74S163	1.75
74S02	.35	74S85	1.25	74S165	1.50
74S03	.35	74S86	.50	74S174	.90
74S04	.35	74S89	2.00	74S175	.90
74S05	.35	74S112	.50	74S181	3.00
74S08	.35	74S113	.60	74S182	2.00
74S09	.45	74S124	2.20	74S189	1.60
74S10	.35	74S133	.45	74S194	1.30
74S11	.35	74S135	.85	74S195	1.30
74S15	.35	74S138	.80	74S240	1.50
74S20	.35	74S139	.80	74S241	2.00
74S30	.35	74S140	1.00	74S244	1.25
74S32	.40	74S151	.90	74S251	1.20
74S40	.40	74S153	.95	74S257	.90
74S42	.85	74S157	.90	74S260	.75
74S51	.35	74S158	.90	74S373	2.00
		74S161	1.75	74S374	2.00

Connectors

40 PIN EDGEBOARD CONN.	3.00
26 PIN EDGEBOARD CONN.	2.50
50 PIN RIBBON CABLE CONN.	3.50
40 PIN RIBBON CABLE CONN.	3.00
34 PIN RIBBON CABLE CONN.	2.75
26 PIN RIBBON CABLE CONN.	2.50
20 PIN RIBBON CABLE CONN.	2.00

TRANSISTOR SPECIALS

TIP 31B NPN Si TO-220	$ .40
TIP 32B PNP Si TO-220	$ .40
TIP 34 PNP Si	$ .95
TIP 111	$ .50
TIP 121 PNP Si U84	$ .60
TIP 141 NPN Si U97	$1.00
TIP 145	$1.35
BU205	$1.75
2N404A PNP GE TO-5	3/$1.00
2N1307 PNP GE TO-5	$ .40
DPS2000 – DUAL POWER DARL	$3.95
2N2222 NPN Si TO-18	7/$1.00
2N2907 PNP Si TO 18	7/$1.00
TIP 2955 PNP Si	$ .70
2N3055 NPN Si TD-3	$ .60
MJE3055T	$ .60
2N3904 NPN Si TO-92	7/$1.00
2N3906 PNP Si TO-92	7/$1.00
2N6109 PNP Si TO-3	$1.00
2N6109 PNP Si TO-220	$ .55
MJE13009A 400V NPN	$1.00
MRF-8004 CM RF TRANSISTOR NPN	$ .75
HEP G8014 – PNP GE TO-3	$ .85

TTL IC SERIES

7400	.20	7480	.45	74166	1.00
7401	.20	7483	.50	74170	1.50
7402	.20	7485	.55	74173	.75
7403	.20	7486	.35	74174	.85
7404	.20	7489	1.90	74175	.85
7405	.25	7490	.55	74176	.75
7406	.27	7491	.50	74177	.65
7407	.27	7492	.50	74180	1.90
7408	.25	7493	.35	74181	2.00
7409	.20	7494	.60	74182	.90
7410	.20	7495	.55	74184	1.50
7411	.25	7496	.60	74190	.80
7412	.25	74107	.30	74191	.80
7413	.35	74116	1.20	74192	.75
7414	.45	74121	.30	74193	.75
7416	.25	74122	.45	74194	.80
7417	.25	74123	.45	74195	.80
7420	.20	74125	.45	74196	.75
7425	.27	74126	.45	74197	.80
7426	.30	74145	.60	74199	1.25
7427	.27	74147	1.20	74221	1.25
7430	.20	74148	1.20	74273	1.00
7432	.27	74150	1.35	74279	.70
7437	.27	74151	.55	74298	.60
7438	.29	74153	.55	74365	.65
7440	.20	74154	1.25	74367	.65
7442	.45	74155	.75	74390	.90
7445	.65	74157	.55	75325	1.50
7448	.70	74158	.60	75492	1.00
7450	.20	74160	.85	9601	1.00
7472	.35	74161	.65	9602	.90
7473	.35	74162	.65	8T26	1.10
7474	.32	74163	.65	8T28	1.10
7475	.45	74164	.85	8T97	1.10
7476	.35	74165	.85	8T98	1.10

LINEAR CIRCUITS

DAQ08EQ	3.75	LM380	1.20	LM1310	1.40
TL062CP	.95	LM384	1.60	LM1391	1.00
TL064CN	1.50	LM386	1.00	1456	.80
TL072	1.25	LM387	1.25	1458	.50
TL082	.90	LM393	.75	LM1808	1.75
TL084	1.50	LF398A	3.00	AD2700LD	4.95
LM201	.75	LM555	.34	LM2901	.95
LM301/748	.35	LM556	.65	CA3018	1.95
LM307	.45	558	1.75	CA3078AT	1.50
LM308	.65	564	2.50	CA3080	1.00
LM310	1.10	565	.90	CA3089E	1.75
LM311	.60	566	1.25	CA3094	1.30
LM318	1.25	567	.85	CA3130	1.00
LM319	1.30	NE592	.95	CA3140	1.00
LM324	.55	709CH	.85	CA3822	.75
LM339	.90	LM710	.60	LM3900	.50
LM348	.90	733	.95	LM3909	.80
LF351	.60	741CV	.35	4136	.85
LF353	.90	747	.50	N5596A	1.50
LF355	.90	CA758	1.75	S06000	1.00
LF356	1.00	LM798CT	.60	8700CJ	5.95
LM358	.65	DAC0800	2.95	LM13080	.95
LM370	1.60				

2114-4	$ .70
4116-25	$ .75
4164-15	$1.40

6264-15 $9.00

41256-15 $3.75

T IS 73 N FET	$ .45
ER 900 TRIGGER DIODES	4/$1.00
2N2646 UJT	$ .45
2N3820 P FET	$ .45
2N 6028 PROG. UJT	$ .65

DISC CAPACITORS

1UF 16V	10/$1.00	100/$8.00
.01UF 35V	16/$1.00	100/$5.00

PRINTED CIRCUIT BOARD
4" x 6" DOUBLE SIDED EPOXY BOARDED 1/16" THICK $ .60 ea. ..... 5/$2.60

74LS SERIES

74LS00	.20	74LS107	.35	74LS241	.95
74LS01	.20	74LS109	.35	74LS242	.90
74LS02	.20	74LS112	.35	74LS243	.90
74LS03	.20	74LS113	.35	74LS244	1.25
74LS04	.20	74LS114	.35	74LS245	1.40
74LS05	.20	74LS123	.75	74LS246	1.40
74LS08	.20	74LS125	.45	74LS247	.75
74LS09	.20	74LS126	.45	74LS248	1.00
74LS10	.20	74LS132	.55	74LS251	.55
74LS11	.20	74LS136	.35	74LS253	.55
74LS12	.30	74LS137	.90	74LS257	.55
74LS13	.40	74LS138	.50	74LS258	.55
74LS14	.50	74LS139	.50	74LS259	1.75
74LS15	.25	74LS151	.55	74LS260	.55
74LS20	.25	74LS153	.55	74LS266	.55
74LS21	.25	74LS155	.65	74LS273	1.50
74LS22	.25	74LS156	.65	74LS279	.45
74LS26	.25	74LS157	.65	74LS280	1.70
74LS27	.25	74LS160	.65	74LS283	.65
74LS28	.25	74LS161	.65	74LS290	.80
74LS30	.25	74LS162	.70	74LS293	.80
74LS32	.25	74LS163	.65	74LS298	.90
74LS37	.35	74LS164	.65	74LS320	2.00
74LS38	.35	74LS165	.65	74LS323	3.50
74LS40	.30	74LS166	1.75	74LS365	.45
74LS42	.50	74LS169	1.50	74LS366	.45
74LS47	.75	74LS170	1.30	74LS367	.45
74LS48	.75	74LS173	.65	74LS368	.45
74LS51	.30	74LS174	.50	74LS373	1.30
74LS54	.30	74LS175	.50	74LS374	1.30
74LS73	.35	74LS181	2.00	74LS377	1.30
74LS74	.35	74LS190	.90	74LS386	.45
74LS75	.35	74LS191	.80	74LS390	1.10
74LS76	.35	74LS192	.75	74LS393	1.00
74LS83	.60	74LS193	.75	74LS398	2.50
74LS85	.60	74LS194	.65	74LS446	2.00
74LS86	.35	74LS195	.65	74LS541	2.25
74LS90	.55	74LS196	.65	74LS625	1.75
74LS92	.55	74LS197	.65	74LS668	1.60
74LS93	.55	74LS221	.80	74LS670	1.25
74LS95	.75	74LS240	.95	81LS98	1.40
74LS96	.85				

TOGGLE SWITCHES

108D – SPDT	1.00
206D – DPDT	1.40
208P – DPDT – CENTER OFF	1.60

IN4148 (IN914) 15/1.00

L1411-IR DETECTOR	3/$1.00
FP 100 PHOTO TRANS	$ .50
RED LED's .2"	10/$1.00
YEL, GREEN or AMBER LARGE LED's .2"	8/$1.00
RED-GREEN BIPOLAR LED	$ .90
RED-YELLOW BIPOLAR LED	$ .90
MLED92 IR LED	$ .40
MRD148 PHOTO DARL. XTOR	$ .60
MCT2 OPTO ISOLATORS	$ .60
1 WATT ZENERS: 3.3, 4.7, 5.1, 5.6, 6.8, 8.2, 9.1, 10, 12, 15, 18, or 22V	6/$1.00

FULL WAVE BRIDGE

PRV	2A	6A	25A
100			1.40
200	.80	1.30	2.20
400	1.00	1.65	3.30
600	1.30	1.90	4.40

12V DC RELAYS TTL SIZE
S.P. 400 ohm coil .75
D.P. 400 ohm coil .95

SILICON POWER RECTIFIERS

PRV	1A	3A	12A	50A	125A	240A
100	.05	.14	.35	.90	5.50	6.50
200	.06	.17	.50	1.30	7.00	9.00
400	.09	.25	.65	1.50	10.00	12.00
600	.11	.30	.80	2.00	13.00	15.00
800	.13	.35	1.00	2.50	16.00	18.00
1000	.20	.45	1.25	3.00	20.00	26.00

DIP SWITCHES

CTS 206-4		4 POSITION	.75
CTS 206-7		7 POSITION	.95
CTS 206-8		8 POSITION	.95
CTS 206-10		10 POSITION	1.25

REGULATORS

78L05 or 12	$ .30	LM338K	$5.75
LM305G	$ .75	340T-5,6,8,9,12, 15,18 or 24V	$ .75
LM317T	$1.10		
320T 5,12,15 or 24	$ .85	723	$ .50
78M5, 12 or 15	$ .40	LAS1412	
323K (LA1405)	$1.75	+ 12V3A	$3.95

DIP SOCKETS

8 PIN	.10	22 PIN	.25
14 PIN	.15	24 PIN	.25
16 PIN	.18	28 PIN	.35
18 PIN	.20	40 PIN	.40
20 PIN	.25		

TANTALUM CAPACITORS

.22UF 35V	5/$1.00	15UF 16V	3/$1.00
.47UF 35V	5/$1.00	30UF 6V	5/$1.00
.68UF 35V	5/$1.00	33UF 15V	$ .50
1UF 20V	5/$1.00	47UF 20V	$ .85
2.2UF 20V	5/$1.00	68UF 16V	$1.00
3.3UF 20V	4/$1.00	200UF 20V	$1.75
4.7UF 35V	4/$1.00	150UF 16V	$1.30
6.8UF 20V	4/$1.00	330UF 10V	$1.75
10UF 20V	— $ .40		
22UF 10V	— $ .30		

MULTI TURN TRIM POTS

50 OHM 3/$2.00
100 OHM
1000 OHM 5K 20K 50K 100K

WIRE WRAP SOCKETS

14 PIN	.45
16 PIN	.50
18 PIN	.65
20 PIN	.90
24 PIN	1.10
28 PIN	1.25
40 PIN	1.80

20KV DIODES
250 ma. $1.95

DB CONNECTORS

DB9P	$2.00	DB25P	$2.00
DB9S	$3.00	DB25S	$3.00
HOODS	$1.10	HOODS	$1.10

POSTAGE RATES
ADD 10% FOR ORDERS UNDER $25.00
ADD 5% FOR ORDERS BETWEEN $25.00 & $50.00
ADD 3% FOR ORDERS ABOVE $50.00

TERMS: FOB CAMBRIDGE, MASS. SEND CHECK OR MONEY ORDER. MINIMUM TELEPHONE, C.O.D. PURCHASE ORDER OR CHARGE $20.00. MINIMUM MAIL ORDER $5.00.

SEND $.25 FOR OUR CATALOG FEATURING TRANSISTORS & RECTIFIERS. 145 HAMPSHIRE ST., CAMBRIDGE, MASS. 02139

SOLID STATE SALES
P.O. BOX 74D
SOMERVILLE, MASS. 02143

TEL. (617) 547-7053
WE SHIP OVER OVER 95% OF OUR ORDERS WITHIN 24 HOURS OF RECEIPT
TOLL FREE 1-800-343-5230
FOR ORDERS ONLY

CIRCLE 74 ON FREE INFORMATION CARD

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

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.

SUPER-survival catalog!!—seventy publications—electronics, computers, energy, weapons, security, medical, financial—$1. Examples: **"Electromagnetic Brainblaster," "Disk Service Manual," "Computer Phreaking," "Voice Disguiser," "Automatic Teller Machines," " Heal Thyself!!". CONSUMERTRONICS.** (CBS "60 Minutes" stardom), 2011 Crescent, Alamogordo, NM 88310.

C-64 owners: Upgrade your **C-64** with reset key. Plans $2.00. Kit/plans $5.00. **ITRONICS**, 7 West Drive, Port Washington, NY 11050.

FREE "National Semi-Conductor" **pocket calculator** and catalog of Robots "MOVIT" line. Easily assembled. You control. Great fun. Educational. Send $4.00 for postage and handling. **ELECTROMANIA**, 51A Sunrise Hwy, Lynbrook, NY 11563.

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. Bronx, NY 10461.

AUDIO! Inexpensive, professional quality amps, mixers, effects! Plans/products! **DAVISOUND**, P.O. Box 521, Newberry, SC 29108.

HI-FI speaker kits, auto speaker systems and speaker components from the world's finest manufacturers. For beginners and audiophiles. Free literature. **A & S SPEAKERS**, box 7462R, Denver, CO 80207. (303)399-8609.

CABLE TV FILTERS

SUPER powered notch filters. Equivalent of **cable company "cylinders"**. Eliminate undesirable signals. Any channel 2 through 8; 14(A) through 22(I). (Please specify.) Send $20.00 each. **Money back guarantee**. Quantity discounts, **CATV**, Box 17621, Plantation, FL 33318.

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.

• • • • • • • • • • . . . Parts .

TOLL FREE
800-854-8230
Calif. Residents
714-558-8813

OUR POLICY
- •NO surcharge for VISA or Mastercard.
- •NO sales tax. •All shipments Insured.
- •Your card is Not charged until we ship.
- •Same day FEDEX shipment is available.
- •Volume purchasing agreements available.
- •Government agencies, corporate and Institutional PO's accepted.
- •Orders subject to availability.
- •All items have manufacturer warranty. Some warranties up to 5 years.
- •Pricing subject to change w/o notice.
- •Returns or cancellations may be subject to restocking fee.
- •ACP Retail Store pricing may vary.
- •We are not responsible for typos.

UPS POWER SUPPLY

Back Up Power for your IBM, Apple or Compatible

UPS-PC 200 Watts	$277.00
UPS-XT 425 Watts	455.00
UPS-AT 1000 Watts	975.00

A-B PRINTER SWITCH

An AB Switch allows use of two printers with your computer system. We stock over 15 different configurations.

AB Switch (Centronics)	$59.00
AB Switch (DB25)	59.00

COLOR VIDEO CARDS

Plantronics Color Plus	$375.00
IBM Color Card	227.00
IBM Mono Card w/parallel	219.00
STB Graphics Plus	389.00
Paradise Multidisplay Card	345.00
Everex Graphics Edge	345.00

SPECIAL BUY
Shugart SA 4004 14" 29Mb Hard Disk
$499.00

DRIVE CABINETS

IBM Style Hard disk with power supply and fan	$195.00
Dual Hard Disk w/power sup & fan	295.00
Dual 5¼" Full Hight vertical mount	65.00
Dual 5¼" Full Hight horizontal mount	99.00
Dual 5¼" Thinline w/power sup & fan	60.00
Single 5¼" Full Hight w/power sup & fan	56.00
Single 5¼" Thinline w/power sup & fan	60.00

PERSYST CARDS

Persyst Mono Combo — NEW!	$335.00
Persyst Color Combo — NEW!	335.00
Persyst Bob Board	445.00
Persyst Shortport Color	Call
Persyst Mini Mono	Call
Persyst +1 Time Spectrum w/64K	179.95
Persyst 192K Rainbow DEC Card	149.95

MODEM SPECIAL
Hayes Smartmodem Compatible
1200 Baud. External. Sold for 399.00
$219.00

INTERSIL STD-BUS BOARDS

	LIST	ACP
ISB3100 Z80 CPU	$200	$69.95
ISB3101 Z80 Univ. CPU	200	69.95
ISB3110 8085 CPU	200	79.95
ISB3215 16K CMOS RAM	810	99.95
ISB3218 16K Static RAM	200	39.95
ISB3220 16K CMOS RAM	750	119.95
ISB3330 Z80 PIO (D mating)	210	49.95
ISB3331 Universal PIO	210	49.95
ISB3340 Opto Para. Input	300	119.95
ISB3400 Floppy Controller	215	79.95
ISB3410 SASI (DMA) WINI Inter.	255	99.95
ISB3500 Triac	215	99.95
ISB3510 Opto-Iso Input	270	119.95
ISB3520 SPST Relay	150	69.95
ISB3521 DPDT Relay	190	89.95
ISB3600 Arithmetic	375	149.95
ISB3610 EPROM Programer	260	79.95
ISB3700 Sync/Async	245	69.95
ISB3711 Univ. Sync/Async	245	69.95
ISB3720 REMDACS	315	149.95
ISB3830 12 Bit A/D	720	269.95

CAPACITORS

.01uF DISC BYPASS CAPACITOR	100/$5.50
.1 uF DISC BYPASS CAPACITOR	100/6.50
.01uF MONOLITHIC CAPACITOR	100/11.25
.1 uF MONOLITHIC CAPACITOR	100/14.25

CORCOM EMI FILTER

STD CORCOM 3 Conductor Filter	$4.50
Line Cord for above — 6 foot	1.49
Line Cord 2 Conductor — 6 foot	35
Line Cord 3 Conductor — 6 foot	.95

MUFFIN FANS

Over 10,000 In Stock

Torin 3" TA-300 Fan	NEW!	$9.95
Torin 4.68" Muffin Fan	NEW!	12.95
12VDC Fan	NEW!	19.95
Finger Guards added		1.49
Power Cords Added		1.49

IC SOCKETS

SOLDERTAIL	1-99	100
8 Pin ST/LP	$ .13	$ .10
14 Pin ST/LP	.15	.11
16 Pin ST/LP	.17	.12
18 Pin ST/LP	.20	.17
20 Pin ST/LP	.28	26
22 Pin ST/LP	29	.27
24 Pin ST/LP	.29	27
28 Pin ST/LP	.39	.32
36 Pin ST/LP	.45	.36
40 Pin ST/LP	.48	.42
64 Pin ST/LP	3.95	3.25
WIREWRAP (GOLD)	**1-99**	**100**
8 Pin WW/3L	$ .49	$ .40
14 Pin WW/3L	.62	.49
16 Pin WW/3L	85	55
18 Pin WW/3L	.88	.77
20 Pin WW/3L	.99	96
22 Pin WW/3L	1.19	1.13
24 Pin WW/3L	1.25	1.17
28 Pin WW/3L	1.49	1.39
40 Pin WW/3L	1.89	1.75

TEXTOOL/ZIF ZERO INSERTION
16 Pin $6.75 24 Pin $7.85 28 Pin $6.95
(We Stock All Types of Sockets)

TRANSISTORS/DIODES

PN2222A	7/$1.00	2N3904	11/$1.00
PN2369A	5/1.00	2N3906	11/1.00
PN918	3/1.00	TIP29A	2/1.00
2N2218A	.45	TIP30A	2/1.00
2N2219A	.45	TIP31A	2/1.25
2N2905	.45	TIP32A	2/1.25
2N2907	.25	1N4148	25/1.00
2N3055	.69	1N751	5/1.00
2N3565	4/1.00	1N4002	12/1.00
2N3638	4/1.00	1N4004	10/1.00
2N3772	1.69	MPQ2232	1.49

OPTO ISOLATORS

MCT-2	$ .59	4N33	$ .89
MCT-6	1.39	4N35	1.25
MCT-66	.55	4N37	1.25
MCA-255	1.69	4N38	98
4N26	.65	TIL117	.79
4N27	65	SPX33	29
4N28	.69	4N25	5/1.00

LED LAMPS

	1-99	100
Jumbo Red	$ .09	$ .08
Jumbo Green	.17	.15
Jumbo Yellow	.17	.15
Mini Size Red	.10	.09
Mini Size Green	.19	.18
Mini Size Yellow	.19	.18

SPECIAL VALUES!

MCM68705 EPROM	$9.95
6116/2016-150mS	10/19.95
DB-25P Male	10/17.50
DB-25S Female	10/19.95
2732A-2	10/29.95
2716DC-450mS	10/24.50
2764-450mS	10/29.95

CALL ACP FOR ALL YOUR VOLUME IC REQUIREMENTS

EDGE CONNECTORS

	1-99	100
S-100 ST	$3.95	$3.25
S-100 WW	4.75	4.10
44 Pin ST	2.75	2.60
44 Pin WW	4.75	4.25
72 Pin ST	6.50	6.10
72 Pin WW	7.25	6.95

D-SUBMINIATURE

	1-24	25
DB25S (Female	$3.10	$2.90
DB25P (Male)	2.40	2.29
Hood $1.25	Mtg H/W $ .99	
DE37S (Female)	$5.95	$5.75
DE37P (Male)	5.25	5.10
Hood $1.75	Mtg H/W $ .99	
DD50S (Female)	$8.95	$8.65
DD50P (Male)	6.00	5.75
Hood $3.25	Mtg H/W $ .99	

(OTHER STYLES IN CATALOG)

CENTRONICS

IDC 36 Pin Male	$8.95
IDC 36 Pin Female	9.49
Solder 36 Pin Male	7.49
Solder 36 Pin Female	8.95

(CALL TOLL FREE FOR IDC's)

IDC CONNECTORS

IDC TYPE	ACP NO	NUMBER OF CONTACTS 10	20	26	34	40	50
Solder Header	IDHxxS	.79	1.20	1.65	2.10	2.40	3.00
Rt Angle Solder Header	IDHxxSR	.79	1.20	1.65	2.10	2.40	3.00
Ribbon Header Socket	IDSxx	.75	.95	1.35	1.50	1.85	2.10
Ribbon Header	IDMxx	—	5.25	5.95	6.75	7.25	8.25
Ribbon Edgecard	IDExx	1.70	2.15	2.50	2.60	3.70	3.95
Wirewrap Header	IDHxxW	1.80	2.90	3.75	4.25	4.95	6.50
Rt Angle W/W Header	IDHxxWR	1.99	3.10	4.10	4.20	4.60	7.15

NOTE: To order insert number of contacts in place of xx in ACP part number.
ORDER QUANTITY OF 50pcs (mixed) AND TAKE AN ADDITTIONAL 10% OFF.

OKIDATA PRINTERS

Okimate 20 Color Printer	$139.00
Plug-N-Print for Okidata 20	69.00
Okidata 182 (120cps, Graphics)	259.00
Okidata 192 (160cps, Graphics)	349.00
Okidata 193 (160cps, 15" Paper)	549.00
Okidata 92 (160cps, Graphics)	349.00
Okidata 93 (160cps, 15" Paper)	599.00
Okidata 84 (200cps, Parallel)	$799.00
Okidata 84 (200cps, Serial)	949.00
Tractor for Okidata 192	44.00
Tractor for Okidata 92	64.00
2K Serial Board for Okidata 192/193	69.00
2K Serial Board for Okidata 92/93	99.00
Extra Ribbon	5.00

6800

68000	$19.95	6810	$2.85	6850	$3.25
68000L10	39.95	6820	3.75	6852	5.65
6800	2.90	6821	2.90	6860	7.90
6802	7.75	6828	14.50	6875	6.75
6803	18.95	6840	12.75	6880	2.20
6809E	9.50	6845	11.95	68047	22.95

6500

6502	$4.50	6504	$6.75	6522	$5.25
6502A	6.90	6507	9.75	6532	9.50
6502B	9.50	6520	4.25	6551	11.50

8000

8035	$5.75	8214	$3.75	8259	$6.75
8039	5.75	8216	1.95	8271	69.95
8080A	2.95	8224	2.20	8275	26.95
8085A	4.90	8226	1.95	8279	8.75
80C85A	9.95	8228	3.40	8282	6.25
8086	24.50	8237	13.75	8283	6.25
8087-2	129.95	8237-5	15.95	8284	5.50
8088	17.50	8238	4.25	8286	6.45
8089	86.95	8243	3.95	8287	6.45
8155	6.75	8250	10.50	8288	11.95
8156	6.75	8251	4.25	8289	44.95
8185	26.95	8251A	5.95	8292	12.95
8202	23.95	8253	6.75	8741	27.95
8203	37.95	8255	4.25	8748	24.50
8205	3.25	8255A	5.95	8749	24.50
8212	1.95	8257	5.75	8755A	34.95

Z-80

	2.5MHz	"A" 4.0MHz	"B" 6.0MHz
Z80-CPU	2.25	2.75	6.95
Z80-CTC	2.50	3.75	9.25
Z80-DART	7.50	8.50	17.95
Z80-DMA	8.00	8.95	17.95
Z80-PIO	2.95	3.50	9.50
Z80-SIO/0	8.50	9.50	22.95
Z80-SIO/1	8.50	9.50	—
Z80-SIO/2	8.50	9.50	22.95
Z80-SIO/9	8.50	9.50	—

Z8030	$34.95	Z8001	$34.95	Z6132	$32.95
Z8530	34.95	Z8002	34.95	Z8671	37.95

DISK CONTROLLERS

uPD765	$24.95	1797	$21.95	6843	$28.95
1771	15.95	2791	32.95	8272	19.95
1791	22.75	2793	32.95	1691	6.95
1793	21.50	2795	32.95	2143	6.95
1795	21.50	2797	27.95	9216	12.95

CRT CONTROLLERS

6845	$11.95	8275	$28.50	TMS9918	$39.50
68B45	17.95	7220	34.95	8350	39.95
6847	11.50	5027	17.95	6545	14.95
46505	14.75	5037	21.95	8002	19.95
68047	19.50	NEC7220 Graphics			34.95

UARTS/USARTS

1602B	$3.95	2350	$8.95	IM6403	$8.75
1013A	3.95	8250	10.50	TMS5501	14.95
1015A	6.75	IM6402	7.75	2651	8.95

EPROMS

1702 (1mS)	$3.90	2732A-4 (450nS)	$4.50
2708 (450nS)	3.65	2732A (250nS)	6.95
2758 (5V)	5.50	2732A-2 (200nS)	8.95
2718 (450nS)	3.75	2764 (450nS)	4.50
2716 (350nS)	5.50	2764 (250nS)	8.50
2516 (5V)	5.50	2764 (200nS)	8.50
TMS2716	7.50	TMS2564 (450nS)	9.95
TMS2532	5.60	MCM68764 (450nS)	19.95
2732 (450nS)	4.60	MCM68766 (350nS)	21.95
2732 (250nS)	6.00	27128-3 (300nS)	9.50
2732 (200nS)	8.00	27128 (250nS)	16.95
CMOS EPROMS		27C32	$9.95
27C16	$8.95	27C64	12.95

STATIC RAMS

2101 (450nS)	$1.89	MK4118	$4.95
21L02 (450nS)	.99	TMM2016-2 (200nS)	3.10
2102-1 (450nS)	.79	TMM2016-15 (150n)	3.95
21L02-2 (250nS)	1.39	TMM2016-1 (100nS)	3.00
2111 (450nS)	2.75	HM6116P-4 (200nS)	4.75
2112 (450nS)	2.75	HM6116P-3 (150nS)	3.25
2114 (450nS)	1.45 8/9.50	HM6116P-2 (120nS)	5.75
2114L-4 (450n)	1.69 8/12.50	HM6116LP-4 (LP)	3.60
2114L-3 (300n)	1.79 8/13.30	HM6116LP-3 (LP)	3.95
2114L-2 (200n)	1.89 8/13.90	HM6116LP-2 (LP)	3.95
2147 (55nS)	4.50	Z6132 (300nS)	32.95
4044-4 (450nS)	3.25	HM6264P-15 (150)	14.95
4044-3 (300nS)	3.75	HM6264LP-15 (LP)	16.95
4044-2 (200nS)	4.35	74S189 (35nS)	1.85
UPD410 (100nS)	3.75	93415 (50nS)	3.95
5101 (CMOS)	3.50	93425 (50nS)	3.95

DYNAMIC RAMS

4027 (250nS)	$1.29	TMS4406 (200nS)	$6.95
1103 (300nS)	.79	TMS4416 (150nS)	$7.75
4116N-2 (150nS)	1.29 8/9.95	41256-150 (150n)	8.95
4116N-3 (200nS)	1.19 8/8.25	41256-200 (200n)	7.95
4116N-4 (250nS)	89 8/5.99	TMS4050 (300nS)	1.85
4164N-150 (150n)	1.59 9/11.95	TMS4060 (300nS)	1.65
4164N-200 (200n)	1.49 9/10.00	MM5280 (300nS)	1.85
4164N-120 (120nS)	6.25	UPD411 (300nS)	1.85
TMS4164 (150nS)	5.95	MM5298 (250nS)	1.85

DISK SPECIAL (IBM PC DSDD)
$1.00 EACH PACKAGE OF 25 — "IBM PC®" DS/DD, Hub Rings, Tyvac Cover, Major Mfgr. — **WOW! Supply Limited**

5¼" DISKETTES	1 Box	10 Box
VERBATIM 525-01 SS/DD	$22.95	$19.95
VERBATIM 550-01 DS/DD (IBM)	27.95	24.95
MAXELL MD-1 SS/DD (All)	19.95	17.95
MAXELL MD-2 DS/DD (IBM)	24.95	22.95
MAXELL DISKS for AT (96tpi)	46.95	43.95
DYSAN 104/1D SS/DD (All)	27.95	25.95
DYSAN 104/2D DS/DD (IBM)	34.95	31.95
ACP SS/DD (All)	14.95	12.95
ACP DS/DD (IBM)	17.95	15.95
3½" DISKETTES		
VERBATIM 3½" MF350 (MAC)	32.00	29.00
MAXELL 3½" MICRODISK (MAC)	33.00	31.00
8" DISKETTES		
VERBATIM 8" SS/DD	28.95	26.95
VERBATIM 8" DS/DD	38.95	36.95
DYSAN 8" SS/DD	32.95	30.95
DYSAN 8" DS/DD	49.95	47.95

5¼" DISK TUB **$8.95** | 3½" DISK TUB **$14.95** | HEAD CLEANING KIT—5¼ or 8 **$9.95**

CMOS

4000	$.26	4028	$.65	4059	$7.90	4505	8.95
4001	.22	4029	.75	4060	.85	4506	1.10
4002	.22	4030	.39	4066	.39	4507	1.10
4006	.79	4031	3.25	4069	.26	4508	1.90
4007	.22	4032	2.15	4070	.35	4510	.79
4008	.95	4034	1.91	4071	.28	4511	.79
4009	.39	4035	.79	4072	.28	4512	.79
4010	.39	4037	1.95	4073	.28	4514	1.18
4011	.24	4040	.75	4075	.28	4515	1.79
4012	.24	4041	.75	4076	.75	4516	1.19
4013	.35	4042	.65	4077	.35	4518	.85
4014	.75	4043	.85	4078	.35	4520	.75
4015	.39	4044	.69	4081	.29	4555	.95
4016	.35	4046	.80	4082	.29	4556	.95
4017	.65	4047	.89	4085	.95	4566	1.35
4018	.79	4048	.99	4086	.95	80C95	1.50
4019	.39	4049	.35	4093	.45	80C97	.49
4020	.69	4050	.34	4094	2.95	MC14406	12.95
4021	.69	4051	.75	4098	1.90	MC14409	12.95
4022	.69	4052	.75	4099	1.85	MC14410	9.95
4023	.25	4053	.75	4501	.69	MC14411	11.95
4024	.59	4055	3.95	4502	.95	MC14412	12.95
4025	.25	4056	2.95	4503	.49	MC14419	4.95
4027	.45	CALL FOR 74HC					

74C00

74C00	$.29	74C74	$.65	74C161	$1.15	74C373	$2.35
74C02	.29	74C85	1.89	74C175	1.15	74C374	2.35
74C04	.29	74C90	1.15	74C240	1.89	74C901	59
74C08	.35	74C93	1.15	74C244	1.89	74C922	4.45
74C10	35	MORE 74C IN STOCK — ALSO IN CATALOG					

LINEAR

LM108AH	$3.95	NE590	$2.45	LM3909	.98
LM300H	.99	NE592	2.70	LM3914	$2.95
LM301N	.35	LM709N	55	LM3915	2.95
LM304H	1.89	LM709H	1.90	LM3916	2.95
LM305H	.95	LM710	.68	MC4024	3.75
LM306H	4.75	LM711	.75	MC4044	4.35
LM307N	.40	LM715	3.95	RC4131	3.75
LM308CN	65	LM723N	.55	RC4136	1.19
LM310CN	1.65	LM723H	.75	RC4151	3.75
LM311CN	62	LM733	.98	CA3023	2.75
LM312H	1.75	LM739	1.85	CA3039	1.25
LM318CN	1.45	LM741CN	.33	CA3046	1.25
LM318H	1.55	LM741H	.40	CA3059	2.85
LM319N	1.19	LM741N	29	CA3060	2.85
LM320 (see VRs)		LM747	.65	CA3065	1.69
LM324N	.55	LM748	55	CA3080	1.10
LM339N	95	LM1014	1.15	CA3081	1.60
LM340 (see VRs)		LM1303	1.90	CA3082	1.60
LM348N	.95	LM1310	1.45	CA3083	1.55
LM358CN	65	MC1330	1.65	CA3086	.80
LM359	1.75	MC1349	1.85	CA3089	2.95
LM360N	2.95	MC1350	1.15	CA3096	3.45
LM370N	4.95	MC1358	1.65	CA3130	1.29
LM373N	3.95	MC1372	6.75	CA3140	1.15
LM376N	3.75	LM1414	1.55	CA3146	1.79
LM377N	1.90	LM1558H	2.99	CA3160	1.49
LM380CN	85	LM1800	2.35	LM13080	1.25
LM380N	1.05	LM1812	6.10	LM13600	1.45
LM381N	1.59	LM1830	3.40	LM13700	1.45
LM382N	1.35	LM1871	5.45	LF347	2.19
LM383N	1.95	LM1872	5.45	LF351	.60
LM384N	1.75	LM1877	3.20	LF353	.99
LM386N	.89	LM1889	1.90	LF355	1.10
LM387N	1.29	LM1896	1.70	LF356	1.10
LM389N	1.15	ULN2001	1.95	LF357	1.39
LM392N	.69	ULN2003	1.49	TL071CP	.79
LM723N	.48	XR2206	3.75	TL072CP	1.35
LM723H	.55	XR2207	2.90	TL074CN	1.90
NE531	2.85	XR2208	2.40	TL081CP	59
NE555	35	XR2211	3.75	TL084CN	1.90
NE556	.65	LM2877P	2.00	TL494	4.10
NE558	1.49	LM2878P	2.25	TL496	1.65
NE561	23.50	LM2900	83	TL497	3.20
NE564	2.85	LM2901	99	MC3423	1.49
LM565	95	LM2903	69	MC3453	4.95
LM566	1.45	LM2907	2.45	MC3456	1.29
LM567	.65	LM2917	2.85	MC3459	3.75
NE570	3.85	LM3900	.55	MC3469	5.25
NE571	2.90	LM3905	1.15	MC3470	7.95

VOLTAGE REGULATORS

7805T Also 8, 12, 15, 24V	.69	7905K Also 12, 15, 24V	1.39
78L05, 12, 15V	.65	79L05, 12, 15V	.75
78M05C	.89	LM309K	1.25
78MG/79MG	1.49	LM317H/K	1.25/3.65
78H05KC	6.75	LM323K	4.85
7805K Also 12, 15, 24V	1.29	LM337K	3.75
7905T Also 8, 12, 15, 24V	.79	LM338K	6.75
		LM350T	4.55
		LM350K	4.75

SPECIAL PURPOSE CHIPS

MC14411	$11.50	58174	$11.25	95H90	$9.25
BR1941	11.50	5832	3.75	76477	3.75
34702	12.50	AY52376	11.50	76488	5.75
5016	14.95	AY53600	11.60	76489	8.75
8116	10.50	2513-001U	9.50	AY38910	7.95
5307	10.50	2513-002L	9.50	AY38912	7.95
MC4024	3.75	UPD7201	27.95	SSI-263	36.95
8038	3.75	3341	4.50	Votrax	39.95
5369	3.50	11C90	13.25	Digitalker	34.95
58167	12.25	MC15906	2.95	LM13600N	1.95
SP1000 Speech	$9.95	TR1863 5V UART			$4.25

DATA AQUISITION

ADC0800	$14.95	ADC0817	$9.75	1408L6	$1.95
ADC0804	3.45	DAC0800	4.75	1408L8	2.85
DAC0806	1.90	DAC0808	2.85	DAC100	7.95
ADC0809	4.45	DAC1020	7.95	DAC08	7.95
ADC0816	14.25	DAC1022	5.85	DAC01	6.95
AD7523JN	1.99	LF353N	1.99	LF13201N	1.99

EXPANSION MEMORY

64K UPGRADE (Set of 9) **$10.00**
256K RAMS (Set of 9) **$45.00**

CABLES/ACCESSORIES

IBM PARALLEL (Shielded)	$29.95
IBM SERIAL (Shielded)	24.95
KEYBOARD EXTENSION	9.95
RS232 GENDER CHANGER Male-Male	14.95
RS232 GENDER CHANGER Female-Female	14.95
NULL MODEM ADAPTOR	14.95

"½"DISK DRIVE IBM PC® Comp. DS/DD Disk Drive **$89.95**

HI-TECH SPECIALS AMD7910 300/1200 BAUD MODEM IC **$19.95**

7400

7400	$.18	7446	$.68	74123	$.45	74176	$.69
7401	.18	7447	.65	74125	.42	74177	.69
7402	.18	7448	.68	74126	.44	74179	1.34
7403	.18	7450	.19	74128	.49	74180	.75
7404	.18	7451	.19	74132	.45	74181	1.75
7405	.23	7453	.19	74136	.75	74182	1.15
7406	.49	7454	.19	74141	85	74184	2.25
7407	.49	7459	.25	74142	2.95	74185	2.25
7408	.24	7460	37	74143	3.70	74190	67
7409	.19	7470	29	74144	2.95	74191	.67
7410	.19	7472	29	74145	.59	74192	.67
7411	.24	7473	.33	74147	1.49	74193	.67
7412	.38	7474	34	74148	1.19	74194	.67
7413	.34	7475	.38	74150	1.09	74195	.67
7414	.49	7476	.34	74151	56	74196	.75
7416	.49	7479	4.60	74152	.67	74197	.86
7417	.49	7480	.69	74153	.53	74198	1.15
7420	19	7482	.95	74154	1.19	74199	1.15
7421	35	7483	.45	74155	69	74221	1.19
7422	.45	7485	.56	74156	59	74251	.75
7423	.58	7486	35	74157	59	74273	1.65
7425	29	7489	1.95	74158	1.65	74276	1.69
7426	29	7490	35	74159	1.58	74279	.75
7427	.25	7491	65	74160	.79	74283	1.40
7428	.55	7492	.45	74161	.69	74284	2.90
7430	.18	7493	35	74162	.69	74285	2.90
7432	29	7494	65	74163	69	74290	1.49
7437	.25	7495	.50	74164	69	74298	1.49
7438	.29	7496	69	74165	69	74365	55
7439	58	7497	2.70	74166	.85	74366	.55
7440	.19	74100	1.50	74167	2.75	74367	.55
7441	.79	74107	.24	74170	1.25	74368	.55
7442	45	74109	.37	74172	4.75	74390	1.45
7443	1.15	74116	1.45	74173	.69	74393	1.33
7444	1.15	74121	29	74174	.69	74490	2.25
7445	.68	74122	.44	74175	.69		

74LS00

74LS00	$.22	74LS113	$.38	74LS247	$.74
74LS01	22	74LS114	.39	74LS248	98
74LS02	.22	74LS122	.45	74LS249	.98
74LS03	22	74LS123	.95	74LS251	59
74LS04	24	74LS124	2.75	74LS253	.59
74LS05	25	74LS125	.49	74LS257	.59
74LS08	27	74LS126	.49	74LS258	.59
74LS09	.28	74LS132	.59	74LS259	2.95
74LS10	25	74LS136	.39	74LS260	.59
74LS11	.33	74LS138	59	74LS261	2.49
74LS12	33	74LS139	.59	74LS266	.55
74LS13	.39	74LS145	1.19	74LS273	1.45
74LS14	.59	74LS148	1.38	74LS275	3.29
74LS15	.33	74LS151	55	74LS279	.59
74LS20	.26	74LS153	.55	74LS283	68
74LS21	29	74LS154	1.49	74LS290	.88
74LS22	29	74LS155	.69	74LS293	.78
74LS26	.29	74LS156	.69	74LS295	98
74LS27	29	74LS157	.69	74LS298	.88
74LS28	29	74LS158	.69	74LS324	1.75
74LS30	25	74LS160	69	74LS347	1.95
74LS32	.33	74LS161	.69	74LS348	1.95
74LS33	.53	74LS162	.69	74LS352	1.25
74LS37	.35	74LS163	.69	74LS353	1.25
74LS38	39	74LS164	.69	74LS363	1.29
74LS40	25	74LS165	.90	74LS365	.48
74LS42	.44	74LS166	1.90	74LS366	.48
74LS47	.74	74LS168	1.15	74LS367	.45
74LS48	.74	74LS169	1.15	74LS368	.45
74LS51	25	74LS170	1.40	74LS373	1.39
74LS54	29	74LS173	.67	74LS374	1.33
74LS55	29	74LS174	.67	74LS375	.69
74LS73	39	74LS175	67	74LS377	1.38
74LS74	.34	74LS181	1.95	74LS385	1.95
74LS75	39	74LS190	.85	74LS386	.45
74LS76	39	74LS191	85	74LS390	1.15
74LS78	.39	74LS192	.78	74LS393	1.15
74LS83	59	74LS193	.78	74LS395	1.15
74LS85	.69	74LS194	.69	74LS399	1.47
74LS86	39	74LS195	69	74LS424	2.95
74LS90	.54	74LS196	.79	74LS668	1.75
74LS92	.54	74LS197	.79	74LS670	2.29
74LS93	54	74LS221	89	81LS95	1.45
74LS95	.75	74LS240	95	81LS96	1.45
74LS96	89	74LS242	95	81LS97	1.45
74LS107	39	74LS243	95	81LS98	1.45
74LS109	39	74LS244	1.25	25LS2521	2.65
74LS112	.39	74LS245	1.45	25LS2569	3.50

74S00/PROMS*

74S00	$.29	74S74	$.55	74S158	$.99	74S260	$1.19
74S02	29	74S85	1.89	74S160	2.49	74S280	1.95
74S03	29	74S86	55	74S161	1.89	74S287*	1.95
74S04	45	74S112	55	74S174	1.19	74S288*	1.95
74S05	.45	74S113	.55	74S175	1.19	74S373	2.09
74S08	.39	74S114	55	74S188*	1.49	74S374	2.09
74S09	39	74S124	2.69	74S194	1.49	74S387*	1.95
74S10	.35	74S132	1.39	74S195	1.49	74S471*	5.95
74S11	35	74S133	.45	74S196	1.49	74S472*	4.95
74S15	35	74S134	.50	74S240	1.99	74S473*	4.95
74S20	.35	74S135	89	74S241	1.99	74S474*	4.95
74S22	35	74S136	1.39	74S242	1.99	74S475*	4.95
74S30	.35	74S138	89	74S243	1.99	74S570*	2.95
74S32	.45	74S139	89	74S244	1.99	74S571*	2.95
74S38	89	74S140	.55	74S251	1.19	74S572*	4.95
74S40	.39	74S151	99	74S253	1.19	74S573*	4.95
74S51	.35	74S153	.99	74S257	1.19	74S940	2.49
74S64	39	74S157	99	74S258	1.19	74S941	2.49
74S65	39			CALL FOR 74HC			

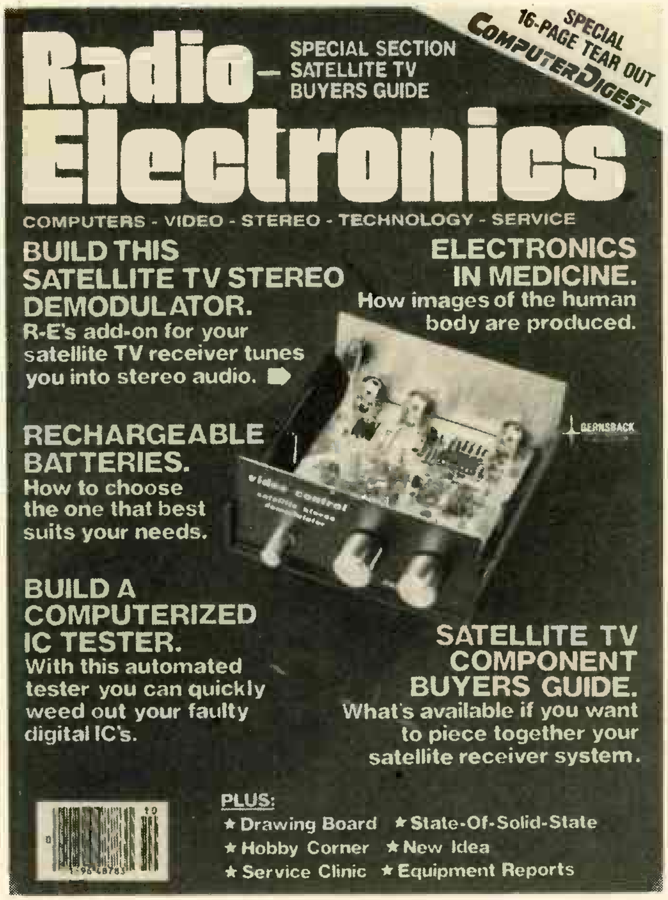
★ Advanced Computer Products Inc.

Mail Order: P.O. Box 17329 Irvine, CA 92713 • Retail: 1310 B E. Edinger, Santa Ana, CA 92705

CIRCLE 128 ON FREE INFORMATION CARD

This will be coming to you when you subscribe to **Radio-Electronics**

- **HELPFUL CONSTRUCTION ARTICLES...**
  - Test Equipment
  - Hi-Fi Accessories
  - Telephone Accessories
  - Music Synthesizers
  - Computer Equipment
  - Automotive Equipment
  - Intruder Alarms-Home & Car
  - Video Accessories
- **NEWS ON NEW TECHNOLOGY**
  - Computers
  - Microprocessors
  - Satellite TV
  - Teletext
  - Automotive Electronics
  - Speech Synthesizers
  - IC Applications
- **FASCINATING "HOW TO DO IT" ARTICLES...**
  - Build Your Own Projects
  - Make Your Own PC Boards
  - Wiring Techniques
  - Soldering and Desoldering
  - Design and Prototyping



- **HOW YOU AND THE COMPUTER CAN BE FRIENDS...**
  - Getting Started
  - Programs, Circuit Design, Games
  - A/D-D/A Interfacing
  - Peripheral Equipment
- **NEW AUDIO DIMENSIONS FOR YOUR PLEASURE...**
  - Noise-Reduction Devices
  - How to Connect that Extra Add-On
  - Hi-Fi Accessories
  - New Technology
- **TV WONDERS FOR YOUR FUTURE...**
  - Latest Receivers and Circuits
  - The Home Entertainment Center
  - Projection TV
  - Satellite TV Receivers
  - Jack Darr's Monthly Service Clinic
  - Service Problems and Solutions
- **REGULAR MONTHLY FEATURES**
  - DESIGNERS NOTEBOOK by Robert Grossblatt
  - HOBBY CORNER by "Doc" Savage, K4SDS
  - STATE-OF-SOLID-STATE by Bob Scott
  - WHAT'S NEWS, new products, stereo news and NEW IDEAS, STEREO PRODUCTS, NEW COMPUTER PRODUCTS FOR HOME/JOB and MUCH MORE!

Radio-Electronics covers all aspects of the fast moving electronics field...featuring
COMPUTERS • VIDEO • STEREO
TECHNOLOGY • SERVICE
COMMUNICATIONS • PROJECTS

Get it all!

Subscribe today to **Radio-Electronics!** Don't miss a single issue and...see subscription card in back of this issue for big savings.

When you select one of the subscription offers listed on the handy coupon—you'll be assured of having your copy reserved, even if it sells out on the newsstand. Make sure you get all the excitement in every issue of **Radio-Electronics**, every month, by filling in and mailing your subscripton card today.

Radio Shack Parts Place™

START YOUR HOLIDAY PROJECT AT RADIO SHACK!

New Special-Order Service

Now Radio Shack Can Replace Almost Any Industrial or Entertainment IC Or Semiconductor Device . . . Fast!

MORE THAN 200,000 SUBSTITUTIONS!

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 and we'll notify you when it arrives. We also offer this service on selected tubes, crystals, phono cartridges and styli. Visit the store nearest you for details!

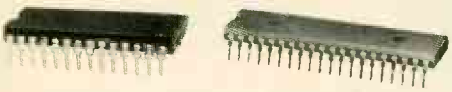
- No Minimum Order
- No Postage Charge

1/4-Watt, 5% Resistors

39¢ Pkg. of 5

Ohms	Cat. No.	Ohms	Cat. No.
10	271-1301	4.7k	271-1330
100	271-1311	10k	271-1335
150	271-1312	15k	271-1337
220	271-1313	22k	271-1339
270	271-1314	33k	271-1341
330	271-1315	47k	271-1342
470	271-1317	100k	271-1347
1k	271-1321	220k	271-1350
1.8k	271-1324	470k	271-1354
2.2k	271-1325	1 meg	271-1356
3.3k	271-1328	10 meg	271-1365

Speech Synthesizer ICs



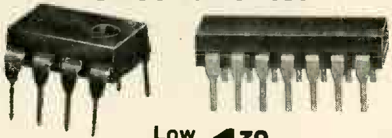
(Extra parts required).

Now You Can Add Voice Output to Almost any Computer or ASCII Terminal

SPO256-AL2. Preprogrammed with 59 speech sounds and five pauses. Complete data and application notes included. 28-pin DIP. #276-1784 . . **12.95**

CTS256-AL2. Converts standard ASCII characters into control data for the IC above. 40-pin DIP with data and circuit examples. #276-1786 . . . . **16.95**

CMOS Timer ICs



Low As **1.39**

TLC555. New high-performance version of standard 555 with same pinout. Silicone CMOS design offers very low power drain—typically one milliwatt with 5 VDC supply. Operates up to 2 MHz, sinks 100 mA. 8-pin DIP with data. #276-1718 . . . . **1.39**

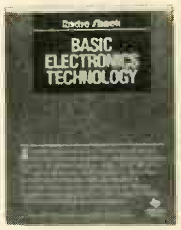
TLC556. Dual version of above. 14-pin DIP with data. #276-1704 . . . . **1.59**

Electronics Textbook

NEW!

7.95

Developed by Texas Instruments Learning Center



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, and computers. Illustrated. 464 pages. #62-1394

Plug-in Boards

Jumbo 2-Bus Board. 4 1/2 x 9 9/16". Fits 44-position socket. Accepts up to 24 16-pin DIP sockets with plenty of room for discrete components. Two supply busses. #276-190 . . . . . **5.95**

Jumbo IC/Discrete Plug-in Board. Like above, but accepts up to 40 16-pin DIPs. One buss. #276-191, **5.95**

Socket for Above. #276-1551 . . **2.99**

Tantalum Capacitors

Low As **49¢**

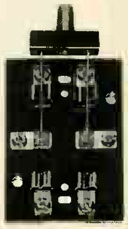
20% tolerance

µF	WVDC	Cat. No.	Each
0.1	35	272-1432	.49
0.47	35	272-1433	.49
1.0	35	272-1434	.49
2.2	35	272-1435	.59
10	16	272-1436	.69
22	16	272-1437	.79

DPDT Knife Switch

Ideal for Projects, Model Railroads, Antenna Switching

99¢



Plated spring contacts rated 0.5 amp at 250 VAC. Screwdriver terminals for every hookup. Molded base with mounting holes. 1 5/8 x 2 3/8 x 3/4". #275-1537

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

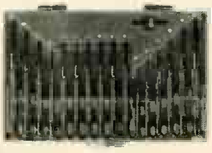
TTL Digital ICs

All Include Pin-Out and Specs

Type	Cat. No.	Each
7400	276-1801	.89
7404	276-1802	.99
7408	276-1822	1.29
7447	276-1805	1.69
7490	276-1808	1.19

Precision Driver Set

8.95



High quality, low price! Great for electronics and jewelry. 4 phillips, 6 slots, 3 nut drivers, 3 hex keys. #64-1961

Big 8 1/2 x 5" case with individual compartments

Digital Logic Probe

19.95

Makes digital testing easy! LEDs and tone output indicate high, low or pulsed logic states. For TTL/LS and CMOS circuits. Overload and polarity protected. With instructions. #22-302

SALE! Fold-Up Multitester

Cut 25%

Reg. 29.95

21.88

Big 4" Scale

You get durability and famous Micronta® quality at $8.07 off. Features 25 switch-selected ranges, built-in meter movement shunt when closed as well as fuse and surge absorber protection. Four detented hinge positions for easy viewing. Measures AC/DC voltage, DC current and resistance. 7 1/4 x 4 5/16 x 1 1/4" when open. Includes probes, manual. Battery extra. #22-211

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

TENMA® the Name You Can Trust in Electronic Test Equipment

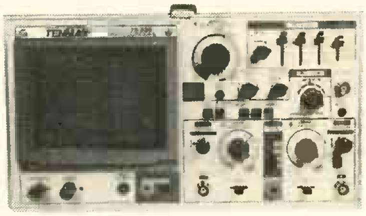
CALL TOLL FREE 1-800-543-4330
(IN OHIO 1-800-762-4315)
(IN HAWAII OR ALASKA 1-800-858-1849)

NEW!

TENMA
AUTORANGING DIGITAL MULTIMETER

■ 3½ digit ■ Auto polarity ■ Low battery indicator ■ 10 amp AC-DC current ■ Continuity buzzer ■ 2¾" x 5¾" x 1⅜" ■ Carrying case included

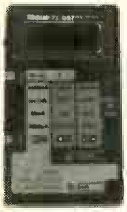
#72-058 $44.95 2-UP
$49.80 1-4



TENMA
35 MHZ DUAL TRACE OSCILLOSCOPE

■ Two High Quality 10:1 probes included
■ Backed by our 2-year limited warranty
■ For specifications see MCM catalog

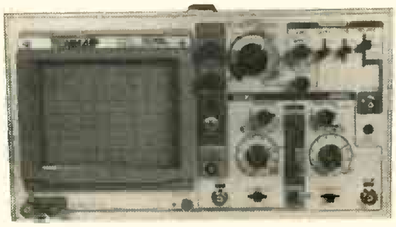
#72-330 $569.00



TENMA
DROP PROOF DIGITAL MULTIMETER

■ DC input impedance 10M ohm
■ Shock-mounted LCD display
■ Overload protection ■ Auto polarity ■ Backed by our 1-year limited warranty ■ For more specifications see MCM catalog

#72-057 $29.95 each

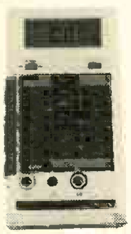


TENMA
20 MHZ DUAL TRACE OSCILLOSCOPE

■ Two High Quality 10:1 probes included
■ Backed by our 2-year limited warranty
■ For specifications see MCM catalog

#72-320 $389.95

NEW!



TENMA
DIGITAL L C R METER

■ Measures inductance, capacitance and resistance
■ L = 1 H to 200 H, C = .1 pf to 200μF, R = .01 ohm to 20 M ohm
■ Carrying case included.

#72-370 $149.95 each

TENMA
15 MHz DUAL TRACE BATTERY POWERED OSCILLOSCOPE

■ Two High Quality 10:1 Probes included ■ Backed by our 2-year limited warranty ■ Internal rechargeable batteries provide 2 hours of continuous operation without the need for any outside power source. ■ For specifications see MCM Catalog

#72-335 $489.95

TENMA
MICROWAVE LEAK DETECTOR

■ Used to check door gaskets, hinges, etc. for leaks in microwave ovens ■ Not intended to be used as a certification instrument.

#72-220
$7.80 1-9
$6.25 10-UP

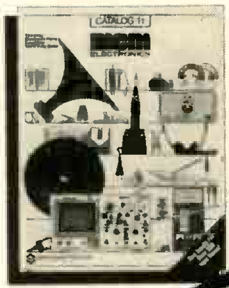
TENMA
COMBINATION FUNCTION GENERATOR AND FREQUENCY COUNTER

■ 6 digit display ■ Output range: .2 Hz to 2 MHz seven ranges ■ Counter range .1 Hz to 10 MHz ■ 5-15 Volt TTL and CMOS output ■ Wave forms: Sine, triangle, square, pulse, and ramp.

#72-380 $219.90

BE SURE TO CALL FOR YOUR FREE CATALOG!

OVER 6000 ITEMS!



We have the Largest Selection of Original Japanese Semiconductors in the Country!

We Also Have...a full line of test equipment, computer accessories, telephone accessories, speakers, television parts, flybacks, yokes, switches, fuses, lamps, capacitors, resistors, cartridges, styli, wire, CATV equipment, and many more.
AT THE LOWEST PRICES AROUND!

Terms:
- $10 minimum order. $1.00 charge for orders under $10.
- $20 minimum charge card order.
- Orders shipped UPS C.O.D.
- Most orders shipped within 24 hours.
- Sales office open 8:30 am to 7:00 pm. Saturdays 10:00 am to 3 pm. EST.
- For prepaid orders add $2.75 for shipping and handling.
- Should shipping & handling charges exceed $2.75, the balance due will be sent C.O.D.

MasterCard VISA

mcm
MCM ELECTRONICS
A DIVISION OF PREMIER INDUSTRIAL
858 East Congress Park Drive
Centerville, Ohio 45459
513-434-0031

SOURCE NO. RE-15

CIRCLE 87 ON FREE INFORMATION CARD

cable tv

DESCRAMBLER PARTS!

We stock the exact parts, PC board and AC adaptor for Radio Electronics February 1984 article on building your own ***Cable TV Descrambler.***

#701 PARTS PACKAGE **$29.95**
Includes all the original resistors, capacitors, diodes, transistors, integrated circuits, coils, IF transformers (toko BKAN-K5552AXX).

#702 PC BOARD **$12.95**
Original etched & drilled silk-screened PC board used in the article.

#704 AC ADAPTOR **$12.95**
Original (14 volts DC @ 285ma) ac adaptor used in the article.

S·P·E·C·I·A·L·S

BOTH #701 & #702 .... NOW **$39**

ALL THREE #701, #702 & #704 .... NOW **$49**

FREE Reprint of Radio Electronics article (February 1984) on Building Your Own **CABLE TV DESCRAMBLER** with any purchase of above.

AC ADAPTOR
9 VDC @ 500mA **$5.95**

PROMS 4k x 8
P2732A (21V) **$3.25**

ADD $2.50 SHIPPING AND HANDLING
$4.50 FOR CANADIAN ORDERS
WE ALSO OFFER QUANTITY DISCOUNTS ON 5 OR MORE UNITS

ORDER TOLL FREE
1-800-227-8529
inside MA 617-339-5372
VISA • MASTERCARD OR C.O.D.

Call or write for a free catalog.

J & W ELECTRONICS, INC.
P.O. BOX 800R MANSFIELD, MA 02048

CIRCLE 65 ON FREE INFORMATION CARD

Jameco ELECTRONICS — HAPPY HOLIDAYS!!! — Jameco ELECTRONICS

Commodore® Accessories

RS232 Adapter for VIC-20 and Commodore 64

The JE232CM allows connection of standard serial RS232 printers, modems, etc. to your VIC-20 and C-64. A 4-pole switch allows the inversion of the 4 control lines. Complete installation and operation instructions included.
· Plugs into User Port · Provides Standard RS232 signal levels · Uses 6 signals (Transmit, Receive, Clear to Send, Request to Send, Data Terminal Ready, Data Set Ready).

JE232CM **$39.95**

VOICE SYNTHESIZER FOR COMMODORE VIC-20 AND C-64

Plug-In – Talking in Minutes!

JE520CM. *(NEW Software-see right)*. **$99.95**

TRS-80 Accessories

MPI 5¼" DISK DRIVE

· Use as a second disk drive · Single-sided · Single/double density · Full-height drive · 48 TPI · Documentation included · Weight: 3.7 lbs.

MPI51S. **$69.95**

EXPAND TRS-80 MEMORY

TRS-80 MODEL I, III

Each Kit comes complete with eight MM5290 (UPD416/4116) 16K Dynamic RAMs and documentation for conversion. Model 1: 16K equipped with Expansion Interface can be expanded to 48K with 2 Kits. Model III: Can be expanded from 16K to 48K using 2 Kits. Each Kit will expand computer by 16K increments.

TRS-16K3	200ns	(Model III).	$5.95
TRS-16K4	250ns	(Model 1).	$5.49

TRS-80 COLOR AND COLOR II

Easy to install Kit comes complete with 8 each 4164N-20 (200ns) 64K Dynamic RAMs and documentation for conversion. Converts TRS-80 Color Computers with D, E, ET, F and NC circuit boards to 32K. Also converts TRS-80 Color Computer II to 64K. Flex DOS or OS-9 required to utilize full 64K RAM on all computers.

TRS-64K-2. . . . . **$9.95**

Update! TRS-80 MODEL IV, 4P *Update!*

Easy to install Kits come complete with: TRS-64K-2 (8 ea. 4164N-20 (200ns) 64K Dynamic RAMs); TRS-64K-2PAL (8 ea. 4164's plus PAL chip) and documentation for conversion.

TRS-64K-2	Expands Model IV from 16K-64K or Model IV & 4P from 64K-128K (w/Mem. Disk). . . .	$ 9.95
TRS-64K-2PAL	Expands Model IV (w/Black & White Monitors only) from 64K to 128K	$29.95

• TRS-80 Model 100 • NEC • Olivetti

Easy to install Module plugs right into the socket increasing memory in 8K increments. Three modules will increase your memory to its full capacity. Complete with module and documentation for installation.

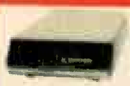
M1008K	(TRS-80 Model 100 Expansion).	$29.95 ea. or 3/$79.95
NEC8KR	(NEC PC-8201A).	$29.95 ea. or 3/$79.95
OM108K	(Olivetti M10).	$29.95 ea. or 3/$79.95

TANDY 200

Easy to install module plugs right into the socket increasing memory in 24K increments. Complete with module and documentation for installation.

M200R (Tandy 200 Expansion). . . $99.95 ea. or 2/$189.95

PROMETHEUS MODEMS



Intelligent 1200/300 Baud Modem with Real Time Clock/Calendar

The ProModem™ is a Bell 212A (1200/300) intelligent stand-alone modem · Hayes command set compatible plus an additional extended command set · Shown with alphanumeric display option.

PM1200 RS-232 Stand-Alone Unit. **$299.95**

OPTIONS FOR ProModem 1200

PM-COM	(ProCom Communication Software). Please specify Operating System – Apple: ProDOS or CP/M – or IBM: PC DOS or MS DOS	$ 79.95
PM-OP512K	(Communication Buffer Option).	$129.95
BUF512K	(512K Memory for PM-OP512K)	$ 54.95
PM-ALP	(Alphanumeric Display).	$ 79.95
PM-Special #2	(Includes PM-OP512K, BUF512K and PM-ALP).	$249.95

DATA BOOKS

30009	**Intersil Data Book (1985).** Complete Line (1075 pages).	$9.95
30013	**Zilog Data Book (1985).** Microprocessors and Support Chips (1045 pages).	$9.95
210830	**Intel Memory Components Hndbk. (1983/84).** Contains all Applications Notes, Article Reprints, Data Sheets & other design information on Intel's RAMs, DRAMs, EPROMs, E²PROMs and Bubble Memories (880 pages)	$14.95
230843	**Intel Microsystem Components Hndbk. (1983/84)** Contains Data Sheets on all of Intel's Microprocessors & peripherals – 2 volumes (2575 pages)	$19.95
30022	**National Logic Data Book Set (1984).** Volumes I & II (3485 pages). Contains information on National's TTL product line and CD4000 family. This includes 7400, 74L, S, AS, LS and ALS Series devices, and MM54HC / 74HC / 54HCT / 74HCT High Speed Micro CMOS family, MM54C / 74C family, and CMOS LSI / VLSI	$24.95

Muffin-Style & Sprite-Style Fans

MUF60 (SPN3-15-2462)
Howard Industries (4.68"sq., 60cfm). . . . **$9.95**

SU2C7
EG&G Rotron (3.125" sq., 32cfm). **$9.95**

★★★★★ APPLE® Accessories ★★★★★

GIVE YOUR COMPUTER A GIFT THIS SEASON... A VOICE!

Voice Synthesizers for Apple, Commodore, IBM & RS232 Computers

NEW Demonstration Software Available!

JE520 VOICE SYNTHESIZER

FOR COMMODORE 64, VIC-20 – APPLE II, II+, *IIe*

Add speech capability to your Commodore 64 or VIC-20, Apple II, II+, *IIe* computer with JAMECO's JE520 Series Voice Synthesizer. Speech – the most effective means of communication available to man – is now immediately available for your computer.

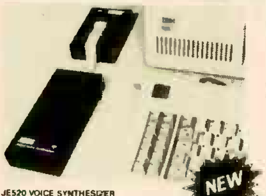
Applications
· Education · Entertainment · Instrumentation
· Games · Telecommunications · Handicap Aids

JE520 Features

- More than 250 basic words, prefixes, suffixes, which allow the formation of well over 500 total words
- Allows music, graphics and speech simultaneously
- Programs in BASIC and/or Assembler
- Very understandable and realistic male voice
- Built-in amplifier, speaker, volume control and audio jack
- Plug-in user-ready with complete documentation and sample software

The JE520 will plug right into your computer and be talking in minutes. It produces a very clear, natural male voice. The outstanding speech quality is produced using National Semiconductor's Digitalker™ speech processor IC with four JAMECO custom memory chips. Case size: 7¼"L x 3¼"W x 1⅝"H. Weight: 1 lb.

PART NO.	COMMODORE 64 or VIC-20	PRICE
JE520CM	Voice Synthesizer for Commodore 64 or VIC-20 (Includes JE521 Interface Module). . . .	$ 99.95
JE521TS	Text-to-Speech Program for Commodore 64 or VIC-20 (5¼" Disk).	$ 9.95
JE521	Commodore Interface Module.	$ 19.95
	APPLE II, II+ and *IIe*	
JE520AP	Voice Synthesizer for Apple II, II+ or *IIe* (Includes JE523 Interface Module).	$119.95
JE523TS	Text-to-Speech Program for Apple II, II+ or *IIe* (5¼" Disk).	$ 9.95
JE523	Apple Interface Module.	$ 39.95



JE520 VOICE SYNTHESIZER

FOR IBM OR ANY RS232 COMPUTER

The JE520 Voice Synthesizer for IBM or RS232 computers has the same features as listed above. The JE525 Interface Module allows the JE520 Series Voice Synthesizer to be interfaced with most popular microcomputers with the use of the standard RS232 port and logic levels. The JE525 Interface Module is powered from a wall transformer. Sample program is included in the User Manual.

JE525 Interface Module Features

- IBM compatible
- CP/M Compatible
- Power ON indicator
- Switch for DTE and DCE RS232 formats
- Indicators for DTE or DCE modes
- Standard DB25 female connector

PART NO.	IBM or Computers with RS232	PRICE
JE520IBM	Voice Synthesizer for IBM or RS232 Computers (Includes JE525 Interface Module). . . .	$199.95
JE525TS	Text-to-Speech Program for IBM (5¼" Disk).	$ 9.95
JE525	IBM/RS232 Interface Module.	$119.95

NEW! QUALITY APPLE COMPATIBLE CARDS For Apple II, II+ and *IIe** NEW!

128K RAM Card For Apple II, II+ and *IIe**

Five Key Software Programs! *RAM Disk!*

The JE868 is functionally compatible with the Apple II language card and can be utilized with all software that can be used with a standard 16K card. The JE868 requires no modifications to your Apple computer. Five key software programs are included: Memory Management System, utilities, diagnostics, demos, and RAM disk emulators for DOS 3.3, CP/M and Apple Pascal. Also features DOS relocator. Complete with instructions.

JE868 (Expand-A-RAM). **$119.95**

Applesurance Diagnostic Disk Controller Card

Prevents Crashes! For Apple II, II+ and *IIe**

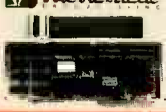
The JE877 serves as a diagnostic tool, an assurance/maintenance tool and a dual disk drive controller. The JE877 will verify and check the operating hardware of your system each time you turn on your Apple II, II+ or *IIe*.* Test your RAM, ROM, CPU, and disk drives. Diagnostic routines may be cancelled at the touch of a key. Complete with instructions.

JE877 (DRV-1/Applesurance II). **$69.95**

Parallel Printer Card For Apple II, II+ and *IIe**

The JE880 Printer Interface board is an intelligent interface to most of today's popular dot-matrix graphics printers. The JE880 is fully compatible with Apple CP/M, Apple Pascal (or FORTRAN), and most other operating systems and software packages available for Apple II, II+ and *IIe*.* The JE880 is shipped configured for the Centronics standard and can be re-configured for other standards if necessary. Advanced text printing features include: video screen echo ON or OFF, auto/disable linefeed after carriage return, set/clear the 8th bit of the output data, set left margin and more! Complete with instructions.

JE880 (PRT-1). **$59.95**



Parallel/Serial Buffer Card For Apple II, II+ and *IIe**

The JE883 provides the user with up to 64K of additional or buffered memory (18 pages of information). Using the parallel jumper cable supplied, the JE883 will attach to the JE880 (above). Parallel Card needed for operation. The JE883 includes a standard parallel input with both parallel and serial (RS232) buffered outputs. With these features you may access and buffer information to two types of printers (one serial, one parallel) simultaneously. Complete with instructions.

JE883 (P/S Buffer). **$79.95**

*APPLE, APPLE II, II+ and IIe are registered trademarks of Apple Computers

Jameco's New 1986 Catalog!

Filled with New Products, Reduced Pricing and Valuable Pin-out Data.

Send $1 Postage for FREE 1986 Jameco Catalog!

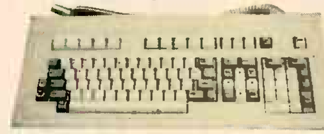
$20 Minimum Order – U.S. Funds Only — CA Residents: Add 6% or 6½% Sales Tax — Spec Sheets – 30¢ each
Shipping: Add 5% plus $1.50 Insurance — Send $1 Postage for FREE 1986 Jameco Catalog — Prices Subject to Change
Send stamped, self-addressed envelope to receive a Quarterly Sales Flyer – FREE!

MasterCard — Mail Order Electronics · Worldwide — Jameco ELECTRONICS — VISA®

1355 SHOREWAY ROAD, BELMONT, CA 94002
12/85 *PHONE ORDERS WELCOME – (415) 592-8097 – Telex: 176043*

IBM® Accessories

IBM PC/XT Compatible Keyboard



IBM-5151 (Equivalent to Keytronics™ 5151). **$129.95**

Additional Add-Ons Available!

MEMORY EXPANSION KITS

IBM PC, PC XT and Compatibles

The IBM64K Kit will increase memory in 64K byte increments. The Kit is simple to install – just insert the 9 - 64K RAM chips in the provided sockets and set the 2 groups of switches. Conversion documentation included.

IBM64K (Nine 200ns 64K RAMs). **$7.95**

IBM PC AT

Each kit comes complete with nine 128K dynamic RAMs and documentation for conversion.

IBM128K (Nine 200ns 128K RAMs). . **$43.95**

IBM PCXT Equivalent 130 Watt Power Supply

UPGRADE YOUR PC!

· Input: 110V @ 60Hz · Output: +5VDC @ 15A, −5VDC @ 0.5A, +12VDC @ 4.2A, −12VDC @ 0.5A · Plug compatible connectors · Fits into IBM PC · Weight: 6 lbs.

IBM-PS. **$99.95**

Prometheus Modems

The ProModem 1200B/BS is a 1200/300 baud modem card which plugs into IBM PC and XT. Provides a third serial Comport. Two versions available: 1200B (without software) and 1200BS (with software). The PM1200BS is supplied with powerful MITE communications software from Mycroft Labs. Software available: PC DOS or MS DOS.

PM1200B	(without Software).	$239.95
PM1200BS	(with MITE Software).	$274.95

IBM Compatible! DISK DRIVES

Documentation Included

RFD480	(Remex 5¼" DS full-ht.).	$69.95
FD55B	(Teac 5¼" DS half-ht.).	$99.95
SA455	(Shugart 5¼" DS half-ht.). . . .	$99.95
TM100-2	(Tandon 5¼" DS full-ht.).	$99.95

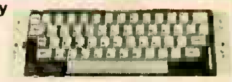
JMR 5¼" DISK DRIVE ENCLOSURES

Complete with power supply, switch, power cord, fuseholder and connectors

DDE-1FH	(Houses 1 full-ht. 5¼" floppy drive) . .	$ 69.95
DDE-2HH	(Houses 2 half-ht. 5¼" floppy drives – vertical).	$ 79.95
HDDE-1FH	(Houses 1 hard drive).	$199.95

General Application Keyboards

Mitsumi 54-Key Unencoded Keyboard



· SPST keyswitches · 20 pin ribbon cable connection · Low profile keys · Features: cursor controls, control, caps (lock), function, enter and shift keys · Color (keycaps): grey · Weight: 1 lb. · Pinout incl. · Size: 13⅛"L x 4¼"W x ¾"H

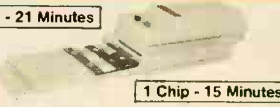
KB54. . . . . **$9.95**

74-Key ASCII Cherry Keyboard

· 7-bit parallel ASCII · Full Upper Case, Full Lower Case except l, m, n, o and p. · Cursor keypad · SPST mechanical keyswitches · 26-pin header connector · Color: white · Size: 18"L x 6¼"W x 1¼"H · Spec included

KB8201. . . . . . *(1500 available)* **$14.95**

UV-EPROM ERASER



Erases all EPROMs. Erases up to 8 chips within 21 minutes (1 chip in 15 minutes). Maintains constant exposure distance of one inch. Special conductive foam liner eliminates static build-up. Built-in safety lock to prevent UV exposure. Compact – only 9.00"L x 3.70"W x 2.60"H. Complete with holding tray for 8 chips.

DE-4	UV-EPROM Eraser.	$74.95
UVS-11EL	Replacement Bulb.	$17.95

CIRCLE 114 ON FREE INFORMATION CARD

CIRCLE 256 ON FREE INFORMATION CARD

JDR Microdevices

1224 South Bascom Avenue, San Jose, CA 95128
(408) 995-5430 • FAX (408) 275-8415 • Telex 171-110

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	.65	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

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

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	see7900	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	see7800	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	MC40	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

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)

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

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

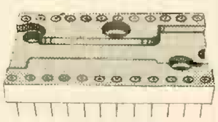
DIP CONNECTORS

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

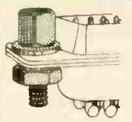
1N751	.25	4N26	.69
1N759	.25	4N27	.69
1N4148	25/1.00	4N28	.69
1N4004	10/1.00	4N33	.89
1N5402	.25	4N37	1.19
KBP04	.55	MCT-2	.59
KBU8A	.95	MCT-6	1.29
MDA990-2	.35	TIL-111	.99
N2222	.25	2N3906	.10
PN2222	.10	2N4401	.25
2N2905	.50	2N4402	.25
2N2907	.25	2N4403	.25
2N3055	.79	2N6045	1.75
2N3904	.10	TIP31	.49

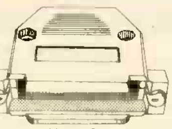
D-SUBMINIATURE

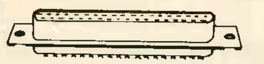
DESCRIPTION		ORDER BY	CONTACTS 9	15	19	25	37	50
SOLDER CUP	MALE	DBxxP	.82	.90	1.25	1.25	1.80	3.48
	FEMALE	DBxxS	.95	1.15	1.50	1.50	2.35	4.32
RIGHT ANGLE PC SOLDER	MALE	DBxxPR	1.20	1.49	---	1.95	2.65	---
	FEMALE	DBxxSR	1.25	1.55	---	2.00	2.79	---
WIRE WRAP	MALE	DBxxPWW	1.69	2.56	---	3.89	5.60	---
	FEMALE	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

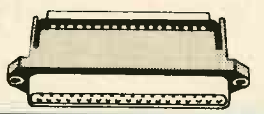
ORDERING INSTRUCTIONS: INSERT THE NUMBER OF CONTACTS IN THE POSITION MARKED "xx" OF THE "ORDER BY" PART NUMBER LISTED.
EXAMPLE: A 15 PIN RIGHT ANGLE MALE PC SOLDER WOULD BE DB15PR.

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

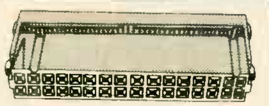
DIFFUSED LEDS

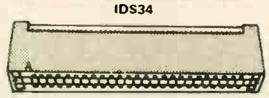
		1-99	100-UP
JUMBO RED	T1¾	.10	.09
JUMBO GREEN	T1¾	.14	.12
JUMBO YELLOW	T1¾	.14	.12
MOUNTING HDW	T1¾	.10	.09
MINI RED	T1	.10	.09

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

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

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.

RIBBON CABLE

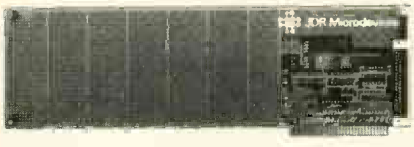
CONTACTS	SINGLE COLOR 1'	10'	COLOR CODED 1'	10'
10	.18	1.60	.30	2.75
16	.28	2.50	.48	4.40
20	.36	3.20	.60	5.50
25	.45	4.00	.75	6.85
26	.46	4.10	.78	7.15
34	.61	5.40	1.07	9.35
40	.72	6.40	1.20	11.00
50	.89	7.50	1.50	13.25

CALL FOR VOLUME QUOTES

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

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

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 CONOUCTOR	.39
LC-3	2 CONOUCTOR	.99
LC-HP	3 CONDUCTOR W/STO FEMALE SOCKET	1.49

MUFFIN FANS

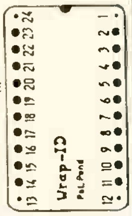
3.15" SQ	ROTRON	14.95
3.63" SQ	ETRI	14.95
3.18" SQ	MASUSHITA	16.95

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)

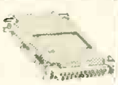


ID WRAP 24

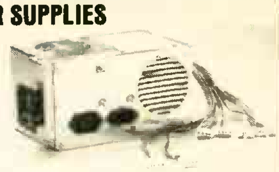
FRAME STYLE TRANSFORMERS

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/150

PS-IBM $99.95
- FOR IBM PC-XT COMPATIBLE
- 130 WATTS
- +5V @ 15A, +12V @ 4.2A -5V @ .5A, -12V @ .5A
- ONE YEAR WARRANTY

PS-IBM-150 $129.95
- 150 WATTS
- FOR IBM PC-XT COMPATIBLE
- +12 @ 5.2A, +5 @ 16A
- -12 @ .5A, -5 @ .5A
- ONE YEAR WARRANTY

PS-100/130

PS-100 $89.95
- 100 WATTS
- SWITCH ON REAR
- FOR USE IN OTHER IBM TYPE MACHINES
- 90 DAY WARRANTY

PS-A

PS-130 $99.95
- 130 WATTS
- SWITCH ON REAR
- FOR USE IN OTHER IBM TYPE MACHINES
- 90 DAY WARRANTY

PS-3

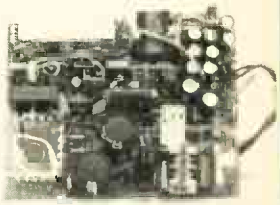
PS-A $49.95
- USE TO POWER APPLE TYPE SYSTEMS
- +5V @ 4A, +12V @ 2.5A -5V @ .5A, -12V @ .5A
- APPLE POWER CONNECTOR

PS-ASTEC

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-TDK

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!

IC MASTER $79.95

THE INDUSTRY STANDARD

A complete listing of currently manufactured ICs from over 225 manufacturers. It includes a part # index, an alternative source guide as well as specification and application notes on thousands of devices.

WISH SOLDERLESS BREADBOARDS

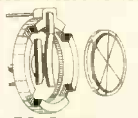
PART NUMBER	DIMENSIONS	DISTRIBUTION STRIP(S)	TIE POINTS	TERMINAL STRIP(S)	TIE POINTS	BINDING POSTS	PRICE
WBU-D	.38 x 6.50"	1	100	---	---	---	2.95
WBU-T	1.38 x 6.50"	---	---	1	630	---	6.95
WBU-204-3	3.94 x 8.45"	1	100	2	1260	2	17.95
WBU-204	5.13 x 8.45"	4	400	2	1260	3	24.95
WBU-206	6.88 x 9.06"	5	500	3	1890	4	29.95
WBU-208	8.25 x 9.45"	7	700	4	2520	4	39.95

RELAYS

VOLTAGE	CONTACTS	FITS	PRICE
5 VDC	SPST REED	DIP	3.95
12 VDC	DPDT 2 AMP	DIP	3.95
6 VDC	6PDT 3 AMP	RELAY SOC	2.95
12 VDC	4PDT 3 AMP	RELAY SOC	3.95
24 VDC	DPDT 3 AMP	RELAY SOC	3.95
48 VDC	4PDT 3 AMP	RELAY SOC	3.95
120 VAC	4PDT 3 AMP	RELAY SOC	3.95

LITHIUM BATTERY

AS USED IN CLOCK CIRCUITS



3 VOLT BATTERY	$3.95
BATTERY HOLDER	$1.49

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

CIRCLE 258 ON FREE INFORMATION CARD

JDR Microdevices

1224 South Bascom Avenue, San Jose, CA 95128
(408) 995-5430 • FAX (408) 275-8415 • Telex 171-110

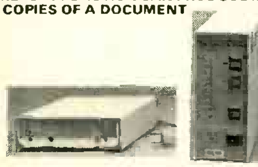
BAL PRINTER BUFFERS

- 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

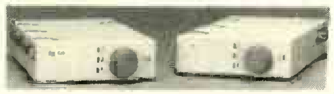
SP110 PARALLEL $249.95
- 64K UPGRADABLE TO 512K
- SPOOLS OUTPUT OF UP TO THREE COMPUTERS
- LED BARGRAPH DISPLAYS AMOUNT OF DATA IN BUFFER
- RESET FUNCTION CLEARS DATA IN BUFFER
- REPEAT FUNCTION CAN PRODUCE MULTIPLE COPIES OF A DOCUMENT



SP120 SP110

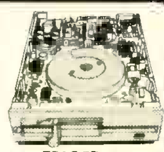
BAL 3-WAY SWITCH BOXES

- 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

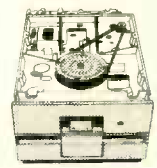
MPI

MPI-B52	5¼" (FOR IBM) DS/DD	$89.95

SIEMENS 8" DISK DRIVES

FD100-8	SS/DD SA801 EQUIV.	$119.00
FD200-8	DS/DD SA851 EQUIV.	$159.00
JFORMAT-2 SOFTWARE		$49.95

SUPPORT FOR QUAD DENSITY DRIVES FROM TALL TREE SYSTEMS



TANDON TM100-2

IBM PRINTER CABLE

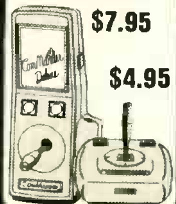
- DB25 TO CENTRONICS
- SHIELDED CABLE

$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-2SV5 CAB-2FH8

NASHUA DISKETTE SPECIALS

5¼" SOFT SECTOR DS/DD WITH HUB RINGS

$9.90 BOX OF 10 — **89¢ea** BULK QTY 50 — **79¢ea** 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

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

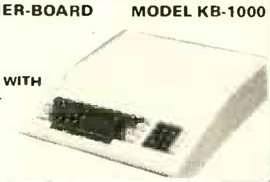
- REPLACEMENT FOR APPLE II KEYBOARD
- CAPS LOCK KEY
- AUTO-REPEAT
- ONE KEY ENTRY OF BASIC OR CPM COMMANDS

$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

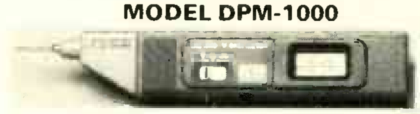
35 MHz DUAL TRACE OSCILLOSCOPE

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

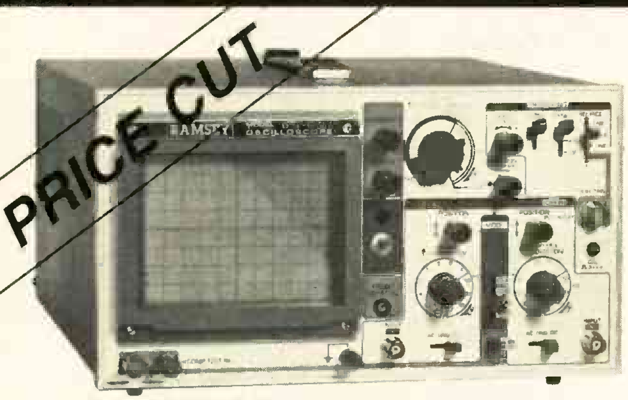
CALL FOR VOLUME QUOTES

CIRCLE 259 ON FREE INFORMATION CARD

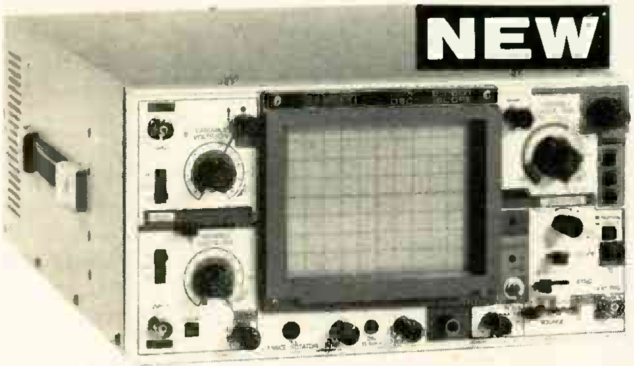
RAMSEY

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

~~$399.95~~* high quality hook on probes included

$369.95

*USA—Add $10.00 per unit for postage, overseas orders add 15% of total order for insured surface mail.

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

~~$799.95~~* high quality hook on probes included

$669.95

*Same as unit to left.

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

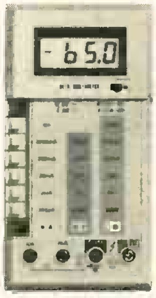
$12.95

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

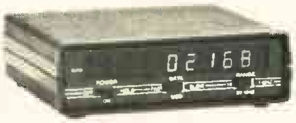
CT-70 kit $99.95
BP-4 nicad pack 8.95

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

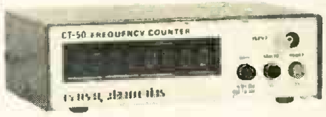


CT-125 9 DIGIT 1.2 GHz COUNTER

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

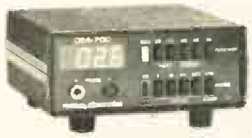


CT-50 8 DIGIT 600 MHz COUNTER

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 ball, 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 70 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

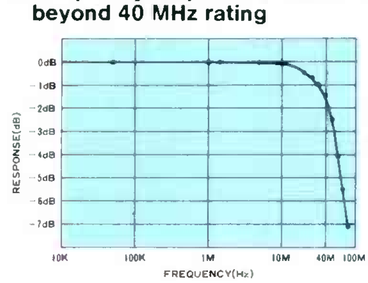
MIDWEST/Texas/Arkansas/Okla.
Ralph Bergen
Radio-Electronics
540 Frontage Road—Suite 325
Northfield, IL 60093
312-446-1444

PACIFIC COAST/ Mountain States
Marvin Green
Radio-Electronics
15335 Morrison St.—Suite 227
Sherman Oaks, CA 91403
818-986-2001

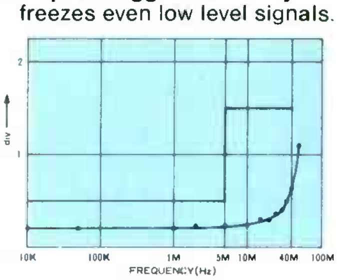
SS-5705, THE ALL-NEW 3-INPUT 6-TRACE 40 MHz OSCILLOSCOPE FROM IWATSU

- **H and V axes accurate to within ±2 %**
- **CRT with 12 kV accelerating voltage for bright traces**
- **Three input channels, six traces:** an enlarged delayed sweep waveform can be displayed for each channel for a total of 6 simultaneous traces. Each channel has its own position control.
- **Maximum delay jitter of 1/20,000**
- **Fastest sweep rate of 10 ns/div**
- **Jitterless circuitry** for stable high frequency signals observation.
- **High sensitivity:** 1 mV/div
- **CH 1 signal output:** 50 mV/div (into 50 Ω)
- **High-stability calibrator** with frequency and voltage accurate to within ±1 %.
- **Stable observation of video signals possible**
- **Traces do not shift when the attenuator is switched**
- **Pushbutton controls** for easier operability and improved reliability.
- **Accuracy guaranteed** in temperatures ranging from 10 to 35°C (50 to 95°F).
- **Variable holdoff** for triggering when observing complicated waveforms.
- **FIX triggering**
- **Beam finder**

- **Frequency response extends beyond 40 MHz rating**



- **Superb trigger sensitivity** freezes even low level signals.



- **Single sweep:** essential if waveforms are to be photographed.
- **Trace rotation control** allows compensation for inclination of traces due to terrestrial magnetism.
- **Two probes provided as standard accessories:** both switchable between 10:1 and 1:1.
- **Wide range of optional extras** for more diverse applications.
- **Compact and lightweight:** 282W x 152H x 403D mm (11-1/8" x 6" x 15-7/8"), 7.2 kg (15.9 lbs).

IWATSU®

IWATSU INSTRUMENTS INC.

430 Commerce Boulevard, Carlstadt, NJ 07072 Phone: (201) 935-5220 TLX: 7109890255

CIRCLE 64 ON FREE INFORMATION CARD

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 59 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