Popular Electronics®

WORLD'S LARGEST SELLING ELECTRONICS MAGAZINE DECEMBER 1981/$1

THE ELECTRONIC WORLD

A User's Guide to Computer Languages

Detect Car-Battery Drain Before It's Too Late

Comparing New High-Tech Audio Cassettes

...ests IBM's
...y Personal Computer

Baked Apple.

Last Thanksgiving, a designer from Lynn/Ohio Corporation took one of the company's Apple Personal Computers home for the holidays.

While he was out eating turkey, it got baked.

His cat, perhaps miffed at being left alone, knocked over a lamp which started

a fire which, among other unpleasantries, melted his TV set all over his computer. He thought his goose was cooked.

But when he took the Apple to Cincinnati Computer Store, *mirabile dictu*, it still worked.

A new case and keyboard made it as good as new.

Nearly 1,000 Apple dealers have complete service centers that can quickly fix just about anything that might go wrong, no matter how bizarre.

So if you're looking for a personal computer that solves problems instead of creating them, look to your authorized Apple dealer.

You'll find everything well-done.

The personal computer. apple®

For the authorized dealer nearest you, call (800) 538-9696. In California, call (800) 662-9238. Or write: Apple Computer Inc., 10260 Bandley Dr., Cupertino, CA 95014.

CIRCLE NO. 4 ON FREE INFORMATION CARD

In a world where sound reaches new levels every day, ADC delivers the ultimate high.

The ultimate high is total control. And an ADC Sound Shaper® Frequency Equalizer lets you control your sound and custom-tailor your music with the mastery of a pro.

And no better way demonstrates the benefits of an ADC Sound Shaper than taping. Even without a studio environment, you can recreate your personal recordings by changing the frequency response curve of the source material—making the sound more like the original and more agreeable to your ears.

Our complete ADC Sound Shaper IC line* has an equalizer that is right for you and your system. The SS-110 ten-band full octave equalizer, a step up from our SS-1, features LED-lit slide controls and one-way tape dubbing. If you desire even more control, our twelve-band SS-II and top-of-the-line SS-III include two-way tape dubbing and sub-sonic filters. Our SS-III Paragraphic™ with 24 ancillary switches that enable you to control 36 bands per channel combines

the ease and control of a graphic equalizer with the precision and versatility of a parametric. All at a price you can afford.

All of our equalizers feature LED-lit slide controls allowing for visual plotting of the equalization curve. And all ADC Sound Shapers embody the outstanding ADC technology that has made us the leaders in the industry.

To really complete your custom-tailored control-ability, our ADC Real Time Spectrum Analyzer is a must. Equipped with its own pink noise generator and calibrated microphone, the SA-1 provides a visual presentation of the changing spectrum through 132 LED displays. So you can actually see proof of the equalized sound you've achieved.

With an ADC Sound Shaper and an ADC Real Time Spectrum Analyzer, you can attain a new level of control. And ultimately, isn't that the musical high you've always wanted?

Sound Shaper®
Frequency Equalizers
and Spectrum Analyzer

ADC
A BSR COMPANY

Sound thinking has moved us even further ahead.

Write for a free 24-page booklet. "Shaping Sound at Home: A Guide to Equalization" (A $2.50 value.)

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CIRCLE NO. 64 ON FREE INFORMATION CARD

DECEMBER 1981 VOLUME 19, NUMBER 12

Popular Electronics

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

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 Popular Electronics (ISSN 0032-4485) December 1981, Volume 19, Number 12. Published monthly by Ziff-Davis Publishing Co., at One Park Ave., New York, NY 10016. Richard P. Friese, President; Selwyn Taubman, Treasurer; Bertram A. Abrams, Secretary. One year subscription rate for U.S. and Possessions, $15.00; Canada, $20.00; all other countries, $23.00 (cash orders only, payable in U.S. currency). Second Class Postage Paid at New York, N.Y. 10016 and at additional mailing offices. Authorized as second class mail by the Post Office Dept., Ottawa, Canada, and for payment of postage in cash. POPULAR ELECTRONICS including ELECTRONICS WORLD, Trade Mark Registered. Indexed in the Reader's Guide to Periodical Literature. Ziff-Davis also publishes Boating, Car and Driver, Cycle, Flying, Popular Photography, Skiing, Stereo Review, Electronic Experimenter's Handbook, and Tape Recording & Buying Guide. **Forms 3579 and all Subscription Correspondence:** POPULAR ELECTRONICS, Circulation Dept. P.O. Box 2774, Boulder, CO 80302. Please allow at least eight weeks for change of address, enclosing, if possible, an address label from a recent issue.

The $149.95 personal computer.

Introducing the Sinclair ZX81

If you're ever going to buy a personal computer, now is the time to do it.

The new Sinclair ZX81 is the most powerful, yet easy-to-use computer ever offered for anywhere near the price: only $149.95* completely assembled.

Don't let the price fool you. The ZX81 has just about everything you could ask for in a personal computer.

A breakthrough in personal computers

The ZX81 is a major advance over the original Sinclair ZX80—the world's largest selling personal computer and the first for under $200.

In fact, the ZX81's new 8K Extended BASIC offers features found only on computers costing two or three times as much.

Just look at what you get:

- Continuous display, including moving graphics
- Multi-dimensional string and numerical arrays

*Plus shipping and handling. Price includes connectors for TV and cassette, AC adaptor, and FREE manual.

- Mathematical and scientific functions accurate to 8 decimal places
- Unique one-touch entry of key words like PRINT, RUN and LIST
- Automatic syntax error detection and easy editing
- Randomize function useful for both games and serious applications
- Built-in interface for ZX Printer
- 1K of memory expandable to 16K

The ZX81 is also very convenient to use. It hooks up to any television set to produce a clear 32-column by 24-line display. And you can use a regular cassette recorder to store and recall programs by name.

If you already own a ZX80

The 8K Extended BASIC chip used in the ZX81 is available as a plug-in replacement for your ZX80 for only $39.95, plus shipping and handling—complete with new keyboard overlay and the ZX81 manual.

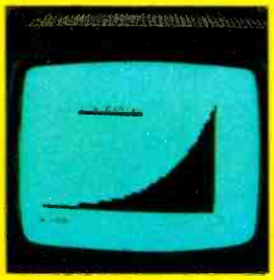
So in just a few minutes, with no special skills or tools required, you can upgrade your ZX80 to have all the powerful features of the ZX81. (You'll have everything except continuous display, but you can still use the PAUSE and SCROLL commands to get moving graphics.)

With the 8K BASIC chip, your ZX80 will also be equipped to use the ZX Printer and Sinclair software.

Warranty and Service Program**

The Sinclair ZX81 is covered by a 10-day money-back guarantee and a limited 90-day warranty that includes free parts and labor through our national service-by-mail facilities.

**Does not apply to ZX81 kits.



NEW SOFTWARE: Sinclair has published pre-recorded programs on cassettes for your ZX81, or ZX80 with 8K BASIC. We're constantly coming out with new programs, so we'll send you our latest software catalog with your computer.

ZX PRINTER: The Sinclair ZX Printer will work with your ZX81, or ZX80 with 8K BASIC. It will be available in the near future and will cost less than $100.

16K MEMORY MODULE: Like any powerful, full fledged computer, the ZX81 is expandable. Sinclair's 16K memory module plugs right onto the back of your ZX81 (or ZX80, with or without 8K BASIC). Cost is $99.95, plus shipping and handling.

ZX81 MANUAL: The ZX81 comes with a comprehensive 164-page programming guide and operating manual designed for both beginners and experienced computer users. A $10.95 value, it's yours free with the ZX81.

The $99^{95} personal computer.

Introducing the ZX81 kit

If you really want to save money, and you enjoy building electronic kits, you can order the ZX81 in kit form for the incredible price of just $99.95.* It's the same, full-featured computer, only you put it together yourself. We'll send complete, easy-to-follow instructions on how you can assemble your ZX81 in just a few hours. All you have to supply is the soldering iron.

How to order

Sinclair Research is the world's largest manufacturer of personal computers.

The ZX81 represents the latest technology in microelectronics, and it picks up right where the ZX80 left off. Thousands are selling every week.

We urge you to place your order for the new ZX81 today. The sooner you order, the sooner you can start enjoying your own computer.

To order, simply call our toll free number, and use your MasterCard or VISA.

To order by mail, please use the coupon. And send your check or money order. We regret that we cannot accept purchase orders or C.O.D.'s.

CALL 800-543-3000. Ask for operator #509. In Ohio call 800-582-1364. In Canada call 513-729-4300. Ask for operator #509. Phones open 24 hours a day, 7 days a week. Have your MasterCard or VISA ready.

These numbers are for orders only. For information, you must write to Sinclair Research Ltd., One Sinclair Plaza, Nashua, NH 03061.

sinclair

AD CODE 12PE

	PRICE†	QTY.	AMOUNT
ZX81	$149.95		
ZX81 Kit	99.95		
8K BASIC chip (for ZX80)	39.95		
16K Memory Module (for ZX81 or ZX80)	99.95		
Shipping and Handling	4.95		$4.95
To ship outside USA add $10.00			
		TOTAL	

MAIL TO: Sinclair Research Ltd., One Sinclair Plaza, Nashua, NH 03061.

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ADDRESS ____________________

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† U.S. Dollars

EDITORIAL

The IRS Cometh

Most readers determine their true income-tax bite on a calendar-year basis, so December 31 likely spells the end of the tax year for you. Therefore, you still have time to avail yourself of tax reductions related to your special interest in electronics for the year 1981.

Obviously, one cannot claim deductions for a purely avocational pursuit. But since so many readers use electronic-related equipment for business purposes, you may well have a legal opportunity to reduce your income tax. This is an advantage you might take even though you are an employee!

I remember a study made of purchasers of the MITS "Altair" computer in early 1975 in which more than 40% of respondents indicated that they purchased the computer for either business or combined business and personal use. Doubtless, this percentage has increased today.

"Business" means an activity for profit, of course. This might even be a requirement by an employer for the end user to do work at home that requires use of a computer. If this can be a proven fact, discuss the activity with your accountant. It could mean that the computer may be depreciated as business equipment. Furthermore, there's an extra depreciation that can be taken during the first year of a purchase, which has two clear advantages: Recouping more of your investment during the year you bought it and, if taken in '81, a more desirable year for tax deductions than 1982. Consider software tax deductions, too, as well as diskettes, printer paper, and so on.

Must you have a professional calculator, such as a Hewlett-Packard HP-41CV, which is not inexpensive, for your job? Well, this could be considered a tool of the trade, much as a plumber's or carpenter's tools. Do you pay dues to a professional organization such as the IEEE? Subscribe to publications to help you keep up with your profession, such as POPULAR ELECTRONICS? Buy texts on electronics? Don't overlook these possible deductions, either.

Additionally, do you earn extra income by servicing electronic equipment, producing computerized mailing lists for local business people, etc.? If you do, then you open up a new world of possible tax deductions, such as your telephone expenses, business entertainment, promotional material, automobile depreciation and expenses, test instruments, hand tools, home utility costs, etc. If the foregoing are also used for personal reasons, then you would have to apportion a percentage of the expenses used for business purposes.

One doesn't even have to make a profit all the time to justify being in "business," so long as there is some profit for two or more years within a five-year period. Thus, you might be able to report some losses within a five-year period, decreasing your tax burden along the way.

A personally rewarding way to earn income as a result of your experience in electronics, of course, is to write articles for POPULAR ELECTRONICS. To get started, simply send a brief summary of your proposed article to my attention. If it's a construction project, include approximate cost to the builder and a legible schematic. There's no better way to prove that you're using your electronic gear (and typewriter, desk, et al.) for profit-making than to have your byline accompanying a published article, as well as a payment stub as proof of income.

Do check all this out with an accountant for the tax implications. There's a fair chance you're giving money to the IRS that rightly belongs to you.

Art Salsberg

Season's Greetings and Happy New Year

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Synthesized Hand-Held Scanner!

Chances are the police, fire and weather emergencies you'll read about in tomorrow's paper are coming through on a scanner right now. All scanners sold by **Communications Electronics** bring the real live excitement of action news into your home or car. With your scanner, you can monitor the exciting two-way radio conversations of police and fire departments, intelligence agencies, mobile telephones, energy/oil exploration crews, drug enforcement agencies and more.

Some scanners can even monitor aircraft transmissions! You can actually hear the news *before* it's news. If you do not own a scanner for yourself, now's the time to buy your new scanner from **Communications Electronics.** Choose the scanner that's right for you, then call our *toll-free* number to place your order with your Master Card or Visa. A scanner is an excellent holiday gift.

We give you excellent service because **CE** distributes more scanners worldwide than *anyone* else. Our warehouse facilities are equipped to process thousands of scanner orders every week. We also export scanners to over 300 countries and military installations. Almost all items are **in stock** for **quick shipment**, so if you're a person who prefers fact to fantasy and who needs to know what's *really* happening around you, order your scanner today from **CE**!

NEW! Bearcat®† 350

The Ultimate Synthesized Scanner!

Allow 30-60 days for delivery after receipt of order due to the high demand for this product.

List price $599.95/**CE price $419.00**

7-Band, 50 Channel • Alpha-Numeric • No-crystal scanner • AM Aircraft and Public Service bands. • Priority Channel • AC/DC

Bands: 30-50, 118-136 AM, 144-174, 421-512 MHz.

The new *Bearcat* 350 introduces an incredible breakthrough in synthesized scanning: Alpha-Numeric Display. Push a button—and the Vacuum Fluorescent Display switches from "numeric" to word descriptions of what's being monitored. 50 channels in 5 banks. Plus, Auto & Manual Search, Search Direction, Limit & Count. Direct Channel Access. Selective Scan Delay. Dual Scan Speeds. Automatic Lockout. Automatic Squelch. Non-Volatile Memory. Reserve your *Bearcat* 350 today!

Bearcat® 300

List price $549.95/**CE price $339.00**

7-Band, 50 Channel • Service Search • No-crystal scanner • AM Aircraft and Public Service bands. • Priority Channel • AC/DC

Bands: 32-50, 118-136 AM, 144-174, 421-512 MHz.

The *Bearcat* 300 is the most advanced automatic scanning radio that has ever been offered to the public. The *Bearcat* 300 uses a bright green fluorescent digital display, so it's ideal for mobile applications. The *Bearcat* 300 now has these added features: Service Search, Display Intensity Control, Hold Search and Resume Search keys, Separate Band keys to permit lock-in/lock-out of any band for more efficient service search.

NEW! Bearcat® 350

Bearcat® 250

List price $429.95/**CE price $269.00**

6-Band, 50 Channel • Crystalless • Searches Stores • Recalls • Digital clock • AC/DC Priority Channel • Delay • Count Feature

Frequency range 32-50, 146-174, 420-512 MHz.

The *Bearcat* 250 performs any scanning function you could possibly want. With push button ease you can program up to 50 channels for automatic monitoring. Push another button and search for new frequencies. There are no crystals to limit what you want to hear. A special search feature of the *Bearcat* 250 actually stores 64 frequencies and recalls them, one at a time. Overseas customers should order the *Bearcat* **250FB** at $379.00 each. This model has 220 V AC/12 V DC power supply and 66-88 MHz low band coverage.

NEW! Bearcat® 20/20

List price $449.95/**CE price $279.00**

7-Band, 40 Channel • Crystalless • Searches AM Aircraft and Public Service bands • AC/DC Priority Channel • Direct Channel Access • Delay

Frequency range 32-50, 118-136 AM, 144-174, 420-512 MHz.

The *Bearcat* 20/20 automatic scanning radio replaces the *Bearcat* 220 and monitors 40 frequencies from 7 bands, including aircraft. A two-position switch, located on the front panel, allows monitoring of 20 channels at a time.

Bearcat® 210XL

List price $349.95/**CE price $219.00**

6-Band, 18 Channel • Crystalless • AC/DC

Frequency range: 32-50, 144-174, 421-512 MHz.

The *Bearcat* 210XL scanning radio is the second generation scanner that replaces the popular *Bearcat* 210 and 211. It has almost twice the scanning capacity of the *Bearcat* 210 with 18 channels plus dual scanning speeds and a bright green fluorescent display. Automatic search finds new frequencies. Features scan delay, single antenna, patented track tuning and more!

Bearcat® 160

List price $299.95/**CE price $184.00**

5-Band, 16 Channel • AC only • Priority Dual Scan Speeds • Direct Channel Access

Frequency range: 32-50, 144-174, 440-512 MHz.

Would you believe...the *Bearcat* 160 is the least expensive *Bearcat* crystalless scanner.

This scanner presents a new dimension in scanning form and function. Look at the smooth keyboard. No buttons to punch. No knobs to turn. Instead, finger-tip pads provide control of *all* scanning operations, including On/Off, Volume and Squelch. Of course the *Bearcat* 160 incorporates other advanced *Bearcat* features such as Priority, Direct Channel Access, Dual Scan Speeds, Lockout, Scan Delay and more.

NEW! Bearcat® 100

The first no-crystal programmable handheld scanner.

Allow 60-120 days for delivery after receipt of order due to the high demand for this product.

List price $449.95/**CE price $299.00**

8-Band, 16 Channel • Liquid Crystal Display Search • Limit • Hold • Lockout • AC/DC

Frequency range: 30-50, 138-174, 406-512 MHz.

The world's first no-crystal handheld scanner has compressed into a 3" x 7" x 1¼" case more scanning power than is found in many base or mobile scanners. The *Bearcat* 100 has a full 16 channels with frequency coverage that includes all public service bands (Low, High, UHF and "T" bands), the 2-Meter and 70 cm. Amateur bands, *plus* Military and Federal Government frequencies. It has chrome-plated keys for functions that are user controlled, such as lockout, manual and automatic scan. Even search is provided, both manual and automatic. Wow...what a scanner!

The *Bearcat* 100 produces audio power output of 300 milliwatts, is track-tuned and has selectivity of better than 50 dB down and sensitivity of 0.6 microvolts on VHF and 1.0 microvolts on UHF. Power consumption is kept extremely low by using a liquid crystal display and exclusive low power integrated circuits.

Included in our low **CE** price is a sturdy carrying case, earphone, battery charger/AC adapter, six AA ni-cad batteries and flexible antenna. For earliest delivery from **CE**, reserve your *Bearcat* 100 today.

Bearcat® 5

List price $134.95/**CE price $94.00**

4-Band, 8 Crystal Channels • Lockout • AC only

Frequency range: 33-50, 146-174, 450-508 MHz.

The *Bearcat* 5 is a value-packed crystal scanner built for the scanning professional — at a price the first-time buyer can afford. Individual lockout switches. Order one crystal certificate for each channel.

Bearcat® Four-Six ThinScan™

List price $189.95/**CE price $124.00**

Frequency range: 33-47, 152-164, 450-508 MHz.

The incredible, *Bearcat* Four-Six Thin Scan™ is like having an information center in your pocket. This four band, 6 channel crystal controlled scanner has patented Track Tuning on UHF. Scan Delay and Channel Lockout. Measures 2¾ x 6¼ x 1." Includes rubber ducky antenna. Order crystal certificate for each channel. Made in Japan.

TEST ANY SCANNER

Test any scanner purchased from **Communications Electronics**™ for 31 days before you decide to keep it. If for any reason you are not completely satisfied, return it in original condition with all parts in 31 days, for a prompt refund (less shipping/handling charges and rebate credits).

Fanon Slimline 6-HLU

List price $169.95/**CE price $109.00**

Low cost 6-channel, 4-band scanner!

The *Fanon* Slimline 6-HLU gives you six channels of crystal controlled excitement. Unique Automatic Peak Tuning Circuit adjusts the receiver front end for maximum sensitivity across the entire UHF band. Individual channel lockout switches. Frequency range 30-50, 146-175 and 450-512 MHz. Size 2¾ x6¼ x 1." Includes rubber ducky antenna. Order crystal certificates for each channel. Made in Japan.

Fanon Slimline 6-HL

List price $149.95/**CE price $99.00**

6-Channel performance at 4-channel cost!

Frequency range: 30-50, 146-175 MHz.

If you *don't* need the UHF band, get this model and save money. Same high performance and features as the model HLU without the UHF band. Order crystal certificates for each channel. Made in Japan.

OTHER SCANNERS & ACCESSORIES

***NEW!* Regency®‡ D810 Scanner**	$319.00
***NEW!* Regency® D300 Scanner**	$219.00
***NEW!* Regency® D100 Scanner**	$169.00
***NEW!* Regency® H604 Scanner**	$129.00
Regency® M400 Scanner	$259.00
Regency® M100 Scanner	$199.00
Regency® R1040 Scanner	$149.00
SCMA-6 Fanon Mobile Adapter/Battery Charger	$49.00
CHB-6 Fanon AC Adapter/Battery Charger	$15.00
CAT-6 Fanon carrying case with belt clip	$15.00
AUC-3 Fanon auto lighter adapter/Battery Charger	$15.00
PSK-6 Base Power Supply/Bracket for SCMA-6	$20.00
SP50 *Bearcat* AC Adapter	$9.00
SP51 *Bearcat* Battery Charger	$9.00
SP58 *Bearcat* 4-6 ThinScan™ carrying case	$12.00
MA506 *Regency* carrying case for H604	$15.00
FB-E Frequency Directory for Eastern U.S.A.	$12.00
FB-W Frequency Directory for Western U.S.A.	$12.00
FFD Federal Frequency Directory for U.S.A.	$12.00
TSG "Top Secret" Registry of U.S. Government Freq.	$10.00
B-4 1.2 V AAA Ni-Cad batteries (set of four)	$9.00
A-135cc Crystal certificate	$3.00

Add $3.00 shipping for all *accessories* ordered at the same time.

INCREASED PERFORMANCE ANTENNAS

If you want the utmost in performance from your scanner, it is essential that you use an external antenna. We have six base and mobile antennas specifically designed for receiving all bands. Order **#A60** is a magnet mount mobile antenna. Order **#A61** is a gutter clip mobile antenna. Order **#A62** is a trunk-lip mobile antenna. Order **#A63** is a ¾ inch hole mount. Order **#A64** is a ⅜ inch snap-in mount, and **#A70** is an all band base station antenna. All antennas are $35.00 and $3.00 for UPS shipping in the continental United States.

BUY WITH CONFIDENCE

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Mail orders to: **Communications Electronics,**™ Box 1002, Ann Arbor, Michigan 48106 U.S.A. Add $7.00 per scanner or phone product for U.P.S. *ground* shipping and handling, or $14.00 for faster U.P.S. *air* shipping to some locations. If you have a Visa or Master Card, you may call anytime and place a credit card order. **Order toll free** in the U.S.A. Dial 800-521-4414. If you are outside the U.S. or in Michigan, dial 313-994-4444. **Dealer inquiries invited.** Order without obligation today!

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CIRCLE NO. 1 ON FREE INFORMATION CARD

NEW PRODUCTS

Additional information on new products covered in this section is available from the manufacturers. Either circle the item's code number on the Free Information Card or write to the manufacturer at the address given.

Front-Operation Betamax

Sony's new Betamax viedeo cassette recorder, the SL-5000, loads from the front, where controls are also located. The SL-5000 has all the usual features associated with Betamax: BetaScan, pause control, freeze frame, and an electronic tuner/timer with a 14-pushbutton channel selector. The unit records in Beta II or Beta III, and plays back in the mode of either Beta I, II, or III. A 24-hour timer can be set to program at the same time of day, as long as there is tape on the feed side of the cassette. A four-digit counter keeps track of the tape contents. $895.

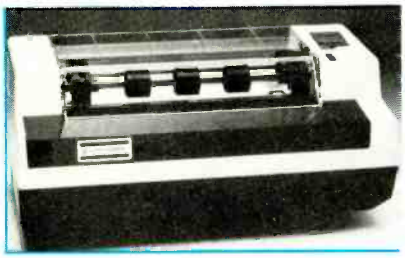
CIRCLE NO. 94 ON FREE INFORMATION CARD

Mitsubishi Receiver

The top-of-the-line DA-R35 has linear switching circuitry, a built-in moving-coil head amp, quartz-synthesized tuning with fluorescent digital display, and seven AM and seven FM presets. The R35 offers 85 watts per channel and features two-speaker relay switching, 12 dB/octave high and low filters, separate record selector with two-tapedeck duplication, mode switch, ten-position loudness compensation, and an input selector with separate MM and MC switches. Specs (amp section): frequency response 20 to 20,000 Hz ±3 dB; THD, 0.005%. The tuner section offers automatic scan, LED signal-strength and multipath indicators, and auto i-f and high-blend circuits with LED indicators and manual defeat. Specs include a THD of 0.10% on wide-band stereo, and a capture ratio of 1.5 dB. $650.

CIRCLE NO. 91 ON FREE INFORMATION CARD

VIC 20 Printer

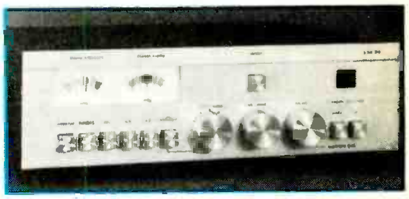


Commodore's Computer Systems Div. has announced availability of a printer for its personal computer, the VIC 20. The printer, designated VIC 1515, can print any of the alphabetic, numeric, and graphic symbols common to the VIC 20. It uses a dot-matrix format and has a speed of 30 cps. Options allow the VIC 1515 to print extra-wide and reversed (negative) characters. $395.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Earth Station Receiver

The ESR24 earth station receiver from R.L. Drake operates over a frequency range of



3.7 to 4.2 GHz and features digital channel display, preset and variable audio subcarrier selector, afc, and full metering. For installation versatility, the down converter module (included) may be mounted internally or at the antenna. Accessories (optional) include a remote control, a remote tuning meter, and splash-proof housing. $1000.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Polyphonic Moog Synthesizer

The Realistic MG-1 Synthesizer (42-2000) by Moog is being introduced at Radio Shack stores. The unit is said to be able to recreate the sounds of musical instruments—from a piccolo to a tuba to an organ—as well as creating special effects such as churning helicopters, raging storms, etc. Its polyphonic quality permits it to play whole chords, rather than simply one note at a time. The MG-1 features a 2½-octave full-chromatic keyboard with three-octave tone sources that produce variable wave shapes (square, triangular, random). Also offered is a detune control for a dissonant or full-interval offsetting of pitch. A modulation section creates vibrato and tremolo, pulsating notes, random tone sequences, and glide effects. The four-control filter alters timbre by controlling cutoff frequency, peak emphasis, and contoured

Household Remote Control

The System X-10 from BSR is designed for use in conjunction with a remote-control setup (also from BSR) for home appliances. If you are away, but able to telephone your home, it is now possible to turn any or all of your appliances on or off as long as they are plugged into the base station. The system is comprised of a calculator-sized telephone transmitter and a base station connected to the owner's telephone. To operate it, the owner dials a three-number security code into the base station before leaving the house. When it receives a call, the base station waits 40 seconds and then answers. The owner places the transmitter to the telephone mouthpiece, enters the code and punches in the desired commands. It works the same way with answering machines; the owner ignores the outgoing message and proceeds as above. The transmitter, designated Model TR274, has to be used with the TR270 telephone responder/controller. As a set they cost $100. A transmitter alone costs $30, and any number of them can be used with the TR270.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Why use their flexible discs:

Athana, BASF, Control Data, Dysan, IBM, Maxell, Nashua, Scotch, Shugart, Syncom, 3M, Verbatim or Wabash

when you could be using

MEMOREX

for as low as $1.94 each?

Find the flexible disc you're now using on our cross reference list... then write down the equivalent Memorex part number you should be ordering.

Product Family	Product Description	Memorex Part Number (3201-)	CE quant. 100 price per disc ($)	Athana	BASF	Dysan	IBM	Maxell	Nashua	Scotch 3M	Shugart	Syncom	Verbatim	Wabash	Control Data
Flexible Disc 1s	IBM Compatible (128 B/S 26 Sectors)	3060	1.99	473071	53426	800506	2305830	FD1-128	FD 1	740 0	S/A 100	15002	FD34-9000	F111111X	421602
Single Headed Drives	IBM Compatible (128 B/S 26 Sectors) w/ W P N	3062	2.04	–	–	–	–	–	–	740-0	–	–	FD34 9000	–	–
Single Density Media	IBM Compatible (128 B/S 26 Sectors) w/ W P N & Hub Ring	3064	2.39	–	–	–	–	–	–	–	–	–	FD34-9000	–	–
	IBM Compatible (128 B/S 26 Sectors) REVERSIBLE	1729	3.19	473072	54431	–	–	–	FD 2	740/2-0	–	15150	FF34-9000	F171111X	–
	IBM System 6 Compatible	3066	2.04	473077	54561	800509	1669959	–	–	740-0 066	–	15003	FD60-9000	F116111X	–
	IBM Compatible (256 B/S 15 Sectors)	3109	1.99	473073	–	800584	2305845	–	–	740-3800	–	15006	FD36-9000	F112111X	–
	IBM Compatible (512 B/S 8 Sectors)	3110	1.99	473074	–	800585	1669954	–	–	–	–	15004	FD60-9000	F113111X	–
	Shugart Compatible 32 Hard Sector	3015	1.99	470901	53802	101/1	–	FH1-32	FD 132	740-32	S/A-101	15025	FD32-9000	–	421322
	Wang Compatible 32 Hard Sector w/Hub Ring	3087	2.49	–	54491	–	–	–	–	740-32RH	–	–	–	F37A411X	–
	CPT 8000 Compatible	3045	2.69	–	–	–	–	–	–	–	–	15226	–	–	–
Flexible Disc 1d	IBM Compatible (128 B/S 26 Sectors)	3090	2.69	474071	54568	3740/1D	–	FD1-128/M2100	FD-1D	741-0	–	–	FD34 8000	F131111X	423002
Single Headed Drives	Soft Sector (128 B/S 26 Sectors) REVERSIBLE	3093	3.69	–	–	–	–	–	–	–	–	–	–	–	–
Double Density Media	Shugart Compatible 32 Hard Sector	3091	2.69	470801	54598	101/1D	–	FH1-32D	–	741-32	S/A-103	15075	FD32-8000	F33A411X	423322
	Wang Compatible 32 Hard Sector w/Hub Ring	3086	3.09	–	–	–	–	–	–	–	–	–	–	–	–
Flexible Disc 2s	Soft Sector (128 B/S 26 Sectors)	3113	3.09	–	54426	800814	1766870	–	–	–	S/A-150	15153	FD10-4026	F121111X	–
Double Headed Drives Single Density Media	Soft Sector (256 B/S 15 Sectors)	3106	3.09	473477	54226	800815	2736700	FD2-256D	–	742-0	–	15154	FD10-4015	F122111X	424612
Flexible Disc 2d	Soft Sector (Unformatted)	3102	3.09	473485	–	DY150	–	FD2-XDM	FD 2D	743-0	–	15103	0034-4001	–	425002
Double Headed Drives	Soft Sector (128 B/S, 26 Sectors)	3115	3.09	–	–	–	–	–	–	–	S/A-150	–	–	–	–
Double-Density Media	Soft Sector (256 B/S, 26 Sectors)	3103	3.09	473471	54325	800817	1766872	FD2-256D	–	743-0/256	–	15101	0034 4026	F144111X	425602
	Soft Sector (512 B/S, 15 Sectors)	3114	3.09	473472	54479	800818	1669044	–	–	743-0/512	–	15100	0034 4015	F145111X	425612
	Soft Sector (1024 B/S 8 Sectors)	3104	3.09	473473	54485	800819	1669045	–	–	743-0/1024	–	15102	0034-4008	F147111X	425622
	32 Hard Sector	3105	3.09	470851	–	101/2D	–	FH2-32D	–	743-32	S/A-151	15125	0032 4000	F34A411X	425322
	Burroughs B-80 Compatible 32 Hard Sector	3092	3.09	–	–	–	–	–	–	–	–	–	–	F34A811X	–
	Soft Sector (1024 B/S, 8 Sectors) w/ Hub Ring	3116	3.49	–	–	–	–	–	–	–	–	–	–	–	–
	Shugart Compatible 32 Hard Sector	3161	3.39	–	–	–	–	–	–	–	–	–	0032-4000	–	–
Flexible Disc FD Memorex 651 or Equiv Drive Compatible	FD VI (Vinyl Jacket)	30712003	2.69	470851	–	FDIV	–	–	FD-186	811-0	–	15026	FD65-1000	F61A111X	–
Mini Flexible Disc 1s	Soft Sector (Unformatted)	3401	1.94	475001	54256	104/1	–	MD1	MD 1	744-0	S/A-104	15300	MD525-01	M11A211X	441002
5¼" Single-Headed Drives	10 Hard Sector	3403	1.94	475010	54257	107/1	–	–	MD 110	744 10	S/A-107	15325	MD525-10	M41A211X	441102
Single Density Media	16 Hard Sector	3405	1.94	475016	54258	105/1	–	MH1	MD 116	744.16	S/A-106	15326	MD525-16	M51A211X	441162
	Soft Sector (Unformatted) w/Hub Ring	3431	2.14	–	–	–	–	–	–	–	–	–	MD525-01	–	–
	10 Hard Sector, w/Hub Ring	3433	2.14	–	–	–	–	–	–	–	–	–	MD525-10	–	–
	16 Hard Sector w/Hub Ring	3435	2.14	–	–	–	–	–	–	–	–	–	MD525-16	–	–
Mini Flexible Disc 1d	Soft Sector (Unformatted)	3417	2.14	–	54646	104/1D	–	–	–	–	–	–	MD525-01	–	–
5¼" Single Headed Drives	10 Hard Sector	3418	2.14	–	54649	107/1D	–	–	–	–	–	–	MD525-10	–	–
Double Density Media	16 Hard Sector	3419	2.14	–	54652	105/1D	–	–	–	–	–	–	MD525-16	–	–
	Soft Sector (Unformatted) w/Hub Ring	3481	2.34	–	–	–	–	–	–	–	–	–	MD525-01	–	–
	10 Hard Sector w/Hub Ring	3483	2.34	–	–	–	–	–	–	–	–	–	MD525-10	–	–
	16 Hard Sector w/Hub Ring	3485	2.34	–	–	–	–	–	–	–	–	–	MD525-16	–	–
Mini Flexible Disc 2d	Soft Sector (Unformatted)	3421	2.59	–	54624	104/2D	–	–	–	–	S/A-154	–	MD550-01	–	–
5¼" Double Headed Drives	10 Hard Sector	3423	2.59	–	54627	107/2D	–	–	–	–	S/A-157	–	MD550-10	–	–
Double Density Media	16 Hard Sector	3425	2.59	–	54630	105/2D	–	–	–	–	S/A-155	–	MD550-16	–	–
	Soft Sector (Unformatted) w/Hub Ring	3491	2.79	–	–	–	–	–	–	–	–	–	MD550-01	–	–
	10 Hard Sector w/Hub Ring	3493	2.79	–	–	–	–	–	–	–	–	–	MD550-10	–	–
	16 Hard Sector w/Hub Ring	3495	2.79	–	–	–	–	–	–	–	–	–	MD550-16	–	–

Memorex Flexible Discs...The Ultimate in Memory Excellence

Quality
Memorex means quality products that you can depend on. Quality control at Memorex means starting with the best materials available. Continual surveillance throughout the entire manufacturing process. The benefit of Memorex's years of experience in magnetic media production, resulting, for instance, in proprietary coating formulations. The most sophisticated testing procedures you'll find anywhere in the business.

100 Percent Error Free
Each and every Memorex Flexible Disc is certified to be 100 percent error free. Each track of each flexible disc is tested, individually, to Memorex's stringent standards of excellence. They test signal amplitude, resolution, low-pass modulation, overwrite, missing pulse error and extra pulse error. They are torque-tested, and competitively tested on drives available from almost every major drive manufacturer in the industry including drives that Memorex manufacturers. Rigid quality audits are built into every step of the manufacturing process and stringent testing result in a standard of excellence that assures you, our customer, of a quality product designed for increased data reliability and consistent top performance.

Customer-Oriented Packaging
Memorex's commitment to excellence does not stop with a quality product. They are proud of their flexible discs and they package them with pride. Both their packaging and their labeling have been designed with your ease of identification and use in mind. The desk-top box containing ten discs is convenient for filing and storage. Both box labels and jacket labels provide full information on compatibility, density, sectoring, and record length. Envelopes with multi-language care and handling instructions and color-coded removable labels are included. A write-protect feature is available to provide data security.

Full One Year Warranty — Your Assurance of Quality
Memorex Flexible Discs will be replaced by Memorex if they are found to be defective in materials or workmanship within one year of the date of purchase. Other than replacement, Memorex will not be responsible for any damages or losses (including consequential damages) caused by the use of Memorex Flexible Discs.

Quantity Discounts Available
Memorex Flexible Discs are packed 10 discs to a carton and 10 cartons to a case. Please order only in increments of 100 units for quantity 100 pricing. We are also willing to accommodate your smaller orders. Quantities less than 100 units are available in increments of 10 units at a 10% surcharge. **Quantity discounts** are also available. Order 500 or more discs at the same time and deduct 1%; 1,000 or more saves you 2%; 2,000 or more saves you 3%; 5,000 or more saves you 4%; 10,000 or more saves you 5%; 25,000 or more saves you 6%; 50,000 or more saves you 7% and 100,000 or more discs earns you an 8% discount off our super low quantity 100 price. Almost all Memorex Flexible Discs are immediately available from CE. Our warehouse facilities are equipped to help us get you the quality product you need, when you need it. If you need further assistance to find the flexible disc that's right for you, call the Memorex compatibility hotline. Dial 800-538-8080 and ask for the *flexible disc hotline* extension 0997. In California dial 800-672-3525 extension 0997.

Buy with Confidence
To get the fastest delivery from CE of your Memorex Flexible Discs, send or phone your order directly to our Computer Products Division. Be sure to calculate your price using the CE prices in this ad. Michigan residents please add 4% sales tax. 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 are final. Prices, terms and specifications are subject to change without notice. Out of stock items will be placed on backorder automatically unless **CE** is instructed differently. Minimum order $50.00. International orders are invited with a $20.00 surcharge for special handling in addition to shipping charges. All shipments are F.O.B. Ann Arbor, Michigan. No COD's please. Non-certified and foreign checks require bank clearance.

Mail orders to: **Communications Electronics**, Box 1002, Ann Arbor, Michigan 48106 U.S.A. Add $8.00 per case or partial-case of 100 8-inch discs or $6.00 per case of 100 5¼-inch mini-discs for U.P.S. *ground* shipping and handling in the continental U.S.A. If you have a Master Card or Visa card, you may call anytime and place a credit card order. **Order toll-free** in the United States. Call anytime 800-521-4414. If you are outside the U.S. or in Michigan, dial 313-994-4444. **Dealer inquiries invited**. All order lines at **Communications Electronics** are staffed 24 hours.

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(800) 521-4414
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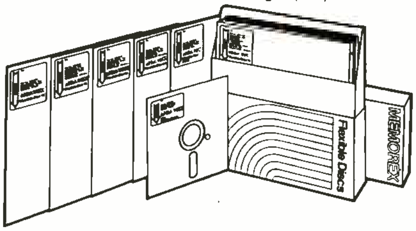

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CIRCLE NO. 2 ON FREE INFORMATION CARD

cutoff. The contour section adjusts tonal rise and fall times; and a sustain feature can be switched in and out. Volume control is available at both headphone and phono-type output jacks that permit direct connection to most sound systems. Dimensions are 20½"L × 12"W × 5"D. $500.

CIRCLE NO. 96 ON FREE INFORMATION CARD

Logic-Control/Metal-Cassette Deck

The Luxman Div. of Alpine Electronics of America introduces its K-117 two-headed cassette deck that offers full-logic solenoid controls, metal-tape capability, and Dolby B noise reduction. A front-panel bias control switch permits a user to alter frequency response of any tape to ±15% of the normal bias point. A fluorescent peak-level indicator adds 3-dB calibration for metal tape, up to ±8 dB. Other features include an MPX filter, and independent left and right input level controls. Specs: 0.04% wow and flutter, 70 dB S/N (Dolby metal), 20 Hz to 20 kHz response (metal), and 0.7% THD (LH tape) at the 1-kHz/0-dB level. Dimensions are 18"W × 5"H × 10½"D. $400.

CIRCLE NO. 97 ON FREE INFORMATION CARD

Video Control Center

The Model VCC-1 Video Control Center from Amco Electronics is a passive 4-input/3-output rf switcher for use with home video systems. Any four sources such as antenna (vhf and uhf), cable, VCR, disk, computer, video games, etc. can be selected independently for viewing on two TVs; and any three can be selected for VCR recording. Internal shielding maintains isolation of at least 60 dB between ports (channels 2-13). Weight is two lb. Dimensions are 8"W × 2½"H × 5½"D. $100.

CIRCLE NO. 98 ON FREE INFORMATION CARD

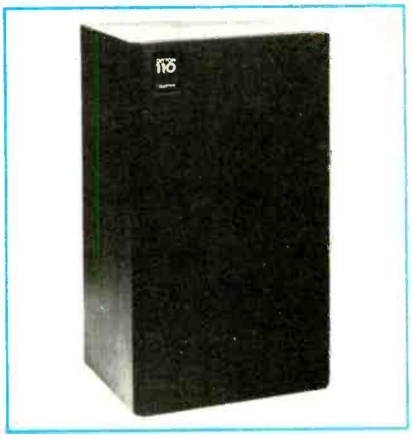
Portable Digital Lab

B&K-Precision has introduced a lab-logic analyzer, the LA-1000. Designed for use by field engineers in the maintenance of microcomputers, it features a 20-MHz single-channel logic analyzer (TTL, CMOS) that

can present data in both time and state domains. State data are formatted in hexadecimal on the four-digit LED display. Timing diagrams can be displayed on most conventional oscilloscopes. The memory permits storage of 16 "words," at 16 bits per "word," providing a total memory capacity of 256 bits. The signature analyzer is formatted in hexadecimal and offers continuous and hold modes. It is compatible with TTL, MOS, or CMOS, and has self-test capability. Autoranging circuitry eliminates the need for a separate DVOM; ac and dc voltage and resistance are displayed on a 3½-digit LED. After a user selects a function and interfaces to a circuit being tested, a built-in microprocessor automatically selects the range providing maximum resolution. Accuracy is claimed to 0.1% dc, 0.5% ac; and to within 0.3% for resistance. The frequency counter also provides autoranging measurements from 1 Hz to 25 MHz. Resolution is given as 1 Hz. The unit weighs 14 lb. $1,745.

CIRCLE NO. 99 ON FREE INFORMATION CARD

Laser-Designed Speakers



Celestion Industries claims to have corrected the minor distortions that affect vibration modes of loudspeaker surfaces by using laser interferometry. The Ditton 110 speaker is an acoustic suspension system with an 8" PVC-surround cone woofer and a 1" dome tweeter, aligned vertically. Specifications: frequency response, 72-20,000 Hz; crossover frequency, 2.3 kHz; impedance, 5 ohms; amplifier requirements, 10 to 50 W/ch; dimensions, 16¾"H x 9½"W x 8¾"D. $350 a pair.

CIRCLE NO. 100 ON FREE INFORMATION CARD

Listen to your planet on a short-wave receiver!

Communications Electronics, the world's largest distributor of radio scanners, is pleased to introduce Panasonic Command Series shortwave receivers. Panasonic lets you listen to what the world has to say. Unlike a scanner, a Command Series radio lets you listen to shortwave broadcasts from countries around the world, as well as the U.S.A. It's the space age shortwave performance you've been waiting for...at a down to earth price you can afford.

All Panasonic shortwave receivers sold by **Communications Electronics** bring the real live excitement of international radio to your home or office. With your Command Series receiver, you can monitor exciting radio transmissions such as the BBC, Radio Moscow, Ham Radio and our own Armed Forces Radio Network. Thousands of broadcasts in hundreds of different languages are beamed into North America every day. You can actually hear the news *before* it's news. If you do not own a shortwave receiver for yourself, now's the time to buy your new receiver from **CE**. Choose the receiver that's right for you, then call our *toll-free* number to place your order with your credit card

We give you excellent service because **CE** distributes more scanners and shortwave receivers worldwide than *anyone* else. Our warehouse facilities are equipped to process thousands of orders every week. We also export receivers to over 300 countries and military installations. Almost all items are **in stock** for **quick shipment**, so if you're a person who needs to know what's *really* happening around you, order today from **CE**.

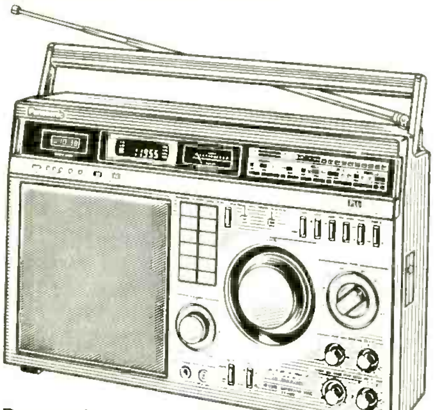
Panasonic® † RF-6300

Allow 30-120 days for delivery after receipt of order due to the high demand for this product.

List price $749.95/**CE price $499.00**

Bands: LW 150-410 KHz., MW 520-1610 KHz., SW1-5 1.6-30 MHz., FM 87.5-108 MHz.

The new Panasonic RF-6300 Command Series PLL synthesized 8-band portable communications receiver, lets you hear the world. The RF-6300 has features such as microcomputer pre-set tuning and PLL quartz synthesized digital tuner. Microcomputer stores up to 12 different frequencies for push-button recall. FM/MW/LW/SW1-5 reception. Manual tuning knob. Wide/Narrow bandwidth selector. Double superheterodyne system. Fast/Slow manual tuning. Built-in quartz digital alarm clock. 5 inch dynamic PM speaker. 3 antennas. Multi-voltage. Detachable AC cord. Operates on 6 "D" batteries (not included). Made in Japan.



Panasonic RF-6300

RF-4900

Panasonic® RF-4900

List price $549.95/**CE price $389.00**

Bands: MW 525-1610 KHz., SW1-8 1.6-30 MHz. FM 88-108 MHz.

The Panasonic RF-4900 shortwave receiver features a 5-digit fluorescent display for all 8 SW bands, as well as for AM/FM. AC or battery operation. Full coverage from 1.6 to 30 MHz on SW. Covers SSB and CW. Premix Double Superheterodyne. Fast/slow 2 speed tuning. AFC Switch on FM, narrow/wide selectivity switch for AM and SW. Antenna trimmer. Calibration control. FET RF circuit. Mode switch for AM-CW/SSB. BFO Pitch control. ANL switch for AM. RF gain control. Tuning-Battery meter with meter function switch. Separate bass and treble tone control. Dial light switch. Digital display on/off switch. Separate power switch. Rack type handle. Made in Japan.

Panasonic® RF-3100

Allow 30-120 days for delivery after receipt of order due to the high demand for this product.

List price $369.95/**CE price $269.00**

Bands: MW 525-1610 KHz., SW1-29 1.6-30 MHz. FM 88-108 MHz.

The Panasonic RF-3100 portable 31-Band portable radio has PLL Quartz-Synthesizer tuning that "locks" onto SW stations. Operates on AC or battery. SW frequencies from 1.6 to 30 MHz. are in 29 bands. All-band 5-digit frequency readout. Horizontal design with front mounted controls for shoulder strap operation. Double superheterodyne for clean SW reception. BFO pitch and RF gain controls. Separate bass and treble controls. Wide/Narrow bandwidth selector. Meter for tuning and battery strength. LED operation indicator. Meter light switch. 3½" PM dynamic speaker. Comes with detachable shoulder belt. Battery power (8 "D" batteries not included). Made in Japan.

Panasonic® RF-2900

List price $349.95/**CE price $249.00**

Bands: MW 525-1610 KHz., SW1-3 3.2-30 MHz. FM 88-108 MHz.

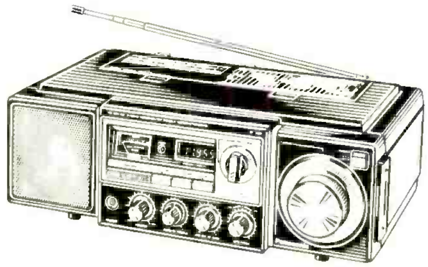
The Panasonic RF-2900 is a portable five-band shortwave radio with digital five digit fluorescent frequency display. Full coverage from 3.2 to 30 MHz. on SW. Covers SSB and CW. Double superheterodyne receiver. Fast/slow two speed tuning. AFC switch on FM, narrow/wide selectivity switch for AM and SW. FET RF circuit. BFO switch and pitch control. RF gain control. Tuning battery meter. Separate bass/treble tone control. SW calibration control. Dial light switch. Digital display on/off switch. Separate power switch. Detachable dial hood included. Rack type handle. Includes whip antenna and ferrite core antenna, speaker, earphone, recording output jacks, AC line and detachable adjustable shoulder belt. Made in Japan.

Command Series RF-2900

CIRCLE NO. 3 ON FREE INFORMATION CARD

Panasonic

Command series



Panasonic RF-3100

TEST ANY RECEIVER

Test any receiver purchased from **Communications Electronics** for 31 days before you decide to keep it. If for any reason you are not completely satisfied, return it in original condition with all parts in 31 days, for a prompt refund (less shipping and handling charges).

NATIONAL WARRANTY SERVICE

All Panasonic receivers listed in this ad are backed by a two-year limited warranty on parts and labor. In addition, this warranty is backed by a broad network of Panasonic service centers. For two years after original purchase, Panasonic will repair or replace your receiver if purchased and retained in the U.S.A. Customer must take it to an authorized service center. Warranty does not cover damage from abuse, misuse, or commercial use. Proof of purchase is needed for in-warranty service.

BUY WITH CONFIDENCE

To ***get the fastest delivery from CE*** of any receiver send or phone your order directly to our Consumer Products Division. Be sure to calculate your price using the CE prices in this ad. Michigan residents please add 4% sales tax. 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. Prices, terms and specifications are subject to change without notice. Out of stock items will be placed on backorder automatically unless **CE** is instructed differently. International orders are invited with a $20.00 surcharge for special handling *in addition* to shipping charges. All shipments are F.O.B. Ann Arbor, Michigan. No COD's please. Non-certified and foreign checks require bank clearance.

Mail orders to: **Communications Electronics**,™ Box 1002, Ann Arbor, Michigan 48106 U.S.A. Add $12.00 per receiver for U.P.S. ground shipping and handling. If you have a Master Card or Visa, you may call anytime and place a credit card order. **Order toll free** in the U.S.A. Dial 800-521-4414. Outside the U.S. or in Michigan, dial 313-994-4444. **Dealer inquiries invited**. Order your Panasonic Command Series receiver today at no obligation.

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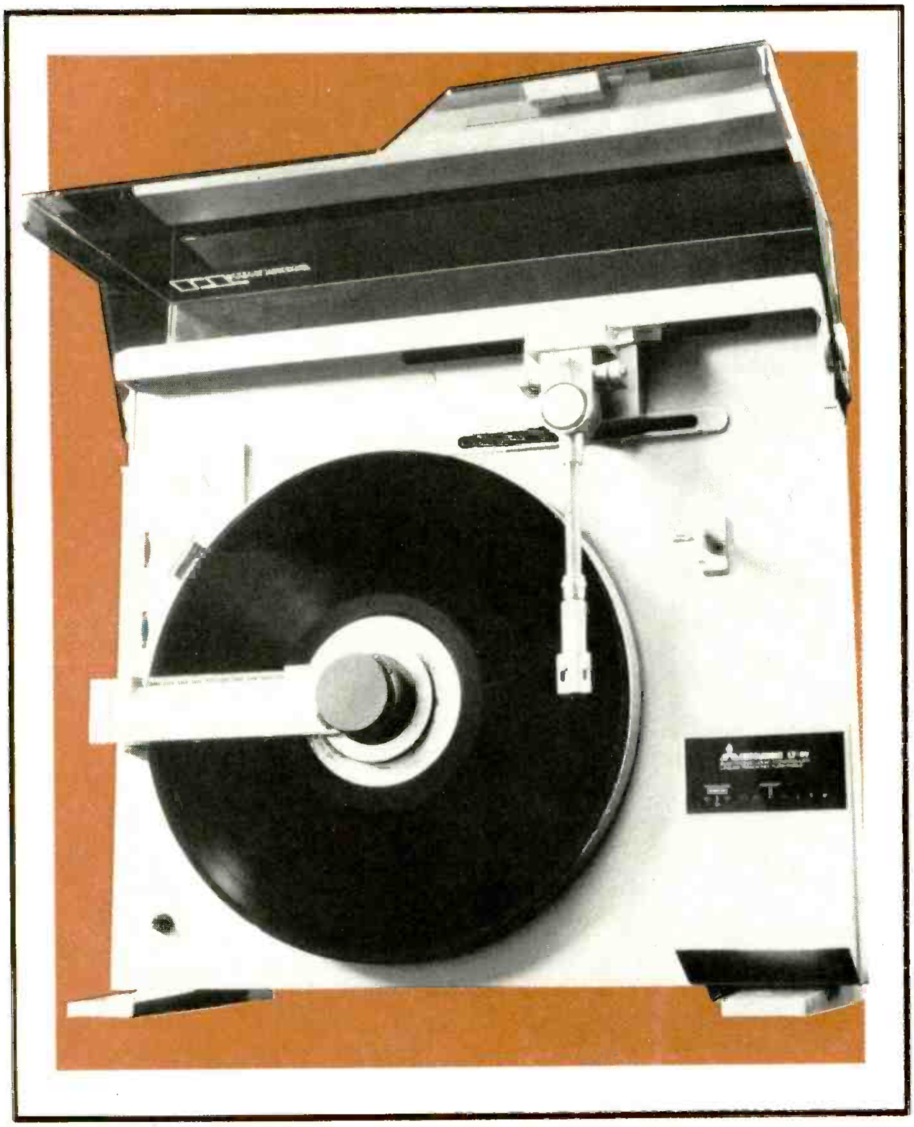
We're first with the best.℠

Audio Product of the Month

CHOSEN BY THE EDITORS OF POPULAR ELECTRONICS

Mitsubishi LT-5V Record Player



THE Mitsubishi LT-5V record player offers a novel mechanical format. Vertically positioned, its linear-tracking servo-driven tonearm is suspended from its pivots with the cartridge hanging down. The heavy cast turntable is belt-driven by a dc servo motor and controlled by an LSI logic system through light-touch pushbuttons. Because of its vertical alignment, the platter is rigidly fastened to the drive shaft and the record is clamped to the rubber mat by a swing-away arm that locks to the center spindle when the record player is operating.

The depth of the LT-5V is very small (only 8″) so it can be installed on ordinary bookshelves. However, since its height is 17″, a large vertical clearance is needed. Each of the four rubber feet is separately adjustable for leveling. Turntable width is 18½″, and it weighs 27½ pounds. $450.

General Description. Other than its unusual orientation, the drive system of the Mitsubishi LT-5V is conventional. The servo-controlled dc motor drives a heavy inner flywheel through a belt. The external platter and rubber mat (which together weigh about 4 pounds) mount on an extension of the drive shaft. The center spindle screws into the end of the drive shaft to hold the platter in place.

An illuminated stroboscope pattern on the internal flywheel is visible through a window on the vertical "motorboard." It is marked for 33⅓ and 45 rpm at 50 or 60 Hz. Near the viewing window is a clear plastic prism that causes a light beam to shine across the mat. The mat and platter are perforated at four places

Pocket Concert Hall

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The Cybernet was built to sell for $200 and wholesale for $119. It has a very sophisticated dual flywheel tape drive system and superb electronics. The best way to test a portable is to play music and shake it. If the music wows badly, or even stops, you have a cheap unit.

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First there was silence. Then from nowhere, there explodes an awesome kaleidoscope of sound. Violins from the left, trumpets from the right, while the sounds of a vocalist seem to come from somewhere above.

You've just experienced a breathtaking experience in sound. It's better than sitting in the middle of a full symphony orchestra.

As you take off the almost weightless 1½ ounce headphones and tentatively look around for the orchestra, the realization of the experience sinks in.

Now you can enjoy more beautiful sound from your cassettes while you are jogging or washing the car than when you are sitting in front of your stereo.

SOMERSAULTS AND CARTWHEELS

If you were on a diet yesterday, you probably lost more weight than the trifling 16 oz. of the Pocket Concert Hall.

The Concert Hall goes where you go with a protective leatherette case that easily hangs on your belt or rides comfortably in your pocket. It also comes with an adjustable shoulder strap.

Whether you're into gymnastics, long walks, or just mowing the lawn, you'll enjoy the unbelievably rich stereo sound of the Pocket Concert Hall. And, to prove our point, we offer you a 30 day risk free trial.

ENGINEERED FOR STRESS

Most fine stereo equipment is designed to be lovingly placed on a shelf and never moved. Obviously, this isn't a practical way to listen when you're walking your dog or riding a bike.

The Pocket Concert Hall incorporates a special dual flywheel tape movement system with a unique anti-rolling mechanism resembling a fine clock. It keeps the music smooth and stable, even when you're doing cartwheels.

The Pocket Concert Hall is specifically designed for rough treatment. Other machines are really redesigned dictation recorders. The Pocket Concert Hall is designed to provide superb stereo music while you're on the move.

You can expect years of enjoyment from this finely crafted revolutionary new sound machine.

MUSIC AT YOUR COMMAND

You won't be 'roughing it' when you leave home. You can play all your cassettes since there is an equalization switch for Metal/Chrome or standard.

The sound is crisp and clean with a frequency response of 30–14,000hz. The entire system is operated by 4 AA batteries (included).

There are convenient lock-in fast forward and rewind buttons, plus cue and review. If you want to listen to a song again, just press the review button without ever leaving play.

You can listen to the outside world by pushing the talk switch without taking off the feather-light stereophones. Dual volume controls, auto-stop and a battery condition/operation indicator light round out a full compliment of convenience features to enhance your musical enjoyment.

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Cybernet is an extremely large Japanese Company with a large presence here in the U.S. They manufacture component systems valued in the thousands of dollars and sophisticated wireless trasmission systems.

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CIRCLE NO. 58 ON FREE INFORMATION CARD

on each of four radii, allowing the light to pass through to photo sensors located below the motor board. This prevents operation of the unit without a record in place and protects the stylus from contact with the mat. The arm merely travels to the center of the platter with the cartridge raised, and returns to rest, shutting off the motor. If a 12-inch disc is on the turntable, the arm descends at the lead-in groove (since all the light "windows" are blocked by the record). A 7-inch record will block only the innermost holes, switching the turntable speed to 45 rpm and indexing the arm to a 7-inch diameter.

Special combinations of size and speed (such as 12-inch 45 rpm, 7-inch 33⅓ rpm, or any 10-inch discs) must be played manually, using procedures described in the instruction manual. This also applies to translucent or colored records, or records of nonstandard size.

The tonearm is driven on a track rod by a small servo motor operating through a worm gear and a fine stainless-steel wire. The arm is free to pivot slightly (parallel to the record surface) and optical sensors on the arm carriage detect any deviation from the vertical position—in which the pickup is tangent to the record groove. The arm servo motor drives the carriage to reduce the tracking error toward zero. The servo operates both toward and away from the center of the record, and can accommodate slightly eccentric records, as well.

The arm itself is a short, straight tube equipped with a universal four-pin bayonet-mount headshell (cartridges with integral plugs can also be used). The cartridge is installed in its shell with the aid of a plastic gauge to set its longitudinal position and its distance from the shell mounting surface. First the arm is balanced with the cartridge hanging down vertically by turning a weight threaded into the structure at the rear of the arm. After balancing, the tracking force scale on the weight is set to zero, and the entire weight is then turned to provide the desired tracking for the stylus. The scale is calibrated from 0 to 2.5 grams at 0.1-gram intervals.

One advantage of the vertical record player is that the cartridge does not have to be counterbalanced, since its mass acts along the axis of the arm tube and pivot. Therefore, cartridges can be interchanged merely by plugging them in, with no need for re-balancing.

The tonearm has a relatively low mass, being just long enough to locate the stylus on a record radius, with no unnecessary overhang or bends to add mass to the arm. This provides very good tracking on warped records. The absence of an antiskating bias gives added stability in the presence of vibration or jarring.

The vertical format of the LT-5V also serves to isolate the unit from base-conducted vibration. Vertical motion has virtually no effect on the cartridge output, since it acts along the axis of the rigid arm tube. Horizontal motion can have the same effect as on any other record player.

OPERATING FEATURES

Controls (Flat pushbuttons)

START: Initiates operating cycle and slews arm inward when held in.

STOP: Initiates end of operation and slews arm outward when held in.

SPEED: Changes speed between 33⅓ and 45 rpm on alternate operations (turntable always starts at 33⅓ rpm)

REPEAT: Causes record to be repeated indefinitely (second touch cancels).

LIFT/CUE: Raises and lowers pickup on alternate operations.

Speed Vernier Wheels: Marked "33" and "45"; produce ±3% shift in the nominal speeds.

Indicator Lights: On panel above operating buttons. Arrows show up or down arm position, direction of slew inward or outward. Dot shows status of REPEAT function. Arm deviation from tangency is shown by arrows flanking TRACKING ERROR line.

Disc Clamper: Swinging arm that locks to center spindle and clamps disc to turntable. Carries index scale for arm cueing. Matching scale above arm carriage.

Arm Lock/Power Switch: Shuts off power when arm is clamped to post. Turntable is switched on by releasing arm lock.

Tracking Force: Dial on adjustable weight mounted on arm pivot housing, used to balance arm vertically before setting tracking force.

Cover: A top-hinged clear plastic cover, that covers the arm and about half the turntable when lowered.

The record clamp is claimed to act as a stabilizer, exerting a damping action on the disc by pressing its center to the turntable platter. Mitsubishi has also used the clamp bar to help solve a problem peculiar to the vertical format—how to cue the pickup to a specific diameter of a record. Under normal circumstances the stylus cannot be seen, calling for some guesswork if cueing is to be done by eye. However, the clamp bar carries a scale, extending across the recorded surface of a record, and calibrated linearly from 0 to 10 with spacings of 0.5 units. By sighting across the top of the scale to the disc, one can estimate the numerical reading corresponding to any band or section of the record.

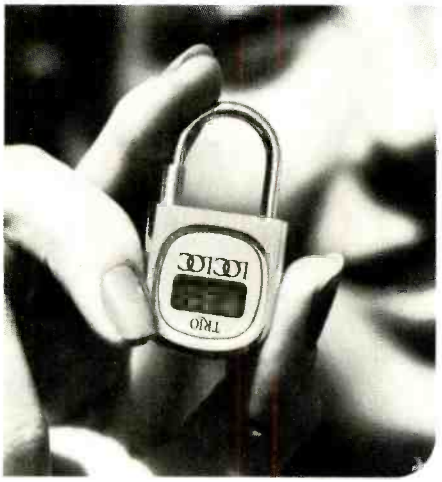
Along the upper part of the record player, next to the rear (top) of the tonearm, is an identical scale. When read against a line marked on the rear of the arm carriage, this scale shows the position of the cartridge along the playing radius. Although the two scales are on opposite sides of the disc, their readings are mirror images and therefore equivalent. By transferring the reading from the clamp scale to the fixed scale, the pickup can be lowered to the record with reasonable assurance of contacting the selected passage.

The operating controls of the Mitsubishi LT-5V are flat pushbuttons that require little pressure and almost no movement. When the unit is activated by unlocking the arm clamp (thereby lighting a "power-on" indicator), a touch on START turns on the motor and causes the arm to scan in to the lead-in groove and descend to playing height. At the end of the record, it lifts, returns to the rest, and shuts off the motor. This can also be done at any time by touching STOP. These buttons serve as slewing controls, since holding in either START or STOP causes the arm to move continuously inward or outward, stopping when the button is released. A touch on LIFT/CUE is required to lower the pickup to the record after it has been slewed.

Small green arrows above the control panel show the operating mode of the record player. The "up" and "down" arrows show the status of the LIFT/CUE control, and "left" and "right" arrows next to them show the slew direction of the arm. A green dot lights when REPEAT is engaged. Finally, the TRACKING ERROR "0" bar lights up when the arm is tangent to the groove (its normal condition). Arrows on either side are lit when the tracking error exceeds the rated maximum of 0.1 degree. This can happen when the pickup enters the eccentric groove at the end of a record, or while the arm is being slewed.

Laboratory Measurements. We installed several different cartridges and found the process straightforward and rapid. The measurements were made using an ADC Integra XLM III, which has an integral plug-in "shell".

Because of the unusual orientation of the record player, it was not possible to measure the actual tracking force or the effective arm mass. However, all the cartridges performed properly when the tracking force dial was set properly, and we have no reason to doubt its accuracy.



LocLoc T.M.

Turn those plain looking belt loops into the latest jewelry fad with America's newest way to tell time.

It's already a fad in Australia. And the minute you unlock its secret, you'll understand why.

The product is a digital watch in a lock called the LocLoc. The LocLoc hangs from your belt loop and the digital display is upside down to everybody but you.

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The LocLoc is a full 5-function digital watch with night light–all housed in a solid brass case. The case is water resistant and comes in three textures: gold-tone, silver-tone, and anodized black.

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Want more? The LocLoc comes in a see through vault-like container that fits into a denim drawstring tote bag. In fact, it's packaged as a perfect gift for both men and women–and for any age group.

Try one at no risk. Send your check for **$29.95** for the silver-tone version or **$39.95** for the anodized black or gold-tone version, plus $3.00 postage and handling. (Illinois residents add 6% sales tax.) Credit card buyers may use our toll-free number below.

We'll send you your LocLoc digital watch and clear vault-like container all packaged in its handy gift denim drawstring tote bag. After you receive it, attach it to your belt loop. Feel the freedom of not wearing a watch on your wrist. See how easy it is to glance down at the time and notice what a great accessory and piece of jewelry it makes. If you're not absolutely convinced that LocLoc is perfect for you, return it for a full refund, including your $3.00 postage and handling charge. But if you really like it, order more for gifts or for your friends.

Each LocLoc has a one-year limited warranty. Your LocLoc was designed to take plenty of abuse. In fact, the case is actually housed in a solid brass lock. But if service is ever required, our service-by-mail center is as close as your mailbox. JS&A is America's premiere electronics company and a company built upon service.

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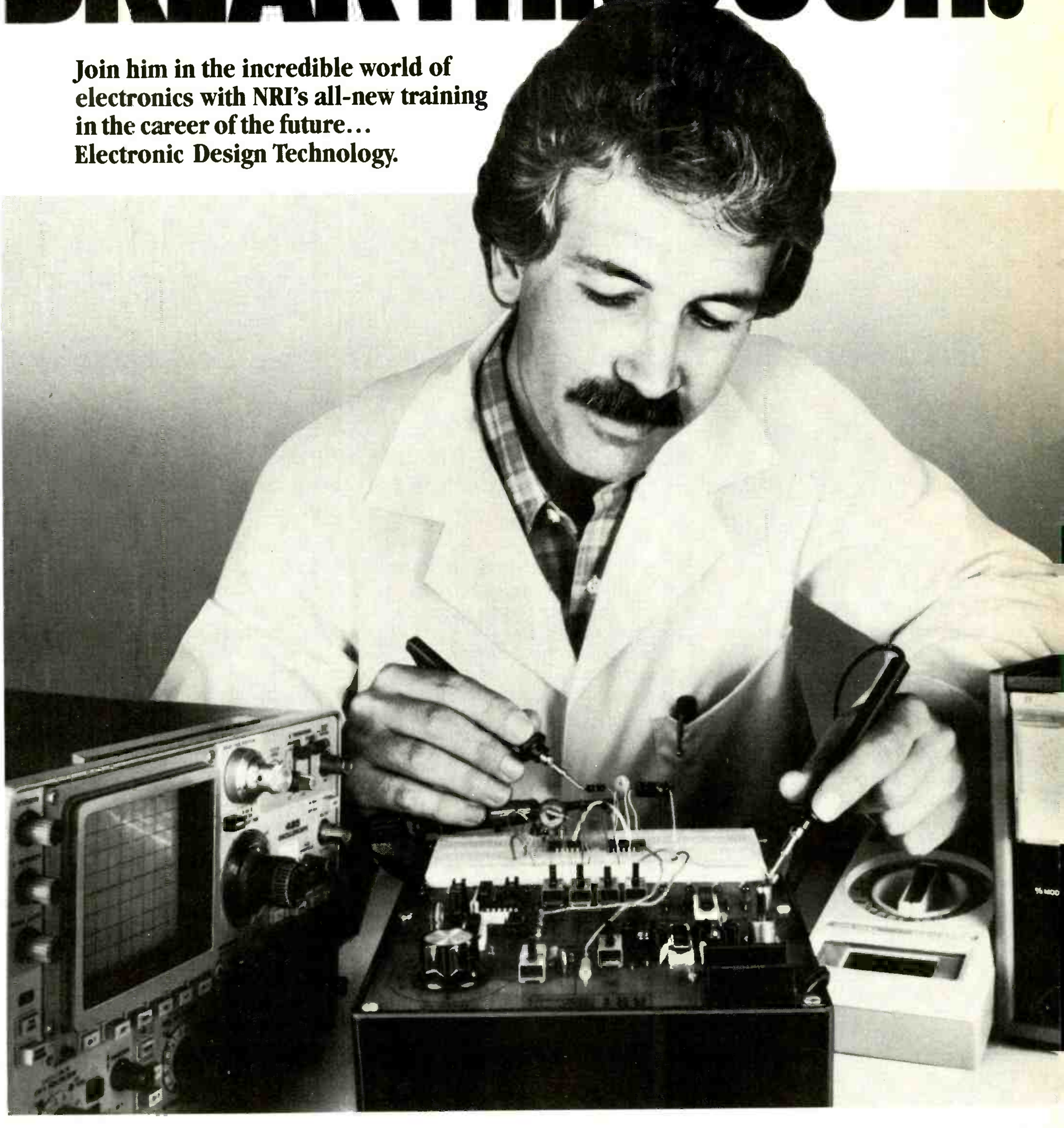

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MITSUBISHI *(continued)*

The capacitance to ground of the arm and signal cable wiring was 215 pF per channel. The low frequency resonance of the arm and cartridge system was 12 Hz, with an amplitude of 7 to 8 dB.

Turntable rumble was very low, measuring −38 dB unweighted and −63 dB with ARLL weighting. The major rumble component was at 10 Hz, with a smaller one at 30 Hz. The flutter was 0.13% weighted peak (DIN) and 0.09% weighted rms (JIS). It mostly occurred at rates of 4 and 10 Hz, and its spectrum dropped off rapidly above 15 Hz.

The speed vernier controls had maximum ranges of +3.9 to −6.5% (33⅓ rpm) and +5.6 to −6.9% (45 rpm), both well beyond the rated 3% range. However, the strobe markings were very difficult to see—lit by a dim red light and recessed so far into the body of the player that they could be viewed only from a narrow angle directly above the window.

The operating controls worked smoothly and silently. Because of the very small force needed to activate the buttons, there was never any tendency to jar the record player when using the controls. The START cycle required about 8 seconds, and the STOP cycle some 13 seconds. The arm slewing functions were easy to use, but they were very slow—requiring some 18 seconds to cover the surface of a 12″ record. The arm lift and cueing mechanism worked very well—operating in less than 2 seconds with only a slight repeat of the record (2 or 3 seconds) each time the arm was raised and lowered in place.

The protective system that prevents the pickup from descending to an empty but rotating platter worked well. The instructions warn against trying to move the arm manually (which could damage its drive system since the arm is constrained at all times by the stainless steel drive wire). However, if the arm is not moved beyond its region of free movement, no harm will result. With the record player operating, we found manual cueing faster and more convenient than the slow internal slew system. If the pickup is lifted by its finger lift and slowly moved in either direction, the servo causes the arm to follow and there is no need to approach the mechanical limits of the arm's movement. Lateral pickup displacement required to light the TRACK ERROR indicators was about ±0.8 degrees. Whether the servo actually responds to a smaller error could not be determined.

Since one of the claims made for the superiority of the vertical turntable mounting is its resistance to vibration, we were especially interested to see how it would fare when placed on vibrators used to measure base isolation. It performed very well, and we consider the manufacturer's claims for this feature to be justified, i.e., a single transmission mode in the 20-to-30-Hz range was measured through the rubber mounting feet. Isolation from vertical vibration was excellent.

User Comment. It would be easy to dismiss the novel design of the Mitsubishi LT-5V as a "gimmick" or novelty to catch the attention of a prospective buyer. While there may be some validity in that assumption, it is a fact that the LT-5V does a superb job of record playing, and would be hard to surpass in any of its measured characteristics.

The advantages claimed for it in improved base isolation are quite real. Although we could not measure its isolation at infrasonic frequencies, we found that vigorous pounding on the supporting shelf usually had no effect on the contact of the pickup with the groove, nor on the sound we heard from the speakers. We conclude that this is a very well engineered record playing system.

To us, one of the chief attractions of the LT-5V is that it fits easily on a narrow shelf. The drawback is that it requires at least 17″ of vertical clearance. In any case, the consumer now has a choice not previously available.

In using the unit, we found only a few minor inconveniences resulting from its format. Because the spindle has a notched tip that locks the pivoted clamp holding the record in place, you have to wiggle the record a bit to remove it from the turntable. Also, the arm indexing scales, while accurate, are inconvenient to use unless they are at eye level. Otherwise, parallax becomes a problem. Finally, the stroboscope markings are much too difficult to see, and should be lit more brightly if they are to remain in their present location.

The appearance, construction, finish, and smoothness of operation of the Mitsubishi LT-5V are suggestive of a more expensive record player. If its special qualities meet one's needs, it might well be the system of choice for many users.—*Julian D. Hirsch*

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CIRCLE NO. 43 ON FREE INFORMATION CARD

Popular Electronics Tests

RCA CTC-111A 19" Color TV Receiver

THE CTC-111A 19" color chassis for 1981/82 offers 127-channel tuning, CCD comb-filtering, and pseudo-stereo sound. It's quite different from either last year's top-of-line CTC-101 or the more recently developed XL-100 CTC-108.

The table model examined here measures 17"H x 17"D x 26"W. It has a black-striped silver front, and walnut-colored plastic top and sides. Large, red LED channel numbers are located above a push/pull on-off and volume control switch that's situated immediately to the left of a 12-button direct-channel address and a programmable up/down slow and rapid scan arrangement. Directly below and behind a 5" x 2.5" plastic door are controls for channel-select, sharpness, brightness, contrast, color, tint, and treble/bass. Suggested retail price is $580.

General Description. *127-Channel Tuning.* When the on/off switch is pulled, audio comes on immediately and the picture appears in about four seconds, a vast improvement over previous 11-second warmups for older-type cathode ray tubes. Channels are selected by up/down pushbuttons, activating a frequency-synthesis manual-scan tuning system that covers all vhf, uhf, midband, superband, and hyperband CATV channels. Selected u/v frequencies may either be added or deleted in the receiver's electronic tuner by simply pressing an add or erase button. And when a channel is entered in memory, the select/lock switch fixes it in position. Memory is retained even if the receiver is disconnected from the ac line. On the set's back are switches for cable-TV-mode tuning and "ColorTrak" defeat.

Electronically, the MST007 composite tuner is divided into three sections: uhf, vhf, and superband/hyperband. Shielding separates the uhf section from the other two. Not only does the tuner furnish the usual 82 u/v channels, but also cable channels A-1 through A-5, A through I, J through W, and W+1 through W+17, for a total of 127. The cable/normal switch does not affect vhf channels 2 through 13, but must be set to *normal* position for uhf. In addition, a sync detector has been added from a transistor on the chassis to defeat aft during improper sync cable search.

Channel scan can be expanded automatically in discrete steps from −2 MHz below video carrier to +2.25 MHz above. After full search, the sync detector cuts off and the system returns to normal operation. Then, even carriers without apparent sync may be received. But such special sync operates *only* in the CATV position.

Other Features. The CTC-111A's SAW (surface wave) filter input, its transistorized preamplifier, the i-f, aft, agc/video detector IC, and the 28-pin LSI chroma and luminance processor are incorporated into the same monolithic chips used in the CTC-108 (POPULAR ELECTRONICS, June 1980). The charge-coupled-device comb filter was used first in the RCA CTC-101 chassis. (See PE, October 1981 review of Toshiba's CB965 TV set for details on how the comb filter works.) Finally, there is an automatic peaking detector, a vastly improved sound detector and output, and a new horizontal/vertical oscillator and regulator control IC—all new for this series.

Auto Peaker. Vertical detail resolution from the comb filter is extracted through a nonlinear processor. This is summed with the delayed luminance in a U701 peaker IC. Further correction is supplied from an automatic peak-frequency detection circuit, the idea being to offer uniform horizontal resolution from one TV station to the next, and to compensate for any poor SWR of the receiving antenna. This occurs without the user having to adjust preferred sharpness for individual channels.

Consequently, a peaking circuit has been designed that consists of three transistors, and related components.

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All-In-One Computer

The heart of the system is the Heath/Zenith 89 Computer, a complete, stand-alone unit with professional keyboard, smart video terminal and 5¼-inch disk drive. It's easy to use for people having little or no experience – yet it can also run extended languages like BASIC, COBOL, FORTRAN and Pascal.

The 89 comes with 48K bytes RAM, expandable to 64K. It has two Z80 microprocessors, one for computer functions, one for terminal functions. And three serial I/O ports for interface with printers and modem.

The video display features a 12-inch diagonal, high-resolution CRT that's easy on the eyes. It displays up to 2,000 characters at a time, 24 lines (plus 25th status line) by 80 characters, with full cursor control. Also 33 block graphic characters for charts and graphs.

The heavy-duty keyboard follows standard typewriter format for easy operator training. All terminal functions are programmable from keyboard or I/O ports.

The 5¼-inch floppy diskette stores 100K bytes of information and interfaces on line with the Heath/Zenith 67 Hard Disk System.

Winchester Disk System

The 67 Disk System features one hard disk and one 8-inch, soft-sectored floppy for total on-line storage of 10.782 megabytes (formatted). That's a huge data base.

The floppy is double-sided, double-density and can also operate in single-sided or single-density modes, compatible with standard IBM 3740 format.

The 67 features write-protect switches for both drives to prevent accidental erasure of information. The average access time of the hard disk drive is 70 milliseconds.

High-speed printer

The Heath/Zenith 25 Printer is a heavy-duty, high-speed, dot matrix printer that gives you sharp, clear printouts. It prints over 150 characters per second with whisper-quiet smoothness.

The entire 95-character ASCII set prints in upper case and lower case with descenders, in a 9 x 9 matrix. Also, 33 block graphic characters let you create graphs and charts. All functions and timing are microprocessor-controlled.

It uses standard edge-punched papers and features a convenient cartridge ribbon for easy, no-mess replacement.

ANNOUNCES
IN SYSTEM PERFORMANCE

Versatile software and accessories

The Heath/Zenith System offers you a choice of operating systems, including popular CP/M.

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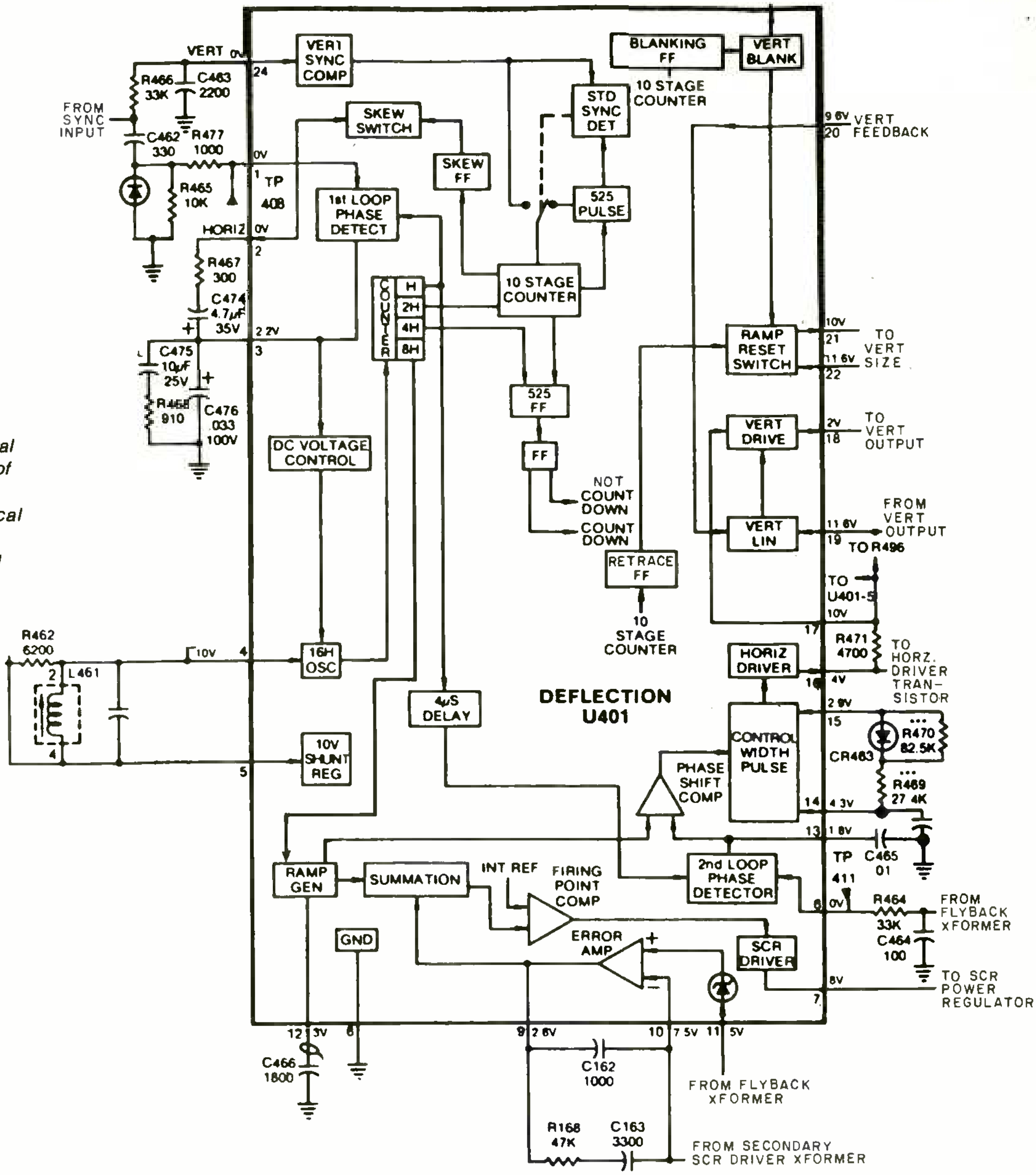
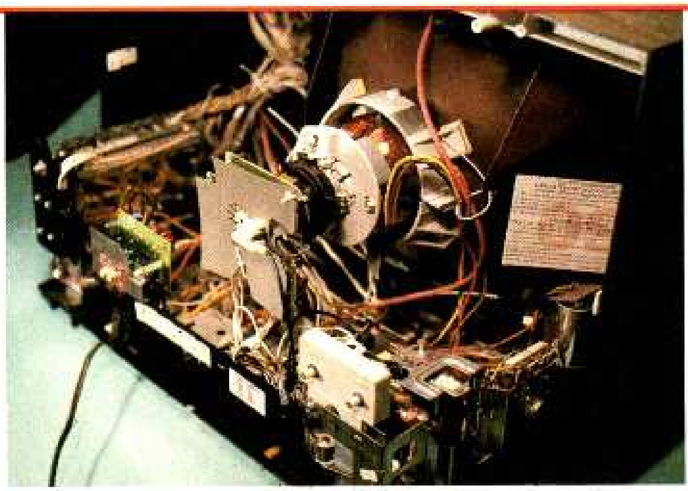


Fig. 1. Functional block diagram of the 3-part horizontal/vertical phase-lock, count-down and regulator IC.



Internal view of the CTC-111A chassis.

A Horizontal/Vertical Oscillator and Regulator Control, a U401 IC, was first used successfully in RCA's 9-inch CTC-115 color chassis that was introduced earlier this year. It's a rather complex 24-pin IC, with three feedback loops. The first two of these are used for sync control and the third operates an SCR voltage regulator.

Circuit operation begins with a 16 × 15,734-Hz horizontal-frequency LC461 tank circuit that oscillates at 251.744 kHz as sync input enters the monolithic chip in Fig. 1 between *R466* and *C462*. A standard sync detector receives normal sync and compares it with internal frequencies (derived from double the normal horizontal frequency and divided by 525). Seven fields of 262.5 lines each constitute an acceptably good signal, while a defective one overlaps and free-runs temporarily, pending extended 568-line countdown and lockup. When

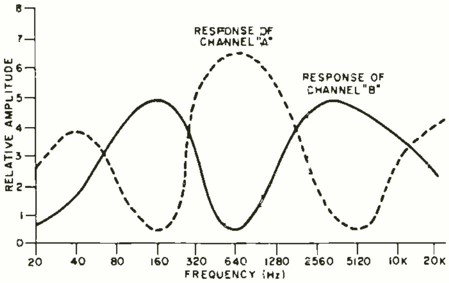


Fig. 2. Frequency response of the synthesis stereo circuit.

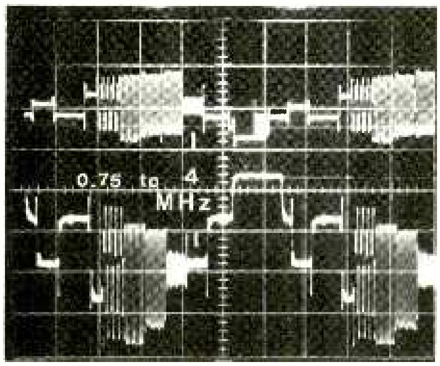


Fig. 3. Multiburst test at the video detector (top) and CRT (bottom).

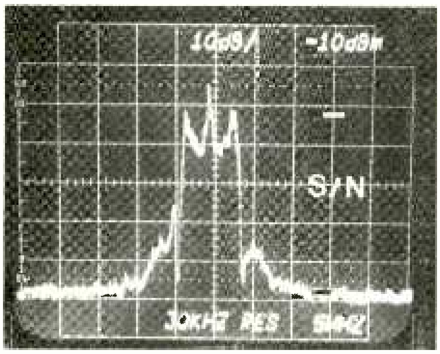


Fig. 4. Spectrum analyzer display of luminance at the CRT.

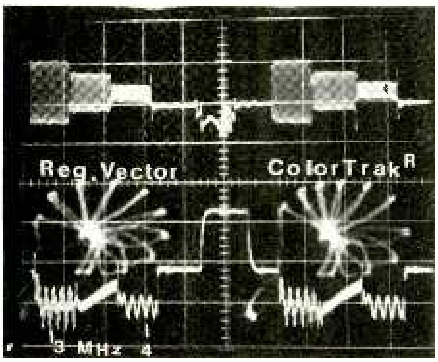


Fig. 5. Swept chroma test at video detector and CRT. Vector test is at center.

RCA MODEL FFR495W (CTC-111A) 19″ COLOR TV TABLE MODEL LABORATORY DATA

Parameter	Measurement
Tuner/receiver sensitivity (min. signal for snow-free picture):	vhf (Ch. 6): −11 dBmV uhf (Ch. 30): −3 dBmV
Voltage regulation w/signal input (line varied from 105 to 130 V):	Low voltage: 125-V supply—99.6% 16-V supply—95% High voltage: 29-V supply—96.8%
Luminance bandpass at video detector:	4 MHz
Luminance bandpass at CRT:	4 MHz (approx.)
S/N at CRT:	46 dB
Convergence:	99%
Horizontal overscan:	8%
Pincushion/barreling:	None
Agc response (before sync clipping or white/black level shifts):	66 dB
CRT color temperature measurement (with normal picture on screen):	6500°K
Dc restoration:	88%
CB interference (at 60 ft):	Slight on Ch. 2
Power requirements (signal applied)	125 W (max.)

NOTE: Instruments used in these measurements are: Tektronix 7L12 and 7L5 spectrum analyzers; Tektronix/Telequipment D66, D67 oscilloscopes; Sadelco FS-3D-VU f/s meter; Winegard DX-300 amplifier; Data Precision 245, 258, 1750 multimeters and 585 frequency counter; B&K-Precision 1248, 1250 color bar generators and 3020 function generator: Sencore VA48 (modified), CG189 color bar and signal generators, PR57 variable power supply; Tektronix C-5A camera.

channel or other changes cause sync interrupt, the vertical sync pulse is first detected between the 513 and 568 count. The vertical ramp will then reset at a 525 count. Following seven consecutive fields of coincidence between the 525 count and detected vertical sync, the countdown is locked up in standard mode. To get out of the countdown mode, there must be two consecutive fields that are *not* apparent in the 525 count. Following the 525-line flip-flop, the count/*no*-countdown flip-flop makes the decision and, if the result is no, it resets the counter.

Frequency synthesis within the U401 begins with the high-frequency LC461 tank oscillator via the 16H oscillator block and goes from there to the counter and chain of dividers.

Dual Dimension Sound was first introduced in RCA's CTC-101 series in 1979, and has seen major improvements for the 1981/1982 line. This pseudo-stereo effect is created by synthesizing audio sound separation into two channels so that one speaker handles midfrequency audio between 60 and 200 Hz and 1.2 and 10 kHz, as shown in Fig. 2. This is done by selective filter separation, with two electrical paths each going to a single-output amplifier.

Both L and R jacks seem to have adequate power to drive stereo hi-fi amplifiers with a quasi-stereo effect.

The limiter/amplifier, FM detector, and dc volume control and tone controls are contained in a TDA2791 16-pin IC package. The power amplifier, a TDA2611A, is capable of 5 watts output (here about 3.5 W) and comes in a 9-pin in-line package, with a dc operating voltage of 24 V, and a THD of 0.3%.

Laboratory Measurements. RCA's charge-coupled comb filter supplies about 4 MHz (Fig. 3) to the CRT without crosstalk between chroma and monochrome. A high voltage of 29 kV and a warm white color CRT temperature measured at 6500°K (5800°K is average) produced a well-illuminated picture with fine contrast. Video S/N is 46 dB (Fig. 4); and vhf tuner/system signal pickup is −11 dBmV. An agc swing of 66 dB gives a fast response to aircraft flutter. Convergence is accurate; and overscan is a precise 8%.

The ColorTrak mixing circuit in the 42-pin LSI squeezes only oranges and reds together (losing the usual 30° separation (Fig. 5) between the first four petals of the 10-spoke vector). Blues and green, however, are not disturbed.

Comments. This new TV chassis is evidently a fine one, fortified by its 127-channel electronic tuner, pseudo-stereo sound capability, good cable-TV response, better-than-average dc restoration, a CRT that brings out the best in color, and a handful of very satisfactory specifications in other areas.

Nothing is perfect, though. Serviceability on the chassis might be improved, for example, and we would like to have seen a "cold" chassis for safety's sake when servicing. Too, front-end filtering against CB intrusion on Ch. 2 could be better, and audio is not completely muted when the volume switch is turned down. But these aside, the RCA CTC-111A receiver is a fine chassis, featuring a sharp, bright picture, as well as better-than-average sound for a table-top model.—*Stan Prentiss*

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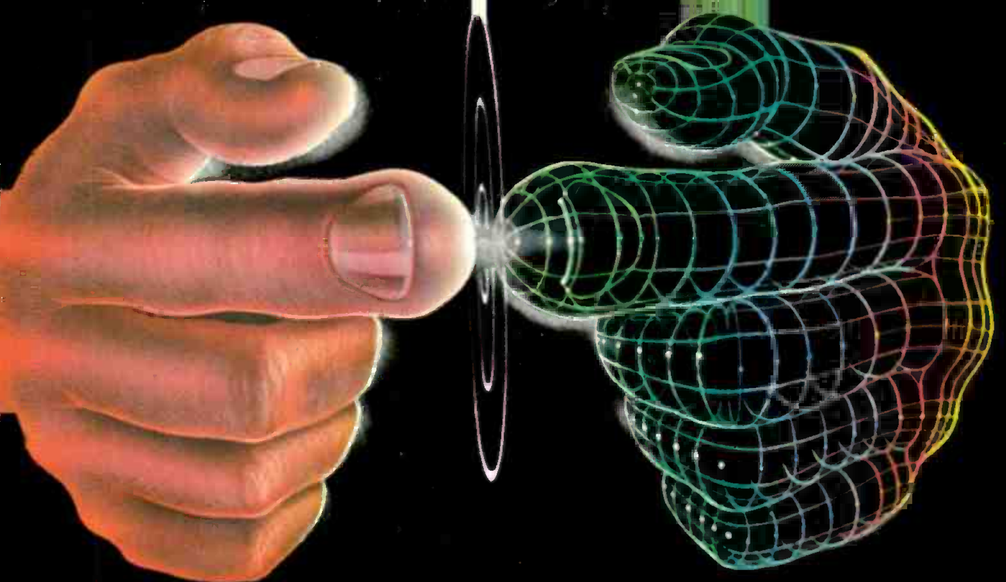

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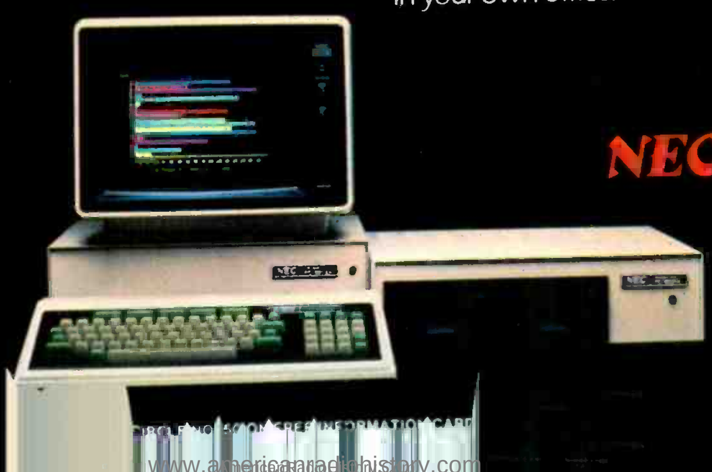

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MAGNAVISION

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Popular Electronics Tests

The IBM Personal Computer

THE long-awaited entry of IBM into the microcomputer field—rumored since 1976—has occurred. Happily, we were able to spend considerable "hands-on" time with it and can share the results with our readers without delay. This 16-bit microcomputer (based on an Intel 8088) is designed for business, school, and home use. It will be available from ComputerLand dealers and business-equipment outlets of Sears, Roebuck Co., as well as through IBM's sales centers and a sales unit in its Data Processing Division.

The basic expandable system consists of a detached keyboard (cable-connected to the System Package) and the System Package that contains 16K of RAM, 40K of ROM (carrying the operating system and BASIC), a TV receiver adapter, and a cassette port. The cassette recorder is not supplied. This basic package has a suggested retail price of $1565.

The full system includes 64K of RAM, a 12″ monochrome video monitor, two Tandon 5¼″ disk drives (mounted within the System Package), and an Epson MX-80 printer (carrying the IBM logo). The complete system has a suggested retail price of $4500 (the single-disk version is $3005). Options include a full-color monitor and adapter, joysticks, and a light pen. The independent enclosures are pearl-white to match any environment.

General Description. The microprocessor-controlled keyboard has 83 keys including 10 for numeric entry and cursor-control and 10 for special functions (user definable). Each key features autorepeat. The sloped keyboard has both tactile and "click" touch feedback, concave tops, and ¼″ key travel. Furthermore, the keyboard can be positioned flat on the operating surface or via a pair of detent supports, at a shallow but comfortable angle. Some keytop legends are unusual. For example, there is no key marked RETURN but there is a large-size key marked with the international "return" symbol (a left-facing arrow). A four-character keyboard buffer is provided, and many keys have four selectable functions—normal, shifted, control, and alternate.

Of the 256 characters available, 16 are for game and special-character graphics that include the four playing-

card suits, music symbols, etc.; 16 are used as a word-processing editing set; 96 are conventional ASCII upper/lower case, numerics, and symbols; 32 form an international character set for foreign languages; 16 form an extended Spanish and special character set; 48 are line graphics; and the remaining 32 are devoted to a mix of Greek and scientific symbols.

Physically, the keyboard is 20"W × 2"H × 8"D, and it weighs about 6 pounds. It is cable-connected to the System Package via a six-foot coiled telephone-like cable. A pencil "ledge" is provided above the keyboard, and four synthetic cork, nonskid bumpers are located near each bottom corner.

The Systems Package contains the 8088 and its associated logic on a "motherboard" having five bus-expansion slots. The system switching power supply, a fan, the cassette I/O port, a 2¼" speaker, and up to two 5¼" disk drives are located in this enclosure.

The disk drives use double-density, single-sided diskettes in a Tandon 5¼" drive. There are 512 bytes/sector, 8 sectors/track, 40 tracks/diskette, with 160K-byte capability and 320K bytes maximum. A LED "in-use" indicator signals disk activity. Power requirement is 63.5 watts.

The 8088 CPU combines a 16-bit internal architecture with an 8-bit bus interface. There are 16-bit wide registers, data paths, ALU, and a set of powerful 16-bit instructions identical with the 8086 CPU. The 20-bit memory address range and the 16-bit I/O port address range allows for 1-megabyte of memory and 64K I/O ports. In this computer, the 8088 operates with a 4.77-MHz clock. The RAM memory uses a ninth bit for parity checking, and can be expanded to 256K bytes. The 40K ROM contains the IBM operating system and BASIC.

On power-up, 2K of ROM provides a series of 14 diagnostic tests including the processor, an 8K ROM checksum, DMA, 16K RAM, ROM checksum, interrupt controller, timers, video RAM, cursor, video sync, remaining RAM, keyboard, cassette port, and disk system. Any problems are reported via the speaker and video display. The test takes about 15 seconds.

Physically, the System Package is 20" W × 16"D × 5.5"H and weighs 21 pounds without the disk drives, 25 pounds with one drive, and 28 pounds with two drives installed.

The monochrome monitor uses an 11½"-wide screen having a P39 (green) phosphor. An anti-glare screen surface and contrast and brightness controls are supplied. The display is 25 lines by 80 columns using a 7 × 9 character within a 9 × 14 character box. Underline, blinking, high-intensity, reverse video, and nondisplay for security are provided. Characters can be displayed in three background shades. Graphics resolution is 720 by 350 pixels, and a 4K screen buffer is supplied.

The CRT sweep speeds are unusual in that the horizontal sweep speed is 18 kHz, while the vertical sweep is 50 Hz. The bandwidth of 18 MHz makes for an excellent, crisp display. An optional add-on card is provided for using conventional NTSC monitors.

When using BASIC, each of the 10 user-definable keys can be made to display its function along the 25th line. This feature can be defeated.

Three types of software are provided. Cassette BASIC is provided in 32K ROM and uses the cassette for data storage with no disk facility. Disk BASIC comes on the DOS diskette and requires 32K of RAM. It provides access to both cassette and disk, has an RTC for date and time, and supports RS-232 as well as two additional drives. Advanced BASIC also comes on the DOS diskette and requires 48K of RAM. It features automatic event trapping and the use of function keys, joysticks, light pen, etc. It provides advanced graphics and supports graphic commands CIRCLE, GET, PUT, PAINT, and DRAW. It also provides music support via the PLAY statement.

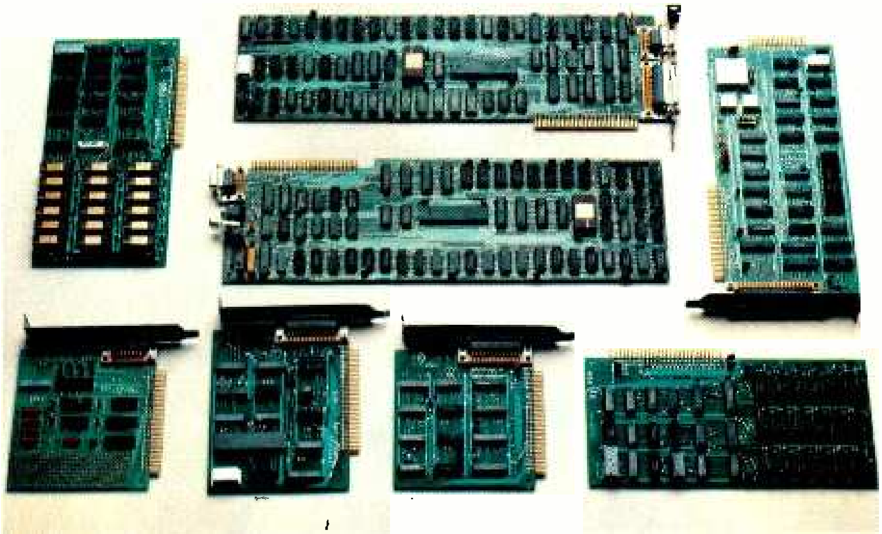
Other software includes VisiCalc, EasyWriter word-processing package, Accounts Receivable/Payable and General Ledger from Peachtree Software, the Microsoft Adventure game package, a Communications package that uses the Asynchronous Communications Adapter, plus a PASCAL compiler. Both CP/M-86 and UCSD p-System are being adapted.

IBM will also solicit software from outside sources. To do this, IBM has created a new department called Personal Computer Software Publishing Department (Dept. 765, Armonk, NY 10504). IBM employees and external authors, from professional programmers to hobbyists, can submit programs for consideration.

The IBM 80 CPS Matrix Printer is actually the popular Epson MX-80 featuring bidirectional printing, a one-line buffer, horizontal and vertical tabs, a choice of 40/66/80/132 characters per line, 12 character styles, and variable vertical spacing. The character set includes 96 standard ASCII, 64 graphic symbols, and 9 special symbols all using a 9 by 9 matrix. A "ripple print" test is provided.

The Asynchronous Communications Adapter supports RS-232C and is fully programmable with 5, 6, 7, or 8 bit characters, even/odd/no parity, and 1/1½/2 stop bits. Baud rate is from 50 to 9600.

The 450-page loose-leaf manual is excellent and is exceptional in its clarity of explanation. It is very detailed and profusely illustrated.



IBM Personal Computer plug-in modules. Lower row, left to right are: game adapter, asynchronous communications card, printer adapter card, and 32K memory board. Upper left is the 64K memory board and upper right is the disk drive adapter. Top center is the monochrome display/printer adapter, and lower center, the color graphics board.

Evaluation. Visually, the IBM Personal Computer is attractive. The three basic units (Keyboard, Systems Package, and the video monitor) complement each other with their pearl-white, smooth, round-cornered enclosures. The keyboard attaches via a coiled cable and it can be angled to the workspace in either of two positions—both very comfortable, and based on research developed in Sweden (of course, if you're a Mediterranean type . . .).

In the basic system, on power up,

BASIC is automatically booted. In the disk system, BASIC resides on the same diskette as the DOS and has to be called as usual. The IBM DOS "looks" a lot like CP/M, but it isn't.

We used the system with both monochrome and a Hitachi color monitor. The video display in both cases was clean and crisp and easily usable to all four edges. Owing to the unusual horizontal/vertical sweep speeds, a conventional video monitor cannot be used unless an adapter is plugged in. In the chroma mode, the colors are exceptionally distinct and the alphanumerics and graphics are crisp. The disk drives are unusually quiet, with each drive having a LED to signal disk activity.

The Microsoft BASIC is very fast, with a lot of the speed due to the 4.77-MHz clock. In the graphics mode, BASIC statements allow the creation of graphic figures that can be stored as an array, and "called," in a manner similar to machine-language routines. The speed of animation is about as fast as machine-language routines. We were impressed by the smooth animated transitions of a "car" while operating a slot-car-racing game on screen. It puts comparable micros to shame.

The BASIC contains some 147 statements, functions, and variables. Among the novel instructions are CIRCLE, where the user can define the parameters of the circle which can then be colored by a PAINT instruction. The circle can be opened up and generally manipulated. Since both alphanumerics and graphics can exist simultaneously, circle segments can be labelled. This is great for business applications when you want to see how the "pie" is divided. Several other graphic commands allow the creation of a limitless number of designs. The computer can also create music up to 32 tones in one voice (with graphics if desired). The SOUND command allows determining the tone frequency and duration. There are also commands for the joystick (STICK), and light pen (PEN). A light-pen adapter is available for the latter mode.

We ran the IBM demo programs, which are very impressive, but didn't have the time to write any lengthy programs of our own. Simple benchmark tests showed this machine to run as fast as (or faster than) the speediest micro hardware/software combinations we have tested to date.

We did write several short programs that used color, and they were great.

The ten "function keys" on the left side of the keyboard may initially add some confusion for the operator, as might some keys with international symbols. However, one adapts very quickly to this, especially since codes at the bottom of the screen enable one to really reduce typing.

We found the green-phospor screen easy on the eyes, fortified by highlighting functions such as underlining, blinking reverse images, and high intensity.

The only negative comment we can make about this system is the fact that, at the present, the user is locked into software that works with the IBM DOS. We were told that CP/M-86 is just down the pike and may be available by the time this review is in print. [Editor's Note: As we went to press, more information became available. See "Computer Sources" in this issue.] With this CP/M, the five expansion slots, and the services of some outside software authors, this new computer will be a force to be reckoned with. Furthermore, there is no doubt that a "cottage industry" will spring up about the IBM bus just as occurred with some other small computers. Also, it would be nice to have an 8" disk option, as 330K dual-disk capacity doesn't seem to be quite enough if one expands memory to its full 256K.

We found the IBM Personal Computer to be an excellent example of what small computers are about. This is a lot of machine for the money.

—Les Solomon

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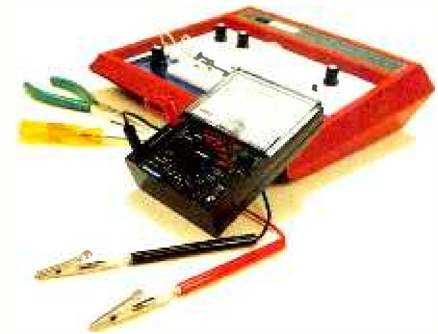

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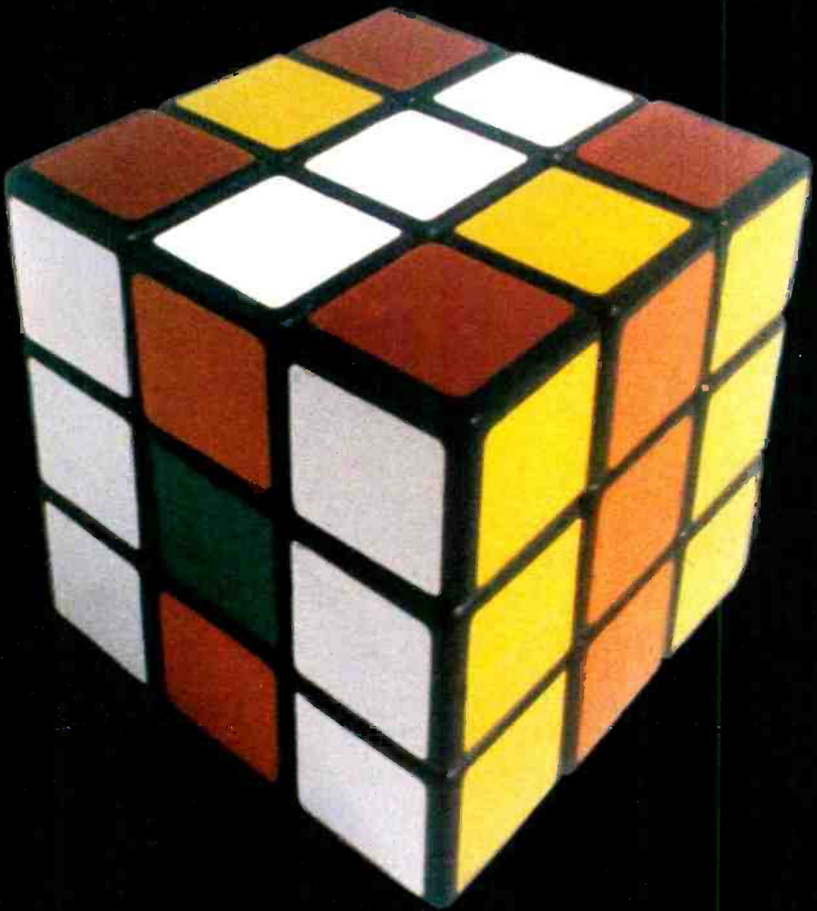

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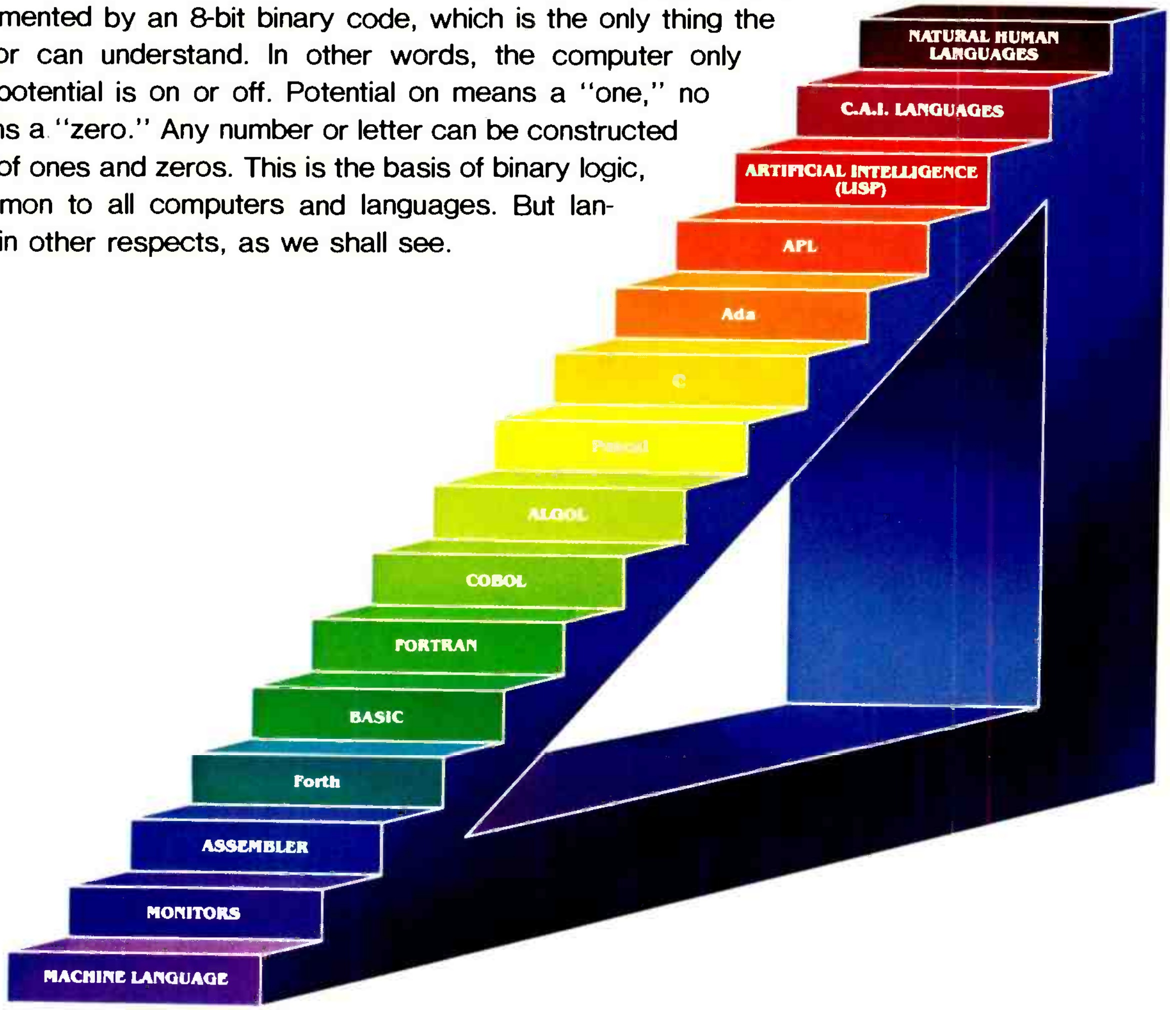
IT WOULD BE nice if people and computers shared a common language. However, since human languages are so complex, it has been necessary to invent computer languages. Most people who buy personal or small-business computers have little choice of computer languages. Someone has already made the decision for them so that, when they turn on the machine, an announcement such as "RADIO SHACK LEVEL II" or "APPLESOFT" is seen on the monitor.

In this article, we will discuss computer languages as thoroughly as possible to provide an understanding of what is available and to enable the computer user to choose the language most appropriate for his needs. The diagram below shows the various levels of computer languages from machine language at the bottom to some types at the top that actually resemble human language. We will examine each step and weigh its cost in computer resources and flexibility.

At the heart of your small computer is the microprocessor chip. It *is* the computer. Everything else, except the memory, supports the chip. It may be an 8080, Z80, 8085, 6502, 6800, etc. What these chips have in common is more important than their differences. They are all 8-bit chips with an 8-bit bi-directional data bus and 16-bit address bus. They all use instructions of one, two, or three bytes that perform similar operations. All of the microprocessors consist of an arithmetical logic unit, control circuits, and various registers. The 8-bit bus means that the word size is 8 bits (one byte) and the data bus is used to send 8 bits of data to or from external memory or input/output devices. The 16-bit address bus means that the microprocessor can directly address 65,536 (2^{16}) unique memory locations.

All of the computer instructions are unique to a particular microprocessor and are implemented by an 8-bit binary code, which is the only thing the microprocessor can understand. In other words, the computer only knows if the potential is on or off. Potential on means a "one," no potential means a "zero." Any number or letter can be constructed from a series of ones and zeros. This is the basis of binary logic, and it is common to all computers and languages. But languages differ in other respects, as we shall see.



Direct Programming in Machine Language

THE METHOD of directly programming the microcomputer in binary form (or its equivalent) is called machine language. Everything else must be translated into machine language before it can be used by the microprocessor.

Programming in machine language consists of supplying the microprocessor with machine instructions, memory locations, and data in certain forms and sequences. The microprocessor cannot distinguish between instructions and data except through the form of the program. The instructions are unique to each microprocessor and are built into the chip, with the "power" of the microprocessor defined by the number and complexity of the instructions it can perform.

Early minicomputers and microcomputers used a set of front-panel switches to represent the binary digits. If a switch was set in one direction it was a "one." In the other direction, it was a "zero." When the row of switches was set to represent the desired binary number for the starting memory location, another switch was operated to cause the computer to go to the specified memory location.

The data switches were then set to represent the first instruction. To enter the instruction into the computer, a switch marked ENTER had to be operated. After each ENTER, the system automatically stepped to the next memory location. The data switches were set to the next binary number and so forth, until the program was entered one binary number at a time. There was usually a set of LEDs associated with the switches to indicate that the program had been entered correctly. When the correct binary number was stored in each successive memory location, another switch was pressed and the computer ran the program. It was a good thing there was not much memory available at the time since the process of manual entry forced the programmer to keep the programs very short. Even today, however, simple single-board computers can be programmed this way.

The Monitor Operating Program

MODERN computers permit direct access to the microprocessor through an operating program called a Monitor. The program is usually stored in Read Only Memory (ROM) and starts to run as soon as the computer power is turned on. Since it is more difficult to work with strings of binary numbers, it has become common practice to shorten the machine codes by using octal notation (base 8) or hexadecimal notation (base 16). Figure 1 shows a short program in binary, octal, and hexadecimal notations.

The Monitor program, written in machine language and burned into the ROM has commands that allow the user to do many things. In minimal computers using cassette-tape data storage, the monitor may act as the operating system. Some of the programming functions in the Monitor permit a user to examine the contents of any memory location, step through the memory showing the contents of one location at a time, and load the memory location with instructions or data in the form of two hex digits (or three octal digits). Each of the hex digits represents four bits (one nybble) of the eight-bit code (one byte) contained in the memory location. The user can also go to any memory location, display its contents, and change it if desired. The Monitor program can also move blocks of code from one memory location to another. Moreover, it can usually operate the cassette machine to store programs.

It is thus possible to enter a machine-language program from the keyboard. To do this, starting at the memory location desired as the program origin, a user enters the hex equivalent of the binary instructions and data comprising the program. As each two hex numbers are entered, the Monitor steps to the next memory location in sequence. If there are any "jump" instructions, the programmer must figure them out and tell the Monitor what memory location to go to and return. After entering the program and checking it, by going to the starting location and again stepping through the program while observing the indicator lights or CRT screen, it can be run by returning to the starting memory location and giving the GO command. If the program runs correctly, it may be saved on a cassette tape so that the next time it may be loaded from tape instead of from the keyboard. This procedure is an improvement over the front panel switches, but not a big one.

Fig. 1. A short program in three numbering systems: binary, octal and hexadecimal.

Some computers do not come with Monitor programs so it may be necessary to purchase them either as a tape or in the form of a plug-in ROM.

In cases where only BASIC is provided (the TRS-80 MOD I, for example), you might want to enter a machine-language program to do something that you can't do in BASIC. The PEEK statement is provided to examine the contents of any memory location and the POKE statement is provided to change its contents, should you wish to. To enter the machine language program you have to POKE each memory location with the correct instruction, or data byte. When the program is loaded, it can be run by using the USR statement in BASIC; or your version of BASIC may permit a CALL to a machine language program which may be in a separate library of machine language routines.

It should be noted that in Microsoft BASIC (including Radio Shack and Applesoft), the contents of memory for PEEK and POKE statements are expressed in decimal rather than in hex or octal. It is therefore necessary to convert the code in the machine-language program into decimal format before using PEEK and POKE. It is also necessary to be familiar with the memory map of the computer you are using so that POKES are not made into reserved memory areas.

Assembly Language and Assemblers

THE DEVELOPMENT of a machine-language program requires the programmer to write the source listing so that he can figure out the memory locations, how many of them are required for each instruction, and how many memory locations are required for the data. To do this using binary numbers makes the program almost impossible to read, so symbols were invented to stand for the instructions. These symbols are called mnemonics (memory aids), and each microprocessor has a unique set of them. Usually several manufacturers will

Fig. 2. Program source for Fig. 1 written on an editor.

Fig. 3. Same program as in Fig. 1 in assembly language.

make the same chip, but all of them use the mnemonics of the originator. These instruction sets are published by the semiconductor manufacturers and are made available to users.

Four identical programs are shown in Figs. 2 through 5. They represent the program source as written on an editor, as well as the assembled, BASIC, and Pascal versions.

The process of using mnemonics and a particular syntax to write a program is called Assembly Language. The form of an Assembly Language line for one instruction is shown below.

```
LABEL   OPERAND   ARGUMENTS  ; COMMENTS
SEARCH:
        LXI       B,0        ;INITIALIZE
                              COUNT TO
                              ZERO
```

In the example, taken from Fig. 1, the Operand is from the Intel 8080 instruction set, where LXI means Load Immediate. The arguments B,0 indicate that the register pair BC are to be loaded with zero. Sometimes, when the value of an argument is not known, a symbolic expression is used to represent it. The label field is optional and represents the location of the memory address of the instruction (which may be unknown), and which will change from application to application. In addition, each Assembler will have a set of pseudo-ops which do not produce machine code. The pseudo-op replaces the instruction mnemonic in the operand field. For example, the pseudo-op ORG (origin) tells the assembler that the program starts at a given location, e.g., ORG 100H (where H stands for hexadecimal).

The pseudo-op END ends the program, while EQU equates the symbolic name in the program to the argument given (*i.e.*: EQU KBD 1 equates the name KBD to the value 1). At assembly time, the name KBD is placed in a Symbol Table and the value 1 is associated with it.

The program that translates the assembly language *source* code into the machine language *object* code is called the Assembler. Sometimes a simple Assembler is provided as part of a Monitor program, but most often the Assembler is a stand-alone program sold for your computer, or provided with the Operating System. CP/M and UCSD Pascal Operating Systems include Assemblers, and they also take care of the input/output connection and disk storage management required by the assembled programs.

A typical Assembler is a two-pass program. The first pass figures the length of the instruction and updates the location pointer in the microprocessor. It will also construct a Symbol Table, putting each symbolic name in alphabetic order. By the end of the first pass, all the symbols should have been given a value; if not, it is called an unresolved reference, and an error message will be printed.

On the second pass, the Assembler again reads the source statements and translates them into object code in machine language, filling in the memory reference addresses with values from the operand field of the source, or with symbolic values from the Symbol Table. If there is an error, an error message is printed. If not, the object code version is printed (See Fig. 3) and the result is saved on the disk.

The object code presents the machine code in a form that can be read by a Loader program and run on the computer.

Some Assembler programs have the capability of creating and using a collection of routines called macros, and are therefore called Macro Assemblers. These are defined as one or more valid statements that may be called up by using a single symbol within the assembly-language program.

The macro has to have been previously defined by the user, within the body of the program. The macro call is the statement that names the macro as the statement operator and gives it the necessary arguments. Such a call within a program causes a macro to be included at the point of the call. It will cause one or more machine instructions to be assembled and the binary code to be generated.

Not every Assembler program is a Macro Assembler and they are not usually included within an operating system. For example, in CP/M the Assembler is not a Macro Assembler (MAC is the Macro Assembler sold by Digital Research, the authors of CP/M).

If you want to use one, you have to buy it as an option. However, once a programmer becomes an accomplished assembly-language user, the extra expense of a Macro Assembler is worthwhile.

A Macro Assembler allows the use of a subroutine (macro) many times in a Linker program by simply calling it by an assigned name. However, most programmers have collections of subroutines that they would like to use over again within many programs.

This program permits the user to have a library of macros stored on a disk. The Linker ties them into a program at assembly time. Of course, the Linker you use must be compatible with the Assembler program in your machine.

One thing that keeps programmers from using assem-

Fig. 4. The sample program is written here in BASIC.

Fig. 5. Same program as before is shorter in Pascal.

bly language to a greater extent is that finding and correcting errors—debugging—is like trying to map a can of worms. Don't worry. There are Debugging programs that make life easy. Using these, you can trace the execution of a program, and see the instructions executed. A program can be traced one step, or more, at a time, and can be modified to correct errors. Breakpoints can be set to stop on an error, and the contents of registers and memory can be displayed. The CP/M debugger is called DDT (Dynamic Debugging Technique), and it's a good one, but it is not the only one in use. There are others with equal capacity and features. Some are sold separately and others are part of operating-system packages. Check the package before buying.

Disk-Operating Systems (DOS)

DISK-OPERATING systems are a topic that must be included in any discussion of computer languages because they are really the control language that makes everything else work.

Before the use of floppy disks for microcomputers, the Monitor program could handle the simple I/O and language support, but with the use of disks everything changed.

The operating system controls the allocation of the system resources. It operates the disk system, keeping track of the storage and retrieval of programs and data. It also creates, opens and closes files. The DOS contains all of the system utilities used to format diskettes, to copy files and entire disks, and to make a back-up copy of the disk system. In addition it provides the input/output connection for all of the languages running on the computer.

A DOS is indeed a complete language, full of commands that must be used in correct syntax to direct the operation of the system. Many of the commands require a complete set of extensions and modifiers. Since the DOS is not one program, but a software system, learning it requires study and experience before a user or programmer can become skilled in its use. CP/M, for example, comes with six manuals to explain its operation. The same can be said of UNIX and almost any complete disk-operating system.

When you buy a computer with floppy disks, it must include a disk-operating system. To get the most out of the operating system you must make a commitment to it that will cost a lot of money, and take a lot of time. The choice of an operating system, more than anything else, may determine the success or failure of your computing program.

The language and the application programs that you choose all depend upon the operating system that runs on the computer. Since the disk-operating system also controls the input/output methods, it indirectly determines the type of peripherals you can use.

Often we read about some great new language we would like to use, or an application program that is just what we need. Upon reading a little more, we find that it runs on a different operating system, uses a different disk format, or needs more memory than the system allows. Sorry, but you are just not going to run that software. With some computers, it is possible to change your operating system. Of course, you may lose your investment in languages and application software, but it could still be worth it. If you have an 8080, Z80, 8085, or 8088 system running in an S-100 bus, you have several choices. You can use CP/M, or one of its offspring such as CDOS, SDOS, IMDOS, OS, MPP/M, and TP/M. The same chip family can also use OASIS, MV FAMOS, UCSD-P System, CIS COBOL, and many others.

The TRS-80 Mod I, II, and III have TRSDOS in several versions, to say nothing of NEWDOS, VDOS and LDOS. And they can also use CP/M. Zenith/Heath has its own system called HDOS, and you can also choose CP/M or UCSD P-system. If you use a 6800 or 6809 on the SS-50 bus there is FLEX, UNIFLEX, OS-9, UCSD P-system, and a few others. The 6502-based APPLE II offers a choice of APPLE DOS and the UCSD P-system, but you can also plug in a Z80 and run CP/M. APPLE III uses a new system called SOS. The OSI computers have several versions of OS-65 and the UCSD P-system. Challenger III models, which have several microprocessors, can also run CP/M on the Z80. Commodore PET/CBM machines can use only the version of PET DOS they were made to use, and nothing else.

If you begin to get the idea that CP/M is almost a de facto standard for microcomputers, you are correct. That is why IBM and Xerox made sure their new micros could use it. CP/M offers the widest choice of languages and application software; and it will remain that way for some time because software authors write for the market where there are the most customers. The UCSD Pascal system (now called the UCSD P-system) is available as an alternate operating system on most computer systems—underscoring Pascal's rising popularity.

With the advent of 16-bit chips and multi-user systems, new DOS's are being introduced. We do not know what will be the "CP/M" of the future, but there are already indications that today's CP/M software will be able to run under the new improvements.

The UNIX operating system from Bell Labs has many advantages—among them, excellent language and application support. (Cromemco's CROMIX is based on it.) It is predicted that UNIX will become the major operating system for minicomputers and microcomputers. However it runs only on 16-bit machines with memory in excess of 64K, and is intended primarily for multi-user systems. There are some "UNIX lookalikes" that may run on 8-bit machines, but they have not become widely used. In the future, UNIX-based systems may replace CP/M, although MP/M II and CPM-86 are also contenders for future dominance, and they would not make all the present software obsolete.

BASIC (Beginners All-Purpose Symbolic Instruction Code)

BASIC is the most popular of all computer languages. It is also the most versatile. Not really one language, BASIC is a tribe of languages having a common root. They range from Tiny BASIC, which fits into a single-chip computer, to a multi-dimensional disk BASIC for a large main-frame computer.

BASIC was invented in 1963 at Dartmouth College by Professors Kemeny and Kurtz to enable noncomputer science students to use the school computer, which was one of the first interactive time-sharing systems.

BASIC was based on an earlier language, FORTRAN (discussed next), and it can do many of the same things. It has been so effective that it was extended by Digital Equipment Corp. (among others) and soon became a standard language for minicomputers.

The first microcomputers had only enough memory for small machine-language programs. With the introduction of the Altair microcomputer and the S-100 bus by MITS, more memory was added and Altair BASIC from Microsoft became the micro standard. Today, most of the microcomputers on the market use some form of Microsoft BASIC. It has been configured for 8080, Z80, 6502, and 6800, as well as for some of the 16-bit chips of tomorrow. Versions exist in ROM, and there are some on cassettes, floppy disks, and hard disks. Other notable versions are DEC BASIC-Plus, Commercial BASIC (Basic Four), E-BASIC and CBASIC-2 (both intermediate code types). There are also North Star BASIC, Benton Harbor BASIC, Alpha BASIC, TSC BASIC, TI BASIC, and many more.

There are both interpretive and compiled versions of BASIC and some that use a combination of both methods. An interpretive language translates the program source from the high-level language syntax into machine-readable code, on a line-by-line basis. When the RUN command is given, the interpreter translates the first line into machine code and the computer executes it. Then the second line is translated and executed, then the rest of the program, one line at a time. If an error is found, the process stops and an error message is printed. If the BREAK key (or "control C" is pressed) the program stops and the line number where the halt occurred is reported.

The interpretive process must be repeated each time the program is run. However, if changes or corrections are needed, only a few words or lines need be modified. The interpreter is quite large and it must always be present in the memory.

A compiled language has several parts associated with the writing and running of a program. First, there is the original document consisting of statements written in the language format. This is called the "source" and it is composed using an editor program. After it is checked and stored on a disk, the source is compiled (or translated) into a machine-code version called the "object" code. The object code is also stored on the disk. When the program is to be run, the object code is loaded from the disk into the computer memory. Then the RUN command is given. This is much faster than the interpreted method because only the object code has to be loaded into the computer. However, if any change is needed, it is made on the source code and the program must be recompiled. The old object code is destroyed.

There is a third method of translation called Intermediate that is a combination of compiler and interpreter. Both E-BASIC and CBASIC2 (among the most popular BASIC dialects) use this method. In intermediate code languages, the source is written and complied as if it were a compiled language. However, the compiler produces an intermediate-code version rather than a machine-language version. Both the source and the intermediate code are saved on the disk. When the program is run, another program is also loaded at the same time as the intermediate code. This is called a Run-time Package and it is an interpreter that translates the intermediate code into machine code on a line-by-line basis and executes it. You may ask "why go to all that trouble?" The answer is that it makes it very easy to transport the language from one computer to another.

When we examine the reasons for the universal popularity of BASIC we find that it is mainly because BASIC is so friendly. Other computer languages are complicated. They use unfamiliar words, symbols and syntax, but BASIC speaks English. It is a very simple English, using only a few hundred words instead of the thousands of words in human language, but you can understand it from the start.

BASIC does have some defects caused by its inherent lack of structure. It is often said that, in BASIC, programmers have too much freedom to jump around. If a complex BASIC program is not well documented with comments, after a while it is even hard for the author to understand what has been done. To overcome this, Structured BASIC was developed. However, purists claim that the best cure for the defects of BASIC is not to use it.

As in FORTRAN, the common mathematical rules are generally followed, except that multiplication uses "*" as a sign instead of "x." Trigonometry, arrays, matrices and other advanced operations can be done in many versions. With the extensions added over the years, BASIC has become an almost universal language.

The letters of the alphabet are used in equations. If you run out of A through Z, some versions let you use two letters, or a letter and a number.

Although BASIC is simple, it must be "spoken" with precision. It will not tolerate sloppiness. There are a few ground rules that must be followed.

A BASIC program (Fig. 4) consists of statements on numbered lines which are executed one at a time. The program can be made to jump around successive statements, or to other sections of the program, and then return to execute the next line in the program. Control of the program operation is executed via a few easily learned commands, such as PRINT, RUN, GOTO, GOSUB, RETURN, READ, and INPUT. A beginner who has never operated a computer can be writing programs after one or two hours of instruction.

One of the most useful features is BASIC's ability to access machine-language routines through call instructions and PEEK and POKE commands. Some versions have the ability to chain BASIC programs together into a complete software system.

The original operating mode of BASIC was as an interactive interpreter. In the interactive mode of operation, the user types a line and then presses the RETURN key or its equivalent. This returns control to the computer which acts upon what the user has typed. The BASIC then returns control to the user, who types the next line.

Many of the more complex versions of BASIC have been written as compilers. Previously, many commercial publishers of business software were afraid to publish application programs in interpretive BASIC because the source had to be supplied to run the program. The introduction of compiled BASIC and intermediate versions removed this condition and has been an important factor in the growth of microcomputer software development for the entire field.

FORTRAN (FORmula TRANslator)

THIS was one of the first high-level languages to achieve standardization and wide acceptance. It was mainly designed for scientific and mathematical use with large computers, and is always a compiled language. Many business calculations are performed in the FORTRAN language.

FORTRAN is a statement-oriented language, using alphanumeric, mathematical symbols, and logical expressions. Only lines with labels that are referenced elsewhere in the program are numbered in ascending order. FORTRAN executes statements in order and is much more rigid in format than BASIC. The sequence of the program statements is: 1. Specification, 2. Statement Function Definition, 3. Executable Statements. In addition, it is possible to call machine-language subroutines, or FORTRAN subroutines from a previously compiled library.

Early microcomputers did not have the memory capacity to run FORTRAN programs and, therefore, made do with BASIC. With the development of larger memories and the ability to run compiled languages, it became possible to run FORTRAN on smaller computers. There are now many FORTRAN compilers used with microcomputers. But because of the wide availability of compiled BASIC and its ability to do anything that FORTRAN can do, weaknesses aside, the latter has not replaced BASIC in popularity.

COBOL (COmmon Business Oriented Language)

DESIGNED to be used in a business environment, within a short time after COBOL's introduction it seemed that every computer installation had evolved its own version. To straighten out the confusion and under the leadership of the U.S. Navy, a new standard language of business was created, known as ANS (American National Standard) COBOL. Today, many versions of COBOL have extensions beyond the standard, but this is clearly indicated in the instruction manuals.

COBOL is a statement-oriented, compiled language, very rigid in format, designed to match the flow of data in normal business transactions. This data is collected, punched into cards, and processed under COBOL programs in a batch mode on mainframe computers.

Interactive COBOL was only recently developed, matching the development of key-to-disk data input (replacing punch cards). This type of COBOL can run on minicomputers.

COBOL has only been available on micros for a short time and it has been used for many business applications from large computer sources. Little original programming has yet been done with microcomputer COBOL, so it is early to say if it will prove to be as popular on micros as it is on larger machines. Where software packages written in COBOL have been sold, often only the object code has been supplied, while the language has been transparent to the user.

COBOL programs are separated into divisions. The first is the Identification Division which always includes the author's name, and the date when the program was compiled. In addition, this division lists the Installation, Date Written, Security level and Remarks, if desired.

The second is the Environmental Division which specifies the hardware needed by the program, and how it relates to the files. The Configuration Section and Special Names are also part of this division. The Input/Output Section is needed if files are used. For each file there is a SELECT entry and an ASSIGN clause.

The Data Division includes the File Section and the Working Storage section. Finally, the Procedure Division completes the program. All of this must be done within rigid specifications. This creates a self-documenting program that only requires an additional explanation of why certain procedures were selected for a problem.

The trouble with using COBOL for interactive microcomputer programs is that all these requirements were originally developed for a punch-card operation in a batch mode, where the programming and operating functions are separated. In an interactive operating mode, these requirements take up space and use a lot of the computer memory. This is one of the reasons there has been no rush to adopt the COBOL now available for microcomputers.

APL (A Programming Language)

APL was created at IBM by Kenneth Iverson. It remained an internal language until it was released in the 1960s as an interactive, time-sharing language running on large mainframe computers. APL was originally a scientific language noted for its ability to create and manipulate multidimensional matrices.

A number of the IBM people who had been involved in the development of APL left the company and started time-sharing services devoted to the language. These services extended APL, added file structures, and made it into a business-oriented language. APL is especially valued by insurance companies and airlines for their complex routing and scheduling problems.

APL has been implemented on mainframes and large minis, but only on two microcomputers. Recently, however, two versions were released to run under CP/M. There are several problems with APL as a popular language. First, it has a character set which is different from any other. Some of the characters require two keystrokes with a backspace in the middle and this is not compatible with most terminals. It does not use the ASCII code (the industry standard) but instead uses Z-code, which is completely different. Second, all operations in APL are evaluated from right to left. In our culture we are used to evaluating things from left to right and this can be confusing. Third, APL uses very complex operators that permit programmers to express complicated ideas on a single line. This has lead to a very compact code that is hard to read unless it has frequent comments.

APL is always an interpretive language, using a lot of memory space and running slower than compiled languages. It gives each user a large block of memory called the Workspace as soon as he signs-on the system. In addition, it does not save individual programs (called functions), but instead saves the entire Workspace. This also uses up memory space.

APL has been restricted to large computers until recently. Thus, it does not have the wide application of COBOL, FORTRAN, or BASIC. In addition, with the development of Pascal, C, and Ada, which can also use multidimensional arrays, one of the main advantages of APL has been usurped. It should be mentioned that the new IBM small computers no longer support APL and that cassette software in APL for the Model 5100 is also no longer supported.

STRUCTURED LANGUAGES

Structured language is based on a hierarchy of operations starting with the general and proceeding to the specific. There has been a movement in computer science toward languages that fully utilize data structures and require a user to declare all the specifications for a program change. Pascal, PL/1, C, and Ada are languages of this type; and they are replacing the older languages for both business and scientific computing. Structured languages, especially Pascal, are becoming the major instructional languages in computer science departments. Accordingly, they are expected to encroach on FORTRAN, COBOL, and possibly even BASIC in time as the most important languages. Pascal is already supported on all major minicomputers, microcomputers, and a great many mainframes. PL/1, which was originally a language for very large computers, has been adapted for smaller machines. And the U.S. Defense Dept. will make Ada mandatory for all its offices and contractors by 1985.

Pascal— BASIC's Successor?

ABOUT the same time that FORTRAN was being developed in the United States, another language was designed to implement solutions to complex algorithms. It was called ALGOL (Algorithmic Language) and it became popular in Europe. It is an excellent language, but somewhat difficult to learn. In 1971, Niklaus Wirth of Zurich, Switzerland, invented Pascal as a tool for teaching ALGOL and to demonstrate the principals of structured language. In 1975, the standard Pascal was defined in *Pascal User Manual and Report* by Kathleen Jensen and Niklaus Wirth. Pascal is an easy language to learn and it is suitable for defining the data structures needed for problem solutions. The language was named for Blaise Pascal, the French mathematician who invented one of the first mechanical computing devices. So the name is not an acronym and, therefore, all letters are not capitalized.

Pascal compilers were written for mainframe computers and the language gained popularity in the computer community. At the University of California, San Diego, Dr. Kenneth L. Bowles started to implement Pascal on mini and microcomputers. The result has been the UCSD Pascal System. This is not only an implementation of Pascal, but an entire operating system that includes several Editors, a File Handling System, an Assembler, a Compiler, and a Debugger. UCSD Pascal now runs on Apple, North Star, Texas Instrument, Radio Shack TRS-80 Mod II, OSI, DEC, Western Digital Microengine, and many other personal computers. Other versions of Pascal are used on minicomputers, large mainframes, and microcomputers. Almost every manufacturer of computers supports some kind of Pascal in addition to whatever other language he uses.

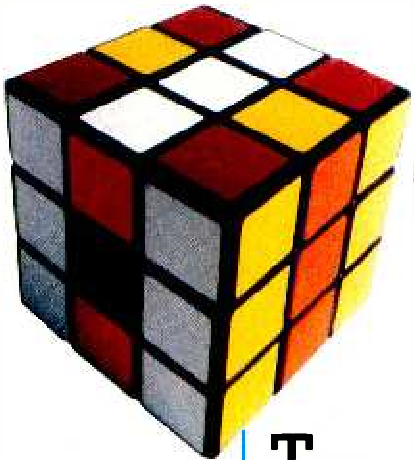
Like BASIC, Pascal "speaks" English, and uses the conventional mathematical symbols. It can do trigonometry and advanced mathematical operations, and deal with character data and strings. Pascal operates on standard data types such as integer, real, and Boolean, but gives the programmer the freedom to define new data types. The programmer can also define new functions and procedures.

Pascal is a compiled language, but it does not usually compile into machine code. Instead, it compiles into an intermediate pseudo-code called p-code. The p-code is then saved on the disk file system. At run-time, the p-code file is interpreted into the machine code of the computer.

As with all other intermediate-code languages, this method makes the language portable. To move Pascal to a new computer, all you have to do is write a new interpreter from p-code to the machine language, a far simpler task than adapting a complete language. In one computer, the Western Digital Microengine, p-code is the machine language of the microprocessor, allowing it to run without the interpretive step.

There are other versions of Pascal that do compile into machine code, called "native-code compilers." They run very fast, but are not transportable from machine to machine. Pascal-Z, produced by Ithaca Intersystems Inc. for the Z-80, is of this type.

Pascal is fast becoming the most popular language for application software, a fact that is not always apparent because only the object code and a run-time package are delivered with the application system. (This provides a measure of protection for the software publisher). Figure 5 shows the same problem used in preceding references, done in Pascal.



The C Language

THE language called C is a computer language designed at Bell Laboratories to operate upon the powerful OS called UNIX. It is a structured language with some resemblance to Pascal. However, Pascal uses both functions and procedures, while the C language achieves modularity only through the use of functions. It builds the entire program structure through the use of functions even to the point of having no Print or Read statements. It does input and output through use of functions. It does have "if-then-else," "while loops," global and local variables and data types, pointers and arrays. Like Pascal, it can replace single statements with compound statements to promote program flow. C is a compiled language in which programs are composed using an Editor and then are compiled into machine code versions to be run on the computer. It has no I/O structure of its own; instead, it uses the I/O of whatever operating system it is implemented on.

A C program is a set of functions. The ability of the programmer to create his own functions according to his needs make C an unusually flexible language. There are no line numbers in C. The program starts with the name of the function, then a square bracket to start function definition. This consists of compound statements between two square brackets. Statements are nested to any depth required and are treated just like simple statements. There are libraries of standard functions and those functions previously defined by the user. All of these can be called for use in the program. There can be both Global and Local variables and there can be arguments for the functions. There are also Expressions which are used to calculate and store data. C can call machine-language routines when needed as well as any of the personal or standard function libraries.

While C originated on the UNIX OS, it has been transported to run on other operating systems such as CP/M and Unix-like systems. Many application software packages for micros have now been written in the C language and sold only in object code form. As the UNIX OS and its look alikes become more popular, the C language will become more widely used. With Pascal, the original idea of a language that was transportable between machines seems to be lost as more and more incompatable versions come into use. With C this has not happened. The entire language was written by one person and there is one book specifying it: *The C Programming Language* by Brian W. Kernighan and Dennis M. Ritche (Prentice-Hall, 1978).

Ada— The Rising Star

THE COBOL language became a standard business language because it was required by government agencies in the 1960's. Now, the U.S. Department of Defense has decided that a new language is needed to coordinate the application needs of the Army, Navy, and Air Force. The process of development for this language was started in 1975 when suggestions were solicited from the three military services, industry, and academia. At the same time, an intensive study of existing languages was made to determine if any of them met the requirements for a universal language, and if not, to develop specifications for one. It was recommended that either Pascal, ALGOL 68, or PL/1 be used as the starting point for the new design. Pascal was the one put forward, and the new language was developed from it. Called the "Green" language, it was renamed Ada in honor of the first computer programmer, Lady Ada Augusta Byron, Countess Lovelace, daughter of the poet Lord Byron. Since then, Ada has been undergoing extensive tests and compilers have been written for several mainframe computers.

Dr. Kenneth Bowles, the leader of the project that developed UCSD Pascal, has left the University of California and is working on implementing Ada on some of the advanced microcomputers using Western Digital microprocessors and the Motorola 68000 chip. Other versions will follow. This kind of support, and the fact that Ada will be mandatory for the Defense Dept. and all its contractors by 1985, portends a very important role for the new language.

Ada looks like Pascal. It has a declarative part and a statement part. It is a strongly typed language because all identifiers must be declared and their attributes specified. The two most important control structures are the conditional statements (which select alternative actions) and loop statements (which specify repetition of an action). Ada uses many types of functions and subprograms called Procedures. In addition, Ada also has two kinds of modules called Packages and Tasks.

Packages are used to define logically related collections of resources for use in computation. Tasks are separate jobs that are done at the same time in either a time-sharing environment, or a distributed processing system. The collective term for this is 'Multitasking' and ADA has been designed to set up and run such jobs as part of a program. Similar things can be done by Pascal, C, or PL/1, but Ada is the first language created to manage the complex computing activities that use multiple processors with almost unlimited memory resources.

Forth— An Independent Language

THIS is another language created by one man, Charles H. More, and it was first used to control the telescope at Kitts Peak Observatory. It has since developed a following of programmers who have carried its banner at all computer meetings and shows, more like a cult than a computer language user group.

Forth is not an easy language to learn as it is quite dissimilar from anything we are used to. In addition, it does its calculations in Reverse Polish Notation (RPN). It is sometimes called the unfinished language because the programmer has almost unlimited freedom to create new Words. *Everything* in Forth is a Word (which is another term for a function). It is not much good as a number cruncher, but it can link to subroutines in other languages for the heavy math. It greatly reduces the cost and work of subroutines. The programmer keeps on defining new words by using old ones, and before you notice, the job is done. You do not have to do much original work to write a new program because when the system comes up, so does all the work you have ever done before, just as if it had always been part of the language! Now you see why programmers take the trouble to learn this strange language.

When you look at a Forth program, it is confusing because everything seems to run together, but after a while it begins to make sense.

In Forth, most operations communicate by using the Stack (that section of memory where you store numbers in last-in-first-out order). While all languages use the stack, its operation is usually incorporated into the language itself. Not so in Forth, where the programmer controls the stack directly.

There are some normal things about Forth. It is a structured language with no GOTOs or labels for statements. It is an interpretive language that is later compiled into machine-readable code, and therefore needs very little space in the computer memory. A full Forth can fit into a 16K machine and have room for 8K of programs. In addition, it is low cost. The Forth Interest Group has made versions available for almost every microprocessor. Even the commercial versions are cheap and offer a lot of features for the money.

One other characteristic of Forth is that it is a Threaded Language. This means that programs are constructed from a few subroutines which are connected together by a series of subroutine calls to perform a larger task. This entity is then called by a larger routine and connected to others to form a still larger entity. Threadedness is not restricted to Forth, but while other languages can use it, all Forth versions do use it.

When you go to a computer show and you see the cult members who have found the One True Language and wear the funny buttons, don't laugh. Perhaps they have found it and the rest of us are just lazy.

LISP (LISt Processing Language)

THE language of artificial intelligence research, LISP was based upon John McCarthy's work on nonnumeric computer languages published in 1960. The language LISP was implemented at MIT and is described in the LISP 1.5 Programmers Manual. It has since been configured on many mainframe computers, minicomputers and microcomputers.

LISP is a nonmathematical language composed of words, like any language. In LISP there are two kinds of words: atoms and lists. Atoms are the basic entities of LISP. Basically, any combination of the characters of the alphabet, A,B,C. . . X,Y,Z with any of the ten digits 0,1. . . 9 is an atom, as long as it starts with a letter. A list is the second type of word in LISP, and it is built up from atoms and other lists. A list consists of a left parenthesis followed by any number of atoms and lists, terminated with a right parenthesis. The language has functions, variables, and arithmetic operators, but it looks strange to BASIC programmers because all the arithmetic operations are in Reverse Polish Notation (RPN). A LISP sentence looks like a list, but it carries meaning and it is actually an elementary program. All LISP functions have a single value and a program consisting of functions applied to arguments. The LISP language has many built-in functions, and the programmer can create functions at will.

The printout of a LISP program looks unusual, but if the LISP includes a "Prettyprint program," which formats a program by indenting subsections, the listing will look much more conventional.

PILOT (Programmed Inquiry, Learning Or Teaching)

PILOT was the first computer language dedicated to computer-aided instruction, and was developed at the University of California, San Francisco. It has been implemented on many computers ranging from very large mainframes to the simplest micros. This interactive language enables a person without prior computer experience to develop and test dialogue programs for teaching, since its structure and syntax are easy to explain to a student.

Using PILOT, the teacher can present the student with a reading passage, give him time to study it and then ask him multiple-choice questions based upon the passage. The program can include computer responses keyed to the answer the student has given. It can also scan his response and give him advice or comment based upon that response. It can introduce a mathematical problem and offer the solution on a step-by-step basis or give the student an opportunity to discover as many of the steps as he can, with hints from the computer.

PILOT instructions are divided into six categories:

1. Core Instructions. These basic functions are single-letter instructions and are standard for all of the versions of PILOT. Thus the programs are portable from machine to machine. The instructions are:

T: TYPE (includes Y: and N:)
A: ACCEPT
M: MATCH
J: JUMP
U: USE
E: END
C:COMPUTE
R: REMARK

There are also multiword instructions called "keywords" that have been added to PILOT for special applications and are not included in all versions.

2. Cursor and video instructions to determine where the text will appear on the screen.

3. Instructions that set various kinds of parameters related to the computer such as output ports, display speed, or memory locations.

4. File system instructions relating to storing and retrieving programs and data.

LOGO—A Learning Language

THE LOGO language represents a completely different path to learning than does PILOT. Its inventor, Seymour Papert, believes that CAI techniques, like PILOT, only transfer the old methods of teaching to the computer without using the unique capabilities of this new tool to combine text, form, color, and sound into a new learning system. For the last ten years at MIT, he and his colleagues have been working to perfect the techniques used in LOGO. The result is a language in which a five-year-old can quickly learn to write a program. Yet it is sophisticated enough for higher instruction.

In the child's version, LOGO uses basic modes called sprites and turtles. The sprites are forms that the child creates that move around the screen at any speed the child selects. The turtle is a figure that the child can interact with, moving it over the screen, coloring it, and making it draw or erase lines.

The teacher can also program more complex functions (programs) that children can interact with through simple keyboard responses. Children learn color, direction, letters, words, and sounds through this medium and usually find it fun. It also teaches them planning, and the use of the computer which will be one of their major educational tools throughout their school years.

At this time, LOGO is available for the T.I. 990/4 computer, and there is a version for the more popular Apple II that MIT has not yet released.

(Continued on page 56)

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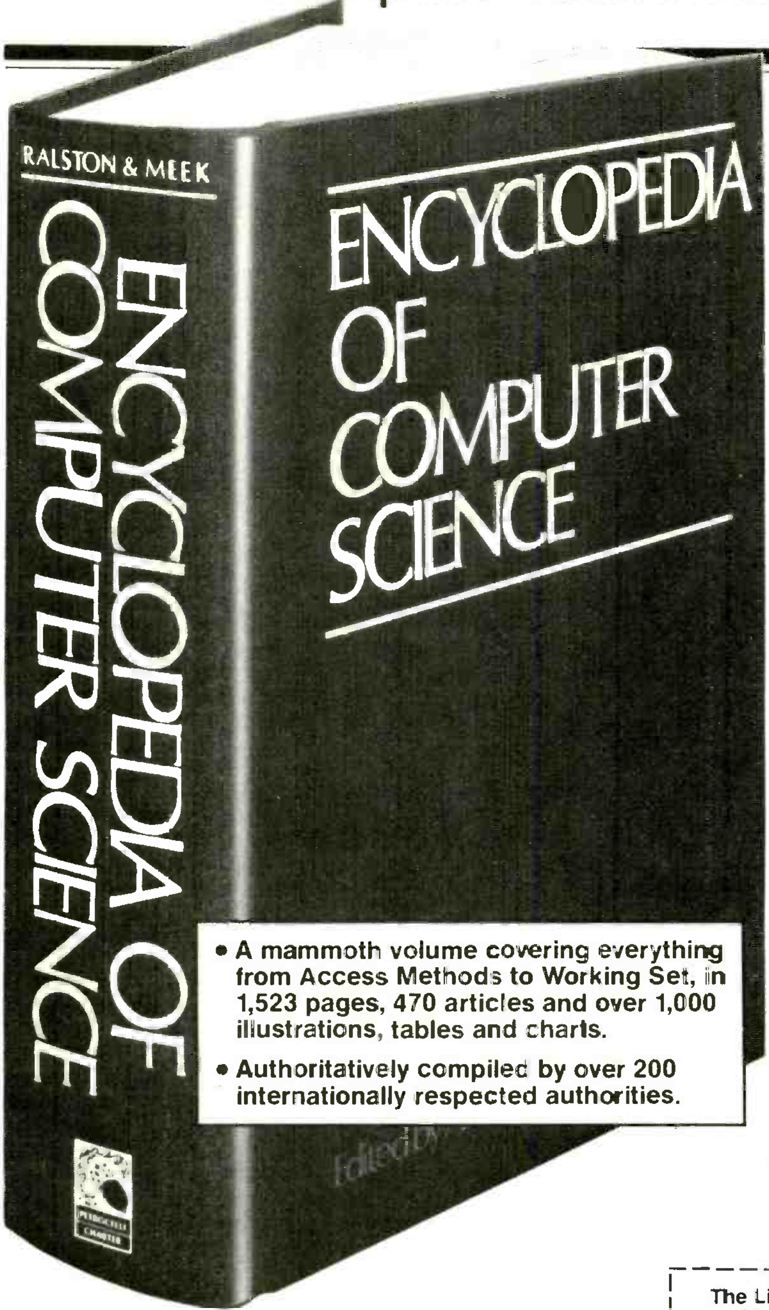

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Other Computer Languages

PL/1. This language was one fo the first structured languages and was designed by IBM to run its mainframe computers. The language suffered from its great scope and complexity. Later subsets of PL/1, such as PL/M, were designed to run on minicomputers, and they were often used as cross-compilers to develop microcomputer software on larger machines. Until very recently, no micro had enough memory and capacity to run PL/1. However, with the development of the 16-bit and 32-bit microprocessors, this language has a future for use on the large micros. Digital Research, the developer of CP/M, has a version called PL/1-80 to run under advanced versions of CP/M and MP/M.

CAI. (Computer Aided Instruction) Languages. This term designates a family of languages used with computers as a teaching tool. In the next decade, CAI will become more important as we learn to use the computer to enhance our educational system. Some of the languages designed to aid in education have already been discussed.

Report Generation Languages. RPG II is one of the most widely used languages for mainframes and large minicomputers. It is used to create report formats for the output of all kinds of application software. In the future, with multiuser and multitasking computers being designed around 16-bit and 32-bit microprocessors, RPG languages may be used by all computers.

Data Description Languages. These languages are used to create, input, select, sort, and format information stored in a general application data base. They are generally not called "languages" by the software publishers, who only refer to the complete system by name. However, the CODASYL (Conference on Data Description Languages) which was formed to set standards for data base systems uses this term to refer to the entire Data Base Management System (DBMS).

Some of the commercial DBMS systems using very complex data description languages are TOTAL, RAMIS, ADBS, and IMS. All of these run on large mainframe computers. With the development of large floppy-disk and hard-disk storage systems, data-base systems became possible using mini and microcomputers. Some of the larger DBMS were scaled down to run on minis, but most of the micro systems were written for microcomputers specifically. They all use operators and functions that are complex enough to be a complete language.

Program Generation Languages. This is a new family of software systems that constitute a set of languages. Their object is to automatically write programs in another language. They are a kind of "paint-by-numbers" software. They present the user with a set of fill-in-the-blank screens to enable the user to specify just what he wants to do. The answers to these questions constitute a psuedo program from which the system "writes" a program in BASIC, or whatever language the system is designed to use. In reality, the "system" is an English-to-BASIC translator language. PEARL and "The Last One" are typical of this type of system, but are by no means the only ones or the last ones.

Conclusion. Once you have read about computer languages and begun to understand their differences, you may find that you still can't decide which one is the best for you. There are just too many choices. For example, you may need to control a robot that has a single-board computer and only 4K of memory. You could use machine language or assembly language, or you could write in Forth and compile to machine code. However, you could also use Control BASIC or Tiny Pascal. The choice is yours, and there is no single answer.

If you are interested in business applications, home controls, or scientific research, the options are still wider. Perhaps this is why Charles More invented Forth to control his telescope; machine and assembly language took too long to use while other languages were too rigid and did not allow him adequate flexibility. Today, you do not have to invent a language to tailor a program to your needs.

For most people, the choice has been made for them. Usually, a computer comes with a language, most often a simple version of BASIC in ROM. Once you learn this BASIC, you will probably find that you can do all kinds of wonderful things with it. You will likely want to do more by adding memory and a floppy disk or two. This, in turn, opens up the world of disk software for word processing, business applications, etc. This is also when you find out that you have to buy the exact package to run with your BASIC and your DOS because there were many different types.

Do you want to try different languages on your computer? Well, it's simple. All you have to do is buy a version of a language that runs under your DOS and does not require more memory than you have. Then read the manual that comes with the package, put the diskette in your drive, and you are running PASCAL, FORTRAN, or COBOL. You also will need a good textbook—one designed for microcomputer versions of the language. The manual you get with the language package teaches you how to run the language and what special things are in that version. It does not teach you the language. Study your text, use what you learn on your computer, and it will bring back the fun you had when you first bought the machine as well as giving you opportunities to use more efficient languages for particular purposes.

For those who haven't yet bought a computer, but are thinking of it, everything we have said applies to you also. If you want to have a choice of languages later, be sure you choose a machine that has a variety of languages available.

Most often, language packages are available from the computer manufacturer. However, they are also sold by software companies that specialize in one or more languages. Another good source is the computer clubs since they may serve as a distribution channel for languages developed by universities and the government. Language user groups also distribute languages at low cost. The FIG (Forth Interest Group), for example, sells its software and books—and at reasonable prices. ◇

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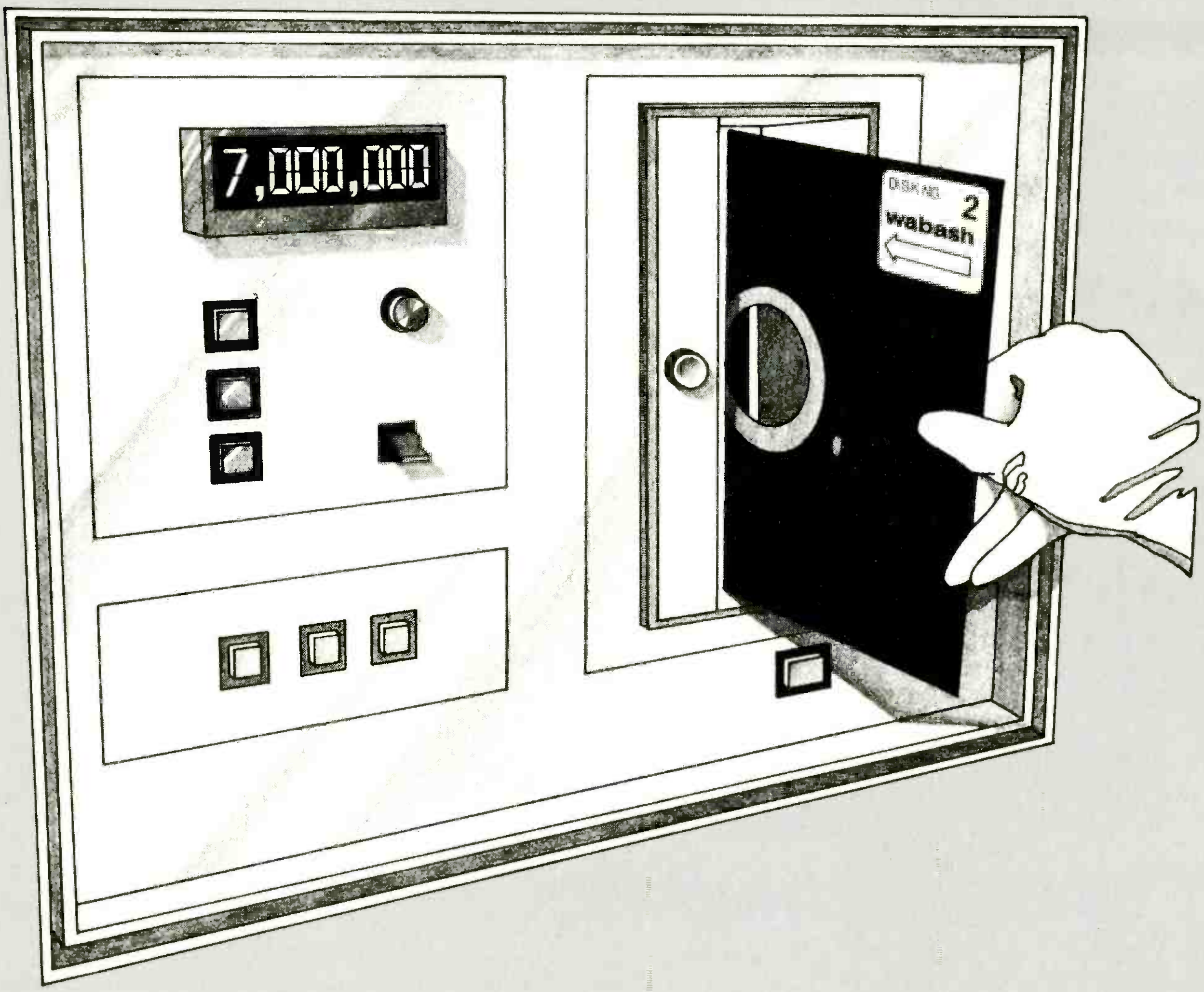

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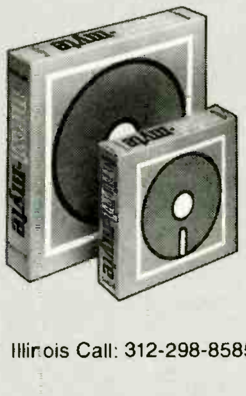
Wabash MAXI-MYTE™ 8″ diskettes and MINI-MYTE™ 5¼″ diskettes are a quality buy no matter what your criteria. In standards testing performed by 25 prestigious drive manufacturers (including the world's largest) Wabash diskettes emerged a sure winner. . . with the papers to prove it.

The fact is, Wabash quality is unsurpassed in the industry, with a five year usage warranty that will keep your customers satisfied for years to come.

So the next time you're faced with a purchasing decision, don't take chances. Any way you look at it, Wabash diskettes are your best bet for the long run.

wabash

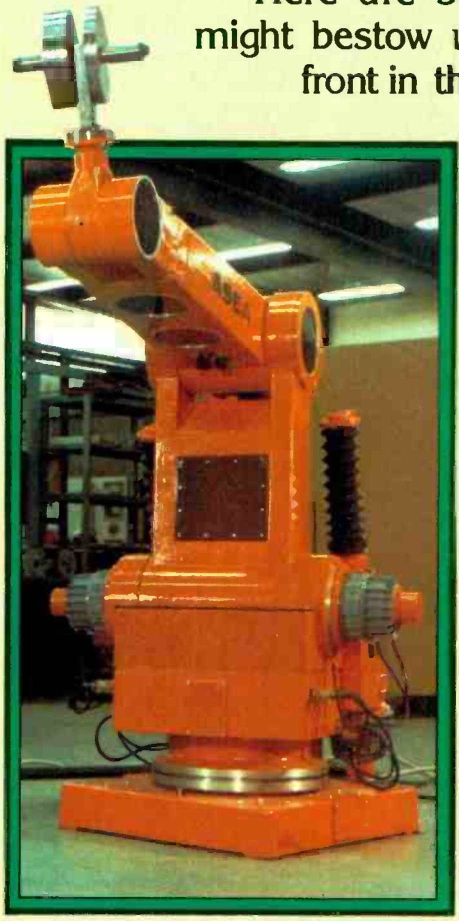


Wabash Tape Corporation 2700 Des Plaines Avenue, Des Plaines, IL 60018 800-323-9868 Illinois Call: 312-298-8585

CIRCLE NO. 51 ON FREE INFORMATION CARD

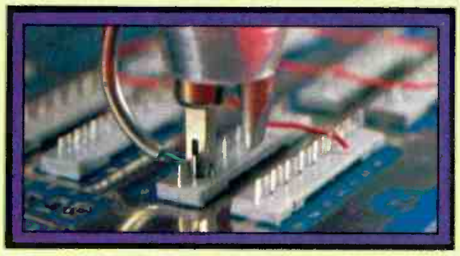
Holiday Gifts for Electronics Enthusiasts

Here are some ideas for gifts you might bestow upon yourself to keep you up front in the electronics revolution.



...PERFECT FOR LARGE REC ROOMS

A programmable robot from the Industrial Robot Div. of ASEA.

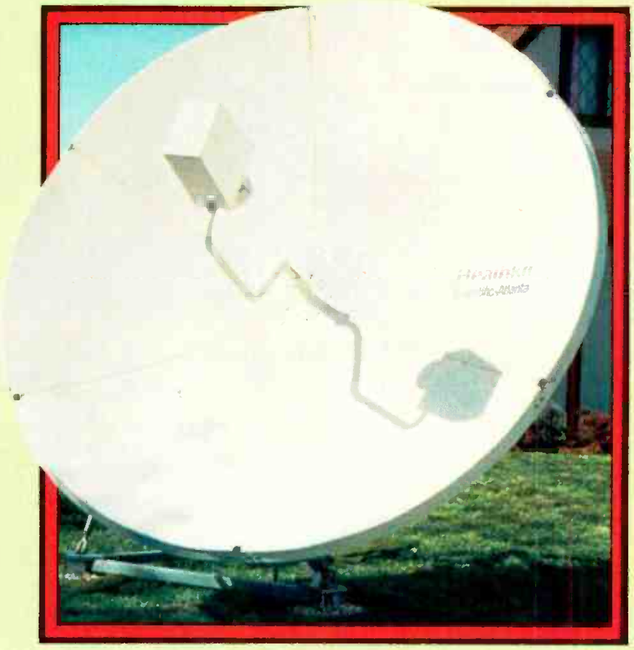


...A NEW EXPANDABLE BREADBOARD SYSTEM FOR PROTOTYPING

Scotchflex solderless plug and strips from 3M uses "U-contract" system with self-feeding wiring tool.

...SPRING-LOADED BINDING POSTS

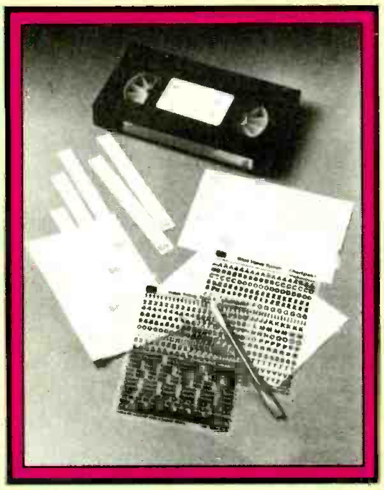
Developed by ITT Pomona Electronics, the insulated binding posts eliminate exposed wires to prevent potential shock ($3.98 each).



...ADD A SHADY SPOT IN YOUR BACK YARD

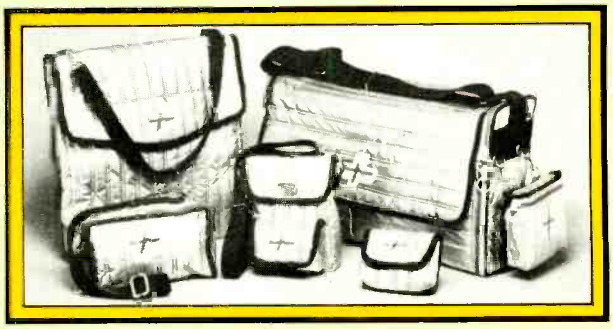
Heathkit/Scientific Atlanta's earth station antenna picks up TV signals directly from satellites for the ultimate in TV viewing pleasure and neighbors' gawking.

Holiday Gifts...



...A VIDEO CASSETTE TITLE & LABEL KIT.

BIB's new VE-17 system gives a professional look to one's VC library.

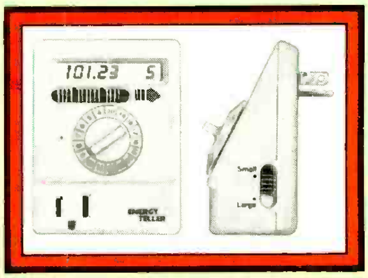


...PADDED CARRYING CASES FOR AUDIO/VIDEO GEAR.

To carry around your VCR, LP records, cassettes, etc., you might like to protect them with the padded silver-color carrying cases by Osawa under the Sound Pepper brand.

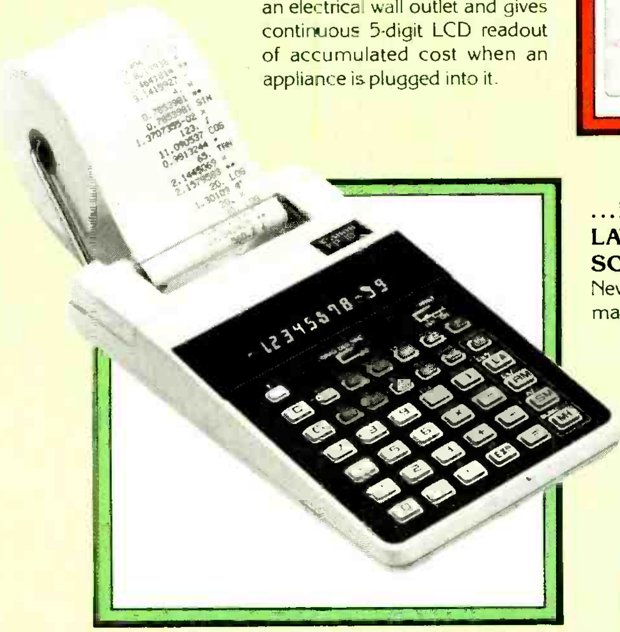
...DISPLAY APPLIANCE ENERGY CONSUMPTION IN $ & ¢.

The "Energy Tellerx" plugs into an electrical wall outlet and gives continuous 5-digit LCD readout of accumulated cost when an appliance is plugged into it.



...MULTIMETER'S SCALES CHANGE WITH FUNCTION.

You can't read the wrong scale with Soltec's LCD-900 analog multimeter, since unused ones disappear from the meter face.

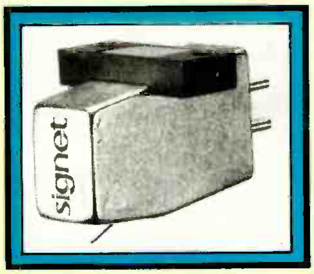


...PORTABLE CALCULATOR/PRINTER WITH SCIENTIFIC PRINTOUT

New Canon FP-10 provides permanent record of calculations.

...TALK OF THE TOWN.

TYPE-N-TALK, VOTREX's text-to-speech synthesizer, allows a personal computer with the standard RS232C interface to produce highly intelligible English speech from text typed on the computer's keyboard.

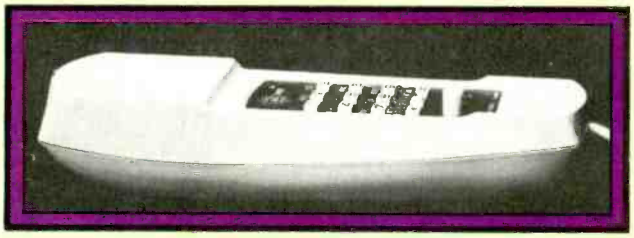


...PHONO CARTRIDGE FOR A ROLLS ROYCE OWNER.

Only $1200.00, the TK100LC from Signet is distinguished by a tubular ruby cantilever and toroidal coils wound with silver wire, plus the omnipresent diamond stylus.

...SECOND COMPUTER IN EVERY HOME.

Mattel's "Children's Discover System," designed for youngsters age 6 to 11, gives them a computer learning experience and frees your personal computer from tiny hands until they're a little older. Has 2K memory, musical effects, LCD viewer, keyboard, and plug-in program cartridges.

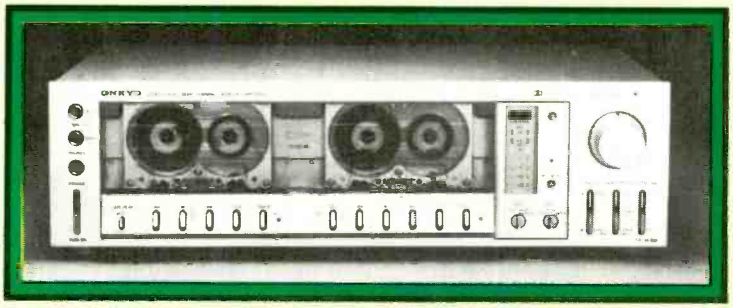


...ONE-PIECE PHONE WITH AUTO MEMORY DIALING & MEMORY-ON-HOLD.

U.S. Tron's innovative replacement telephones store 11 or 22 phone numbers in memory and uses a custom IC that requires no extra power source.

...PLUG-IN CARD ADDS CP/M TO APPLE II.

With Microsoft's "Softcard," you can run all the Z-80/8080 software you thought your Apple II's 6502 CPU couldn't handle. It contains the CP/M operating system, Microsoft BASIC-80, and a Z-80 CPU.



...TWIN-CASSETTE DECK FOR EASY DUBBING.

With Onkyo's TA-W80 you can duplicate cassettes at twice the normal speed using only one machine.

...FROM THE PEOPLE WHO GAVE YOU "WALKMAN."

A stereo FM headphone radio, Model MDR-FM7, from Sony.

...A TALKING TIMEPIECE.

The OMNI "Voice Master" by Personal Electronics tells you the time in a synthesized voice when you press the "speak" button or the 24-hour alarm is activated. For wrist, desk, or automobile, you'll never be lonely again.

...LAZY MAN'S WIRE-WRAPPING TOOL.

A new battery-powered wire wrapper from O.K. Machine and Tool Corp.

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No matter how well your video cassette recorder has been performing, it's never lived up to its full potential. Because until recently, you couldn't buy High Grade video tape for Beta systems.

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So if you own a Beta recorder, try Maxell High Grade. You'll discover that the machine you own is even better than the one you bought.

maxell
IT'S WORTH IT.

Maxell Corporation, 60 Oxford Drive, Moonachie, N.J. 07074.

CIRCLE NO. 48 ON FREE INFORMATION CARD

BY CRAIG STARK

COMPARING HIGH-TECH AUDIO CASSETTE TAPES

What makes one cassette tape better than another? Are there any real differences between the technologically best products? To provide an answer to these questions, samples of some of today's "top tapes" were subjected to a number of established tests designed to bring out their strengths and weaknesses.

LET's begin our comparison with an overview of the tape market. There are four major cassette tape *types* currently available. The most widespread is Type I, ferric oxide (Fe_2O_3), which is produced in all grades of quality, from 3-for-a-dollar unbranded specials to top-notch formulations, some of which are lightly laced with cobalt to improve their magnetic performance. As a type, ferric-oxide tapes use the least record bias, and are designed to be played back with 120-microsecond equalization (see Fig. 1).

Type II tapes are known generically as chromium dioxide (CrO_2), though most such tapes today are cobalt-enhanced ferric-oxide formulations, usually designated as "chrome equivalent." Chrome-type tapes use roughly 50 percent more bias than ferrics, and are intended for playback with 70-microsecond equalization. The difference between 70-microsecond (chrome) and 120-microsecond (ferric) playback equalization affects the amount of tape hiss you hear. All else being equal (though it rarely is!), you'll get less hiss from 70- than from 120-microsecond playback equalization (see Fig. 1).

Ferrichrome (FeCr) tapes are designated Type III, and use two separately coated layers of magnetic material: a relatively heavy layer of ferric oxide, topped by a thin layer of chromium dioxide. Highly popular in the car stereo market, ferrichromes have not won wide acceptance among home-based audiophiles because of wide variations from brand to brand. Thus, hi-fi cognescenti rarely use these tapes for home systems; and for that reason they were not tested in this study.

The newest entrants on the cassette scene, Type IV, are the metal-particle tapes. Although these can be *played back* on any tape deck with a 70-microsecond ("chrome") equalization position, their extremely high bias requirement—approximately twice that of

CrO_2—demands that they be *recorded* on a deck whose heads and bias oscillator are designed to handle the high current associated with such high bias.

Theoretically, the "best" tape is that which produces the least inherent noise while providing the greatest undistorted signal storage capacity across the range of desired wavelengths. "Wavelengths" correspond to "frequency response," once you factor in tape speed. One second's worth of a 1000-Hz tone at a tape speed of 15 inches-per-second has a wavelength eight times as long as the same one-second tone at the cassette speed of 1 7/8 ips, and a tape formulation optimized for the former speed will not be equally suitable for the latter.

"Undistorted" is admittedly a weak word, but long-standing tradition, based on successful experience, favors defining it in terms of 3% third-harmonic distortion at a suitable middle frequency for the tape speed involved. For the tests in this report, the 400-Hz frequency used by Dolby-level calibration tapes was chosen.

Practically, of course, the "best" tape is that which most closely approximates the theoretical ideal *on your machine.* This is an important caveat. Tapes do test (and perform) somewhat differently on different tape decks and under different bias (and record equalization) conditions. I used the top-quality three-head Nakamichi 582, which has a wide record-head gap (3.5 microns) and a narrow-gap playback head (0.9 microns). A typical two-head cassette recorder, on the other hand, might have a record-playback head with a gap of 1.2 to 1.3 microns. The head gap affects both the high- and low-frequency extremes. Too wide a gap limits treble playback response; too narrow a gap *may* limit penetration of the record signal to the full depth of the magnetic coating.

In practical terms, a deck with a wide record-head gap will favor tapes with a relatively thick magnetic coating when measuring signal-to-noise ratio; the advantage of the thick coating may not be realized on a two-head deck. Similarly, a recorder with a narrow-gap playback head will tend to favor tapes with highly polished surfaces, which facilitate flat response to 20,000 Hz and beyond, though this advantage might not show up at all on a typical two-head deck, whose response may only extend to about 16.5 kHz.

Record bias and equalization are additional considerations when tapes are compared. Most decks provide a 3- or 4-position switch that sets bias and equalization (EQ) for optimum performance from a *specific* tape within each basic type. Brand-to-brand differences among tapes of the same type do exist, however, which is the rationale for the "bias optimization" controls included in many decks. Using the adjustments available on my tape deck, I could have optimized the deck for each tape in turn, but this wouldn't show up tape *differences* under the fixed conditions most deck owners have to use. I chose instead, therefore, to set up my test deck with the tapes most frequently specified as having been used in factory alignment by the numerous deck manufacturers whose recorders I have tested in recent years. These are: Maxell UD-XLI (ferric); TDK SA (CrO_2-type); and TDK MA (metal).

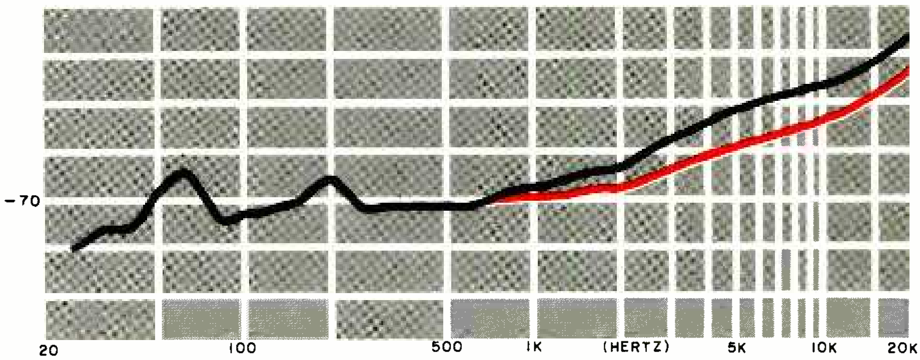

Fig. 1. Comparison of noise-level between 70-microsecond (colored curve) and 120-microsecond (black curve) playback equalization. The 70-dB level is with reference to 200 nanowebers/meter (Dolby level). The 70-microsecond equalization is standard for chromium dioxide tapes and 120-microsecond for ferric. If all other factors are equal, there should be less hiss from the 70-microsecond playback equalization.

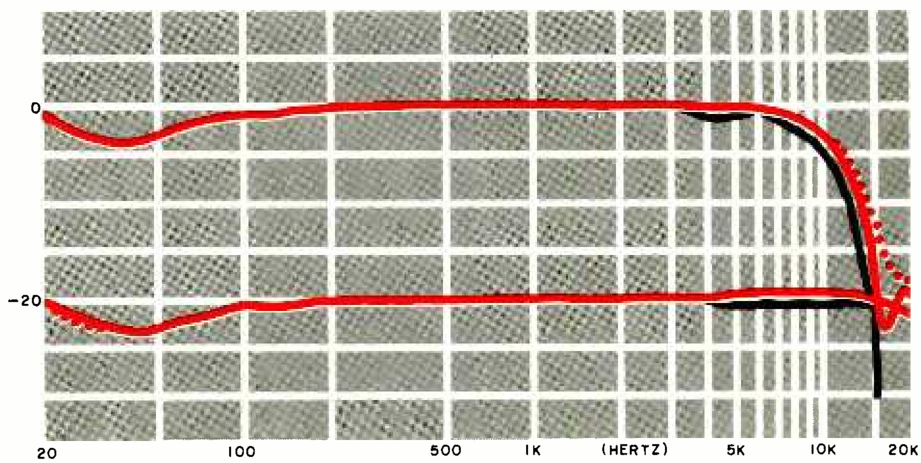

Fig. 2. Response curves for the three reference tapes: Type I, Maxell UD-XLI (ferric), solid black curve; Type II, TDK SA (chrome), solid color curve; Type IV, TDK MA (metal) dotted color curve. (These conventions with regard to the curves and Types apply to all of the response curves on the opposite page.) The tape deck used in the tests was adjusted for the three reference tapes and left that way for the rest of the tests.

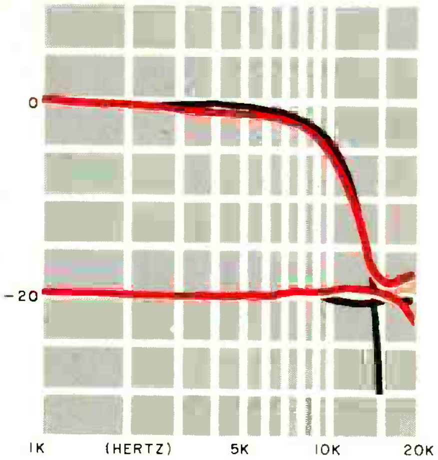

Fig. 3. BASF Professional I (solid black); BASF Professional II (solid color).

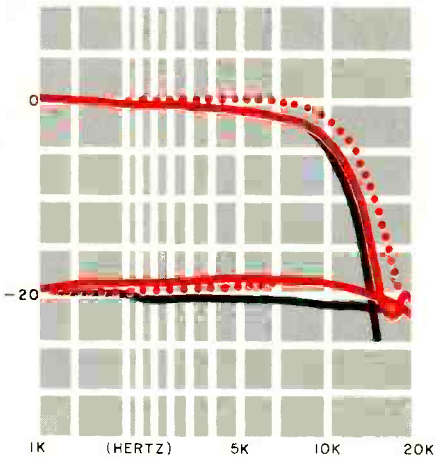

Fig. 4. Fuji FX-I (solid black); Fuji FX-II (solid color); Fuji Metal (dotted color).

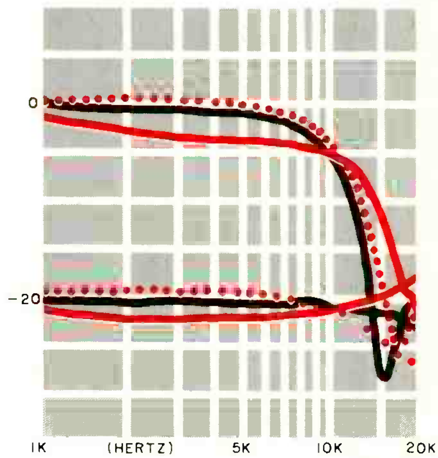

Fig. 5. Loran Normal Bias (solid black); Loran Chrome (solid color); JVC ME-P (dotted color).

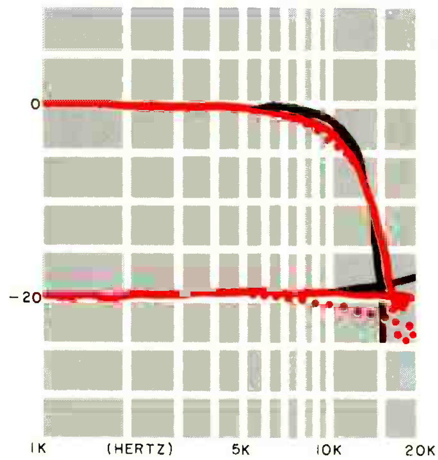

Fig. 6. Maxell XL-IS (solid black); Maxell XL-IIS (solid color); Maxell MX (dotted color).

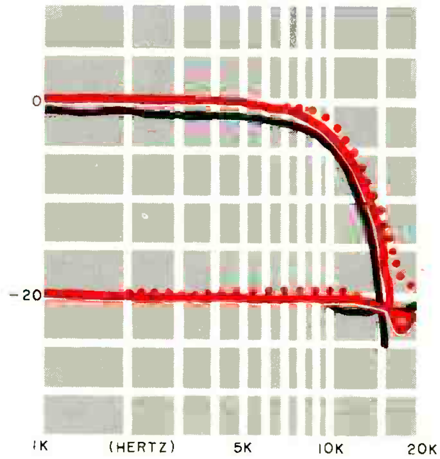

Fig. 7. Memorex MRX-I (solid black); Memorex HBII (solid color); Memorex Metal IV (dotted color).

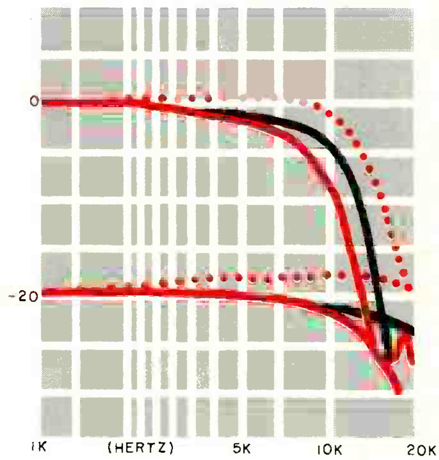

Fig. 8. PD Tri-Oxide Ferro (solid black); PD 500 Crolyn (solid color); PD 1100 Metal (dotted color).

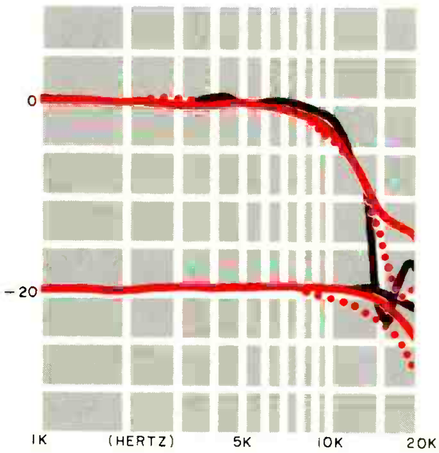

Fig. 9. Scotch Master I (solid black); Scotch Master II (solid color); Scotch Metafine (dotted color).

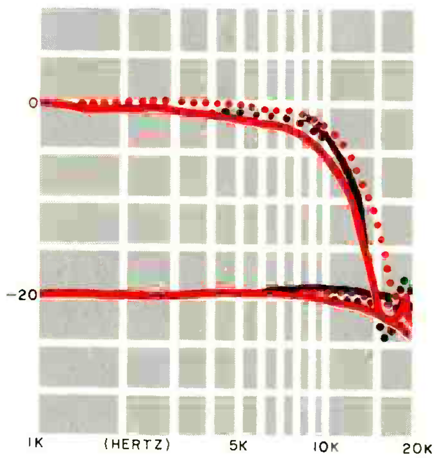

Fig. 10. Sony HFX (solid black); Sony EHF (solid color); Sony Dev. Hi-Bias (dotted black); Sony Metallic (dotted color).

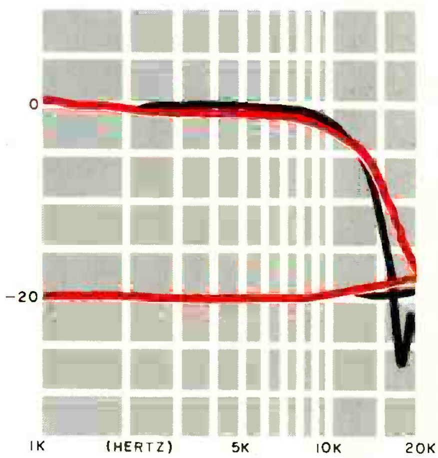

Fig. 11. TDK AD (solid black); TDK SA-X (solid color).

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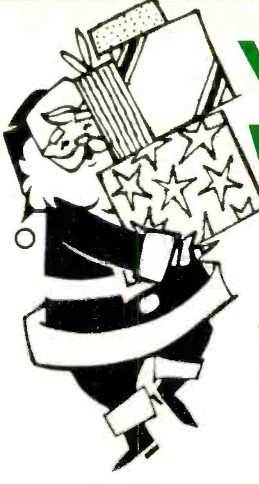

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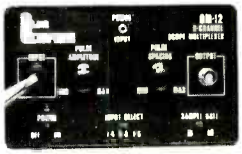

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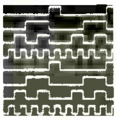

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Intensity modulation	Over 5Vp-p
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Sensitivity and bandwidth	5mV/div ~ 5V/div ± 5%, DC ~ 15MHz, -3dB 1mV/div ~ 1V/div ± 6%, DC ~ 5MHz Typ. -3dB (Using x5 amplifier)
Rise time	24ns
Dynamic range	More than 4div at 15MHz
Input R and C	Direct 1M Ohm, approx. 30pF
Maximum input voltage	600Vp-p or 300V (DC + AC peak)
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• Horizontal deflection	
Sweep mode	Auto, NORM, TV (+), TV (−)
TV synchronization	TV sync-separator circuit
Internal	Over 1 div (V sync-signal)
External	Over 1Vp-p (V sync-signal)

Trigger sensitivity:

Frequency	Internal	External
20Hz ~ 2MHz	0.5div	200mV
2 ~ 15MHz	1.5div	800mV

Trigger slope	±
Sweep time	0.2μs/div ~ 0.2s/div ± 5%, 19 calibrated steps
Sweep-time magnifier	10 times (± 7%)
Max. sweep rate	100ns/div
• Amplitude calibrator	
Waveform	1kHz ± 10% Typ. Square wave
Voltage	0.5V ± 3%
• Power requirements	100V (120 220/240V) ± 10% 50/60Hz 40W
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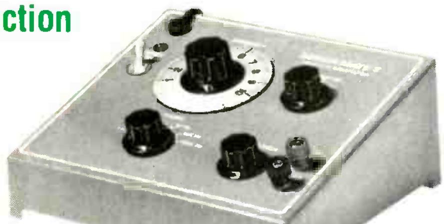

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Testing the Tapes. Using these tapes as reference points for each type, the first test was of tape sensitivity at 400 Hz, the Dolby calibration frequency. Each tape was fed a fixed-level tone, and the resulting output was measured. The results are in the first column of the Table. A variation of ± 1 dB is hardly consequential in and of itself. As ± 2 dB is approached, however, it is possible that some frequency-response errors may occur when using the Dolby noise-reduction system if your deck is not set up with this particular tape.

After checking sensitivity, I raised or lowered (as necessary) the 400-Hz level so that the tape played back at a standard 200 nanoWeber/meter (Dolby) level, and measured the third-harmonic distortion, using a General Radio 1900-A wave analyzer. These results are recorded in the second column. The record signal input was then raised to the point where the tape playback produced 3% third-harmonic distortion, the normal reference level for signal-to-noise measurements. The higher the number in the third column (400 Hz Maximum Output Level) of the Table, the higher is the record level you can use before the onset of serious (audibly noticeable) distortion.

At the 400-Hz 3% maximum, the input signal was short-circuited so that biased tape noise level could be measured under no-signal conditions. The noise level was passed through an IEC "A" weighting network (whose weighting, by frequency, corresponds closely to the sensitivity of the ear to low-level sounds such as tape hiss), and the difference between the MOL and the biased tape noise is reported in the fifth column as the A-weighted signal-to-noise level.

To check the high-frequency capacity of the tape, I used a 10-kHz tone, adjusting the signal-input level to obtain maximum possible output. This is shown in the fourth column of the Table, with reference to the 400-Hz Dolby level of 200 nWb/m. As can be seen, no tape could produce that much output at 10 kHz, so the numbers are all negative. The closer the negative number is to zero, the more 10-kHz storage capacity the tape has, given the bias/machine conditions imposed. A lower bias level would raise the maximum 10.kHz output capacity of all the tapes, but it would also lower the 400-Hz MOL (column 3) and raise distortion at 200 nWb/m (column 2). It would also influence the high-frequency response of all of the tapes. On the other hand, a higher bias level would depress the 10-kHz MOL still further, though it might slightly increase the 400-Hz MOL.

As a final test, each of the tapes was measured for frequency response across the 20-to-20,000-Hz range, both at a 0-dB record level (200 nWb/m) and at the conventional −20-dB level normally used for checking frequency response. These results are presented graphically. Where a tape shows a rising high-frequency response at −20 dB, it is probable that it is slightly under-biased; where there is a treble fall-off at this level, it is almost certainly overbiased, since all of the tapes in this survey are *capable* of flat response throughout the audio range. The degree of high-frequency roll-off at the 0-dB level is an index of short-wavelength storage capacity.

TAPE TEST RESULTS

Tape Type I	400-Hz Sens.(dB)	Dolby-level Distortion (%)	400-Hz MOL (dB)	10 kHz MOL (dB)	S/N A-wtd (dB)
Maxell UD-XLI	0.0	0.38	+6.5	−5.2	58.0
BASF Professional I	−1.0	0.44	+5.5	−5.8	56.8
Fuji FX-I*	−1.3	0.31	+4.8	−6.2	58.5
Loran Normal Bias	0.0	0.34	+7.0	−6.0	59.5
Maxell XL-IS	0.0	0.45	+7.0	−3.0	58.2
Memorex MRX-I	−0.8	0.38	+6.2	−5.5	59.8
PD Tri-Oxide Ferro*	0.0	0.27	+7.0	−6.2	58.5
Scotch Master I	0.0	0.38	+7.2	−4.8	58.2
Sony HFX	−0.8	0.51	+4.8	−5.8	56.1
TDK AD	−1.0	0.50	+4.8	−2.8	58.9
Type II					
TDK SA	0.0	0.64	+5.0	−5.5	59.1
BASF Professional II	−1.4	1.05	+4.1	−6.5	61.2
Fuji FX-II*	0.0	0.86	+4.8	−5.0	60.1
Loran Chrome	−0.3	1.20	+4.1	−6.3	60.9
Maxell XL-IIS	−0.4	0.97	+4.2	−4.5	58.8
Memorex HBII	−0.2	0.80	+4.8	−4.8	59.5
PD 500 Crolyn*	−1.2	1.00	+4.5	−9.8	61.1
Scotch Master II	+0.8	0.49	+6.5	−5.5	60.4
Sony EHF	+0.6	0.77	+5.2	−7.0	59.7
Sony Dev. High-Bias**	+1.3	0.40	+7.0	−4.8	61.1
TDK SA-X	+1.6	0.30	+5.2	−3.0	59.6
Type IV					
TDK MA	0.0	0.54	+6.5	−3.8	59.8
Fuji Metal*	−0.4	0.60	+6.1	−3.5	59.5
JVC ME-P	−1.0	0.54	+6.2	−6.2	60.0
Maxell MX	−0.4	0.58	+6.2	−5.0	60.2
Memorex Metal IV	+0.3	0.31	+7.9	−2.8	61.4
PD1100 Metal*	−0.8	0.94	+5.5	−2.8	59.5
Scotch Metafine***	+0.5	0.48	+6.8	−5.2	62.3
Sony Metallic	0.0	0.54	+6.5	−4.5	60.8

*Single sample only supplied
**New product, to be released soon
***No samples supplied; tapes purchased 4/81 commercially

Conclusions. The differences between tape types and among brands are slight enough to be virtually inaudible. Usually, a 3-dB difference between sounds of like frequency is necessary before a listener can determine which sound is less distorted or "noisy." Looking at each column of the Table, it is clear that the performance of any single tape falls within 3 dB of almost all the others. (The percent of Dolby-level distortion in the second column also reflects differences which would be inaudible to even the listener with above-average sensitivity.) Still, differences can be measured, if not always heard.

As a group, the metal tapes provide a very slight advantage over the CrO_2 types and a more significant advantage over the ferric oxides in terms of signal-to-noise ratio. In terms of 10-kHz storage capacity, metal tapes, overall, are better than ferrics and chromes—hardly surprising since this is metal tape's claim to fame. Keep in mind, though, that the metal tapes cost about 70% more than the other two types. (Ferrics and chromes cost about the same.)

Which should you buy? That's a tough question. If you don't have a high-end cassette deck, it probably doesn't make any difference. If you do, you can check the figures in the Table given here and make a determination based on numbers alone. Or you can trust your ears. Good luck! ◇

BY THOMAS R. FOX

AN EARLY-WARNING CAR BATTERY-DRAIN INDICATOR

To avoid a dead battery, replace the standard "idiot" light with a visual-audible monitoring system

LIKE THE common cold, the "dead battery" syndrome seems to be especially prevalent in the winter. This project, the *M*ultipurpose *E*lectrical *S*ystem *M*onitor *A*nd *T*ester (MESMAT), may help your car avoid the dreaded ailment.

MESMAT replaces the ineffective "idiot" light, which will not light until the 12-V battery is discharging at a rate of 10 to 15 amperes. Consequently, a battery could be completely discharged while the car is running without the standard warning light being activated. The project uses five LEDs to continuously monitor the condition of the vehicle's electrical system, as well as a buzzer that sounds when voltage exceeds 16 to 17 V. (Excessive voltage might be caused by a defective voltage regulator, which could damage an alternator or other part of an electrical system.)

In addition to providing an early warning if a battery is being rapidly discharged, MESMAT audibly indicates when headlights are still on and the ignition is switched off. Furthermore, it can act as a continuity tester for checking fuses, bulbs, etc.

How It Works. MESMAT operates from a circuit board that mounts on the underside of the car's instrument panel. Five LEDs light up in sequence as the voltage through the electrical system is increased. One or the other of three green LEDs will remain lit over the range of normal voltage. A yellow and a red LED on either end of the display light when the voltage is too low or high, respectively.

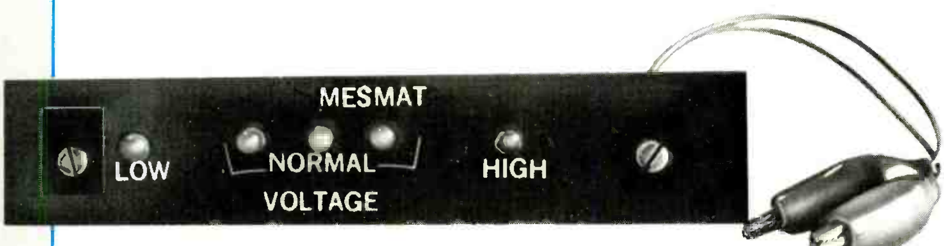
As shown in Fig. 1, MESMAT is built around two integrated circuits—the LM3914 dot/bar graph display driver and the LM324N low-power quad operational amplifier.

In addition to a large network of voltage comparators, the LM3914 contains its own adjustable reference and accurate 10-step voltage divider. In MESMAT, the LM3914 is used in its dot-display mode and some of its outputs are connected together so that it drives four different LEDs instead of the normal 10.

As shown in Fig. 1, *R1* is adjusted so that pin 6 of *IC1* is 1.1 volts more positive than pin 4. (These pins are basically reference voltages.) The voltage (with respect to ground) at pin 6 determines the point when *IC1*'s LED No. 10 output turns on (this output sinks current when it turns on). The voltage at pin 4 plus 0.11 volt determines the point when *IC1* turns on its LED No. 1 output. The other *IC1* outputs turn on at voltages between that at pin 4 and pin 6. The input at pin 5 is equal to approximately one-third that of the positive supply. Note that the positive supply is connected to the *R13/R5* voltage divider. When the voltage at pin 5 exceeds that at pin 4 plus 0.11 volt, *IC1* turns on its LED No. 1 output. When the voltage at pin 5 exceeds that at pin 6, *IC1* turns on its LED No. 10 output. The outputs at LED No. 2 through LED No. 9, of *IC1*, turn on when the voltage at pin 5 is somewhere between that at pin 4 and pin 6.

In this particular device, 10 different LEDs indicating 10 different voltage levels are unnecessary (and may actually be more confusing than helpful), so several of the outputs are connected to the cathode of a single LED. This is possible since *IC1* uses open-collector outputs. Since outputs on LED Nos. 1, 2, and 3 are all connected to the cathode of *LED2*, this LED is lit whenever these outputs are turned on. This occurs only when the applied vehicle voltage is between about 12 and 13.1 volts. *IC1's LED* No. 4 through LED No. 6 outputs are connected together so *LED3* stays lit in the 13.1-to-14.2-volt range. The outputs on *LED* No. 7 through LED No. 9 are tied together, which means *LED4* stays lit in the 14.2-to-15.3-volt range. The LED No. 10 output is connected to the cathode of *LED5*, which lights when the supply voltage exceeds about 15.3 volts. The LM3914 has a small amount of over-lap between segments to ensure that all LEDs are not off at once.

Op amps *IC2A*, *IC2B*, and *IC2D* are used as voltage comparators. The



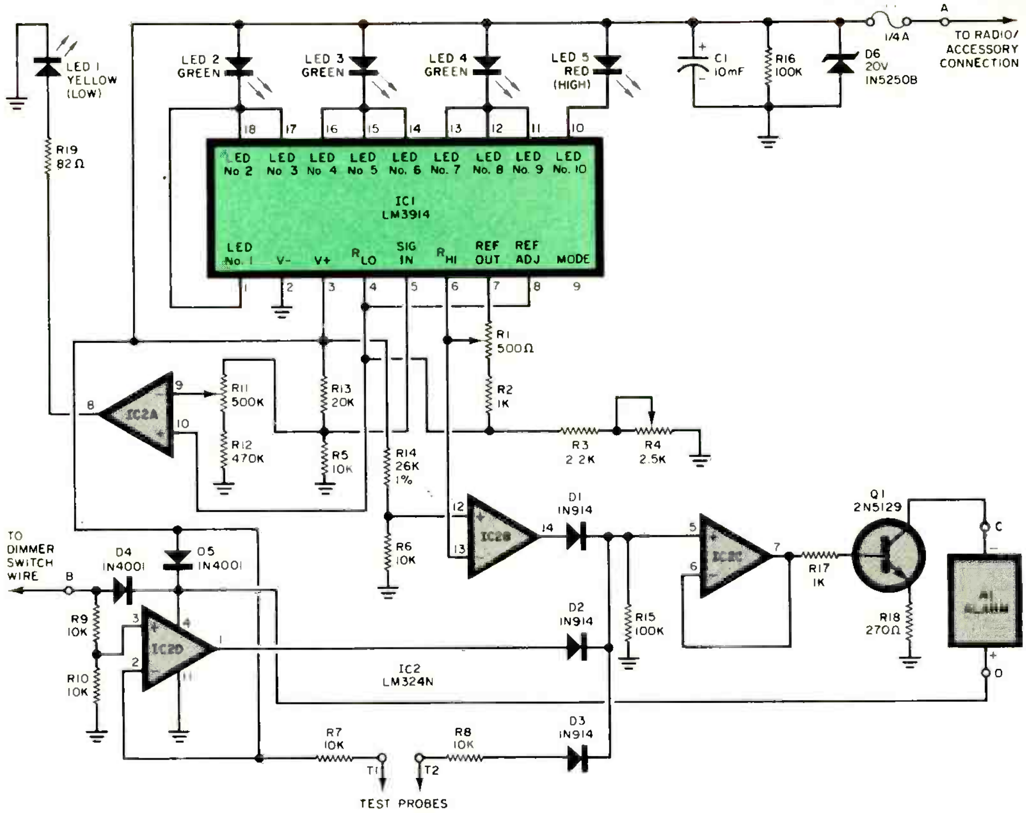


Fig. 1. There are two ICs in the circuit: a display driver and a quad op amp.

PARTS LIST

A1—6-V minibuzzer
C1—10-μF, 25-V electrolytic
D1,D2,D3—1N914 or equal silicon diode
D4,D5—1N4001 or equal silicon rectifier
D6—1N5250B or equal 20-V, 500-mW zener diode
F1—¼-A fuse
IC1—LM3914N dot/bar graph display driver
IC2—LM342N quad op amp
LED1—Yellow LED
LED2, LED3, LED4—Green LED
LED5—Red LED
Q1—2N5129 or equal general-purpose npn transistor
R1—500-Ω pc trimmer potentiometer
R2,R17—1-kΩ, ¼-W, 10% resistor
R3—2.2-kΩ, ¼-W, 10% resistor
R4—2.5-kΩ, pc trimmer potentiometer
R5,R6—10-kΩ, ¼-W, 1% resistor
R7,R8,R9,R10—10-kΩ, ¼-W, 10% resistor
R11—500-kΩ, pc trimmer potentiometer
R12—470-kΩ, ¼-W, 10% resistor
R13—20-kΩ, ¼-W, 1% resistor
R14—26-kΩ, ¼-W, 1% resistor
R15,R16—100-kΩ, ¼-W, 10% resistor
R18—270-Ω, ¼-W, 10% resistor
R19—82-Ω, ¼-W, 10% resistor
Misc.—Printed circuit board, fuse holder, alligator clips, wire, acrylic panel, small right-angle brackets, screws, solder, etc.

Note: A complete kit of parts, including the circuit board but not the front panel, is available from MAGICLAND, 4380 South Gordon Ave., Fremont, MI 49412 for $27.50 postpaid in the United States. Also available separately from Danocinths, Inc., PO Box 261, Westland, MI 48185: pc board for $7.00 postpaid. Ask for part number F402. Michigan residents, add 4% sales tax.

noninverting input of *IC2A* is connected to pin 4 of *IC1* and its inverting input to voltage divider *R11/R12*. The inverting input of *IC2A* is at a potential slightly less than one-third that of the supply. Trimmer *R11* is adjusted so that *LED1* (which alerts the driver to the presence of an abnormally low voltage in the electrical system), just lights when the supply voltage drops below the value that turns on *LED2*, which is about 12 volts. This is the same point at which the potential at the inverting input of *IC2A* drops below the potential at pin 4 of *IC1*. Notice that the *R11/R12* voltage divider is required since, if the inverting input of *IC2A* were connected directly to pin 5 of *IC1* (which, at first glance, would seem the thing to do), *IC2A* wouldn't turn on until the supply voltage dropped below 11.67 volts. Also remember that *IC1*'s LED No. 1 output doesn't turn on until the supply voltage exceeds approximately 12 volts. The output of *IC2B* is connected, through *D1*, to the noninverting input of *IC2C*, which functions as a buffer. The output of *IC2C* is connected to the base of *Q1*, which drives alarm *A1*. Transistor *Q1* also reduces the loading on *IC2C*, which could cause instability.

Power for *IC2*, through *D4* and *D5*, is from two different sources—the radio accessory connection at the vehicle fuse block which leads to point *A* on the circuit board, and a headlight dimmer switch connection which leads to point *B*. The radio accessory connection is "hot" only when the ignition switch is on, and the dimmer switch connection is hot only when the headlights are on. Thus, *IC2* is powered when either (or both) the ignition switch or the headlights are on. Due to *R9* and *R10*, *IC2D*'s noninverting input has a potential of one-half the battery voltage when the headlights are on, and 0 volt when they are off. The inverting input to *IC2D* is equal

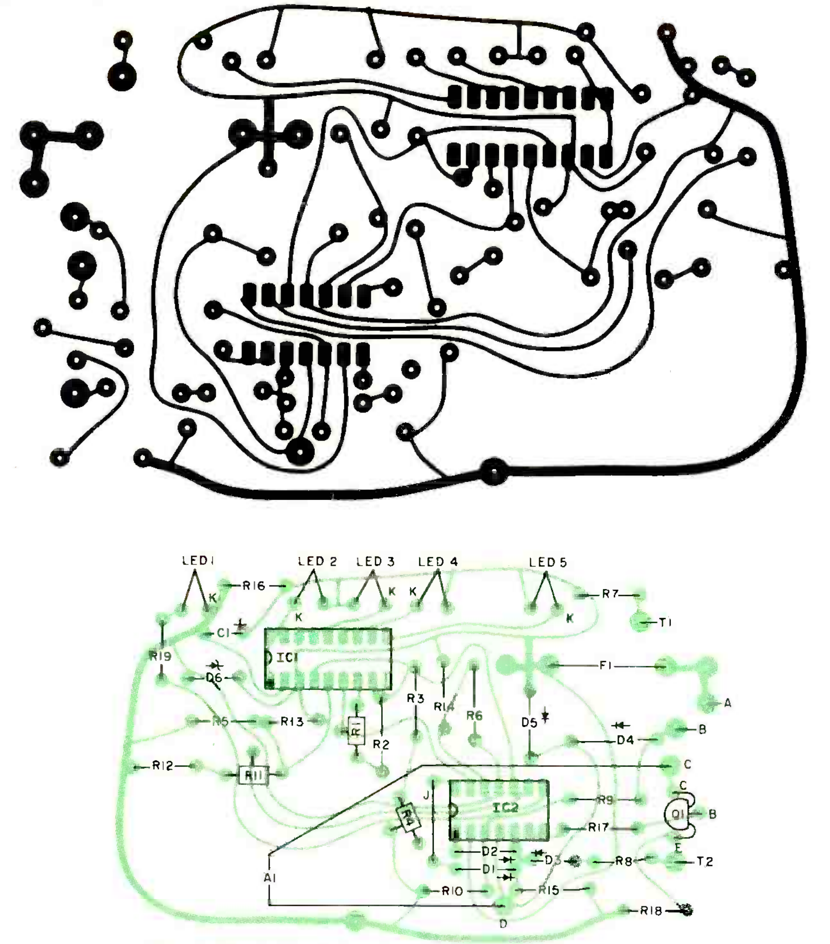


Fig. 2. Exact-size foil pattern (top) and component layout. Use 1/8" drill bit for holes marked with an "X."

to the battery voltage when the ignition switch is on and is at zero otherwise. Thus, when the headlights are on but the ignition is off, *IC2D* switches on, which, in turn (through *D2, IC2C,* and *Q1*), turns on the alarm.

The theory behind the operation of the audible continuity tester portion of MESMAT is simple. When a sufficiently low resistance exists between points *T1* and *T2*, the positive voltage from *T1* is applied to pin 5 of buffer *IC2C* through *D3*. The buffer, in turn, provides a current to the base of *Q1*, which then provides sufficient current to operate *A1*. Fuse *F1* maintains the auto's electrical system reliability and zener diode *D6* increases MESMAT's reliability.

Construction. The circuit can be assembled on a pc board such as that shown in Fig. 2. Connect *A1*'s black (negative) lead to point *C* on the circuit board and its red (positive) lead to point *D*. For use as an audible continuity tester, connect short lengths of flexible wire, with an alligator clip at one end, to points *T1* and *T2* on the circuit board.

While the circuit board can be mounted in any small enclosure, the prototype had only a colored acrylic front panel, with the bulk of the circuit board exposed. Holes in the front panel were drilled for the LEDs, and two small right-angle brackets were used to attach the front panel to the circuit board. The front panel is used only for cosmetic reasons, as the circuit board can be mounted to the auto's instrument panel.

Before applying power, check polarities of the LEDs, diodes, buzzer, and capacitor. Also, check to make sure you have installed the ICs and transistor properly.

Testing and Adjustment. A dc power supply, continuously adjustable from 0 to 18 volts or more, and a dc voltmeter are required. (The current requirements of the supply are less than 50 mA.) Set trimmer pots (*R1, R4,* and *R11*) to their approximate midpoint. Connect the power supply's ground to the circuit ground and the supply's positive terminal to point *A* on the circuit board.

Set the voltmeter to measure 1.2 volts and connect its negative lead to pin 4 of *IC1* and positive lead to pin 6. Adjust *R1* for a 1.1-volt meter indication. Then set the voltmeter so it will be able to measure 20 volts and connect its negative lead to ground and its positive lead to point *A*. Adjust the power supply until the meter indicates 12.0 volts, and adjust *R4* until *LED2* just barely goes off. (Make sure that *LED3* doesn't glow when *LED2* is not illuminated.)

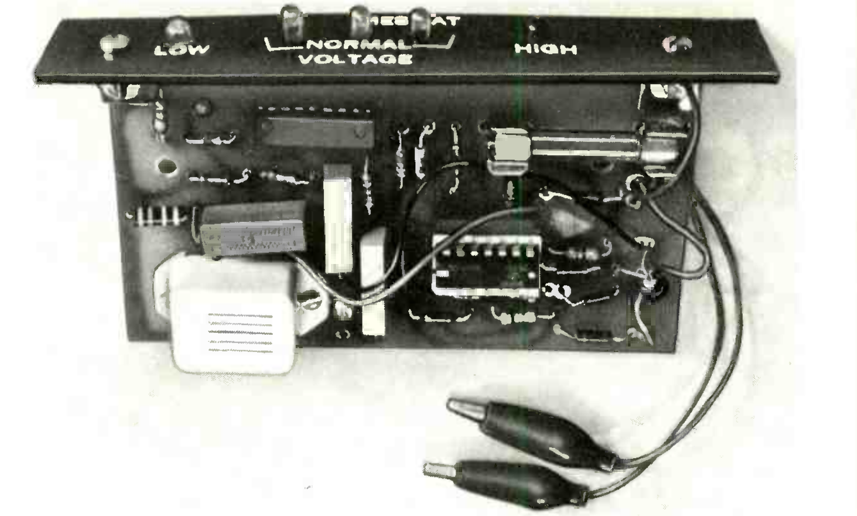
For the final adjustment, leave the power supply set at 12.0 volts and adjust *R11* so that the yellow LED just barely glows.

To check the adjustments, set the power supply at 5 volts, and note that *LED1* (yellow) starts to glow, and remains on to 11 volts. At 12.2 volts, *LED2* (green) should be lit but *LED1* should go off. (Note: As long as the voltage is over 5 volts, at least one of the LEDs should be lit at all times.) As the voltage is increased to 13.3 volts, *LED2* should be off and *LED3* (green) should glow. At 14.4 volts, only *LED4* (green) should glow. At 15.5 volts, *LED5* (red) should glow. As the voltage is increased over 17 volts, *LED5* should still be lit but the alarm will sound. If necessary, readjust *R1, R4* and/or *R11*. Note that, if you desire the alarm to sound off at a specific voltage of your choosing, replace *R14* with a 50,000-ohm potentiometer and adjust it so the alarm sounds off at your specified voltage.

To check the headlight-on reminder circuit, set the supply to 12 volts and disconnect the power supply's positive supply lead from point *A* on the circuit board and connect it to point *B*. The alarm should sound off. Temporarily connect a jumper wire from point *A* to point *B*. The alarm should immediately be silenced.

To check out the optional continuity tester, short the two alligator clips (*T1* and *T2*) together. The alarm should sound off immediately. Be sure you remove the temporary jumper between points *A* and *B* before installation in the vehicle.

Installation. The circuit board is designed to be mounted, foil side up, to the underside of the auto's instrument panel. Use two suitable screws (sheet metal screws will usually work) and two nonconducting thick washers or short spacers. Other types of mounting, including recess, can be used with slight modifications. Al-



Internal view of the authors prototype.

though the author's prototype doesn't have a cabinet all that is really visible to the driver is the front panel.

After you have attached the project to the instrument panel, connect a wire from its ground connection to the auto's ground. A nearby screw which threads into a metal chassis or body part is usually satisfactory. Next, connect a wire from point *A* to the auto's radio or accessory connection at the fuse block. (A connection can be made at the fuse block without soldering by bending a thin solder lug into a semicircle and squeezing it between the fuse and fuseholder.) Use your VOM to make sure this connection is only "hot" when the ignition switch is "on." Note: Whenever you make a connection to a fuse block, always check that the connection is made to the "protected" side—the side that is "dead" when the fuse is removed.

Connect point *B* on the circuit board to a connection at the dimmer switch that is "hot" whenever the headlight switch is "on." The position of the dimmer switch shouldn't matter. If you are on the ultra-cautious side, add a ¼-amp in-line fuse in series with the wire to point *B* on the circuit board.

If you don't like to see the continuity tester's leads dangle when they aren't in use, simply clip the alligators to the bottom of the front panel.

Use. When the voltage of the electrical system is within normal limits (about 12 to 15 volts) one of the green LEDs will glow. Sometimes two LEDs glow at one time, but usually, the center or right green LED will be glowing. Under a heavy electrical load (as happens when the headlights, wipers, fan and electrical defrost are on at the same time) the left green LED may be the only one on. If the yellow LED glows for any extended time, the battery is being discharged and you most likely have some trouble with the alternator or battery. Another possibility is that there is an excessive load due to some short or a malfunction in an electrical part.

When there is little electrical load, it is usually OK for the right green LED and red LED to glow at the same time. However, if the red LED alone stays on for an extended time, you may have voltage-regulator problems. (Immediately after some cold weather starts, the red LED may glow for a few minutes. This is OK.) If the red LED comes on and the alarm sounds off, the voltage in the electrical system of the auto exceeds approximately 16.5 volts, which can cause a multitude of problems with the electrical system—ruined battery, short headlight life, and blown fuses. The difficulty should be determined and repaired as soon as possible.

The headlight-on reminder causes the alarm to sound off if you leave the headlights on and turn the ignition switch off. If you wish to operate the headlights with the engine off and not listen to the alarm, place the ignition switch in the accessory position.

The built-in audible continuity tester can be used to check questionable fuses and bulbs. Simply touch the alligator clips to the appropriate contacts on the fuse or bulb. If the alarm sounds, the part is OK.

In addition to being a worthy accessory for an automobile, MESMAT can be useful in a boat or any other vehicle that uses a 12-V battery. ◇

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BY RANDY CARLSTROM

DESIGNING WITH THE 8080 MICROPROCESSOR

Part 4: A Typical Program

PREVIOUS parts of the article have described how a typical microprocessor works and gave design details for a practical module. Last month, we covered the details of designing software for the system. Here is an example.

Morse Receiving Program. What would Samuel F.B. Morse have thought if he had heard his code being sent at 100 words per minute at the same time it was being printed out on a printer or television screen? Actually, the process involved in such a scheme is fairly simple and straight forward (if you happen to have a microprocessor). The procedure involves converting Mr. Morse's combinations of dots and dashes (which may come from a shortwave receiver) into a more modern and usable code called *ASCII* (American Standard Code for Information Interchange). ASCII is a widely-used code in which 96 displayable characters (letters, number, etc.) and 32 non-displayable control characters are each assigned a unique 7-bit code. For instance, the character "A" is represented in the ASCII code as 41_{16}; the character "3" is assigned the code 33_{16} (see Fig. 22). Many of today's computers communicate with each other using the ASCII code, and ASCII has even found its way into radio.

The 8080 readily handles the ASCII code since each register and memory location is capable of holding one ASCII character code. Occasionally the unused eighth bit (MSB) is utilized as a *parity bit*, which serves to minimize data errors when large amounts of information are being transferred. (This is the principal use of the Parity flag-related instructions in the 8080 instruction set.) The parity bit will not concern us in our discussions, however; we will assume it is always 0.

The Morse code is comprised of two types of marks—the dot and dash—and three types of spaces—the mark space, character space, and word space. Theoretically, the length of a dash is three times the length of a dot. Likewise, a

Character	ASCII Code (hex)	Morse Code	Character	ASCII Code (hex)	Morse Code
A	41	• —	0	30	— — — — —
B	42	— • • •	1	31	• — — — —
C	43	— • — •	2	32	• • — — —
D	44	— • •	3	33	• • • — —
E	45	•	4	34	• • • • —
F	46	• • — •	5	35	• • • • •
G	47	— — •	6	36	— • • • •
H	48	• • • •	7	37	— — • • •
I	49	• •	8	38	— — — • •
J	4A	• — — —	9	39	— — — — •
K	4B	— • —			
L	4C	• — • •	.	2E	• — • — • —
M	4D	— —	,	2C	— — • • — —
N	4E	— •	?	3F	• • — — • •
O	4F	— — —	;	3B	— • — • — •
P	50	• — — •	:	3A	— — — • • •
Q	51	— — • —	(	28	— • — — • —
R	52	• — •	/	2F	— • • — •
S	53	• • •	-	2D	— • • • —
T	54	—	End of message	—	• — • — •
U	55	• • —			
V	56	• • • —	Wait	—	• — • • •
W	57	• — —	End of work	—	• • • — • —
X	58	— • • —	Invitation to transmit	—	— • — — •
Y	59	— • — —			
Z	5A	— — • •	Error	—	• • • • • • • •

Fig. 22. The ASCII code for the Morse symbols.

mark space is equal in length to a dot, a character space equal to a dash, and a word space equal to seven dots.

Ideally, a Morse recognition algorithm would test mark and space lengths at the points half-way between mark and space types, *e.g.*, 2/3 of a dash would be the "critical point" for deciding if a received mark was a dot or a dash, etc. However, after much experimentation with these critical points, a slightly modified algorithm was obtained. For instance, it was observed that many users of the code (hams in particular) tend to cut character spaces too short, which would confuse the ideal algorithm. For this reason, the character space critical point was changed from the ideal 2/3 dash to 1/2 dash (a 17% reduction), which enhanced character-recognition probability. A similar change was made for dot recognition for the same reason. Attempting to change or experiment with these critical points in a random-logic implementation of the code converter would be a large chore in itself.

The program has incorporated into it a subroutine for checking some types of noise often encountered while receiving Morse code on a radio receiver. This routine has proven to be quite effective in discriminating between some types of random noise and Morse code. In this respect, the routine can be thought of as a "software noise blanker." The "bandwidth" can be adjusted simply by changing the value of a parameter byte at memory location 010C of the program (the beauty of using a microprocessor). The bandwidth, and therefore the maximum code speed that may be accurately received, is inversely proportional to the numeric value stored in this memory location.

The Morse program assembly listing is shown here. The source program, which appears in the third column, was assembled beginning at memory location 0. The memory locations in the first column are followed by the object code contained, or assembled, into them. The second column lists the line numbers of the source program which are of no particular significance to the program itself.

Throughout the source program are "labels" to the immediate left of some of the instruction mnemonics. These labels represent relative addresses which are later assigned memory addresses during the assembly process. Labels allow the source program to reference other parts of the program (such as subroutines) without the need of knowing their memory addresses. For example, to Call the subroutine which checks for noise (labeled "VLDMK"), the corresponding source program instruction would be written as CALL VLDMK. VLDMK symbolizes the beginning address in program memory of the noise-checking subroutine. A list of all labels used in the Morse program, followed by their computed values and source program line numbers that use them, appears at the end of the assembly listing.

When assembling a source program by hand, the numeric values of any labels used must be determined before the corresponding machine language instructions can be completely assembled (labels will usually complete an instruction's operand, such as an address). In the case of the VLDMK label, its address was determined to be 0104_{16} after counting the number of bytes that preceded it in memory. So, in this case, "CALL VLDMK" and "CALL 0104H" are equivalent instructions and may be used interchangeably in the source program. It is more convenient, however, to use the symbolic label representation since the memory address may not even be known until the source program is completed. For this reason, and the fact that program changes are almost inevitable in the course of writing new programs (which will most likely change all the memory addresses of the instructions following the program changes), it is recommended that calculating memory addresses be one of the last steps performed when writing new programs. Using labels freely throughout the source program will help avoid some of the tedious work when program changes have to be made.

The next part of this article will cover the hardware implementation of the CPU module. ◇

MORSE-TO-ASCII CONVERSION PROGRAM

```
0000              ORG 0000
0000             *
0000             LEN EQU 64         TERMINAL WIDTH
0000             CW EQU 0FCH        MORSE INPUT PORT
0000             MASK EQU 01        DATA INPUT BIT 0 HAS MORSE
0000             PSTN EQU 0BFFH     LOCATE PSTN BYTE AT END OF RAM AREA
0000             *
0000             * * * * * * * * * * * * * * * * * * * * * * * * * *
0000             *                                                 *
0000             * * * *    MORSE-TO-ASCII CONVERSION PROGRAM    * * * *
0000             *                                                 *
0000             * *                  WRITTEN  BY                  * *
0000             *                                                 *
0000             * * * *          RANDY CARLSTROM, 9/78          * * * *
0000             *                                                 *
0000             * * * * * * * * * * * * * * * * * * * * * * * * * *
0000             *                                                 *
0000             * * * *        MORSE RECOGNITION ALGORITHM      * * * *
0000             *                                                 *
0000             *       IF THE NEW MARK LENGTH IS GREATER THAN OR  *
0000             * EQUAL TO TWICE THE LENGTH OF THE LAST MARK, THE  *
0000             * NEW MARK IS STORED AS A DASH.  IF THE NEW MARK   *
0000             * LENGTH IS LESS THAN ONE-HALF THE LENGTH OF THE   *
0000             * LAST MARK, THE NEW MARK IS STORED AS A DOT. IF   *
0000             * THE NEW MARK DOES NOT FALL INTO EITHER ONE OF    *
0000             * THESE CATEGORIES, THE NEW MARK IS STORED AS THE  *
0000             * SAME TYPE AS THE LAST MARK.                      *
0000             *       IF A SPACE LENGTH REACHES ONE-HALF THE     *
0000             * LENGTH OF THE LAST DASH, A CHARACTER SPACE HAS   *
0000             * BEEN RECEIVED AND THE ELEMENTS ARE ASSEMBLED AND *
0000             * CONVERTED TO THE CORRESPONDING ASCII CHARACTER.  *
0000             * THE CHARACTER IS THEN PRINTED AT THE OUTPUT      *
0000             * PERIPHERAL AND SPACE MEASUREMENT CONTINUES.      *
0000             * IF THE SPACE LENGTH REACHES THREE-HALVES THE     *
0000             * LENGTH OF THE LAST DASH, A WORD SPACE HAS BEEN   *
0000             * RECEIVED AND THE SPACE IS PRINTED.               *
0000             *                                                 *
0000             * * * * * * *    REGISTER   ALLOCATION    * * * * * * *
0000             *                                                 *
0000             * B = DASH REG.  C = DOT REG.  D = LAST MARK LENGTH *
0000             * E = LAST MARK TYPE: 00 = DOT, 01 = DASH          *
0000             * H = MARK/SPACE COUNTER  L = LAST DASH LENGTH     *
0000             *                                                 *
0000             * * * * * * * * *   INITIALIZATION   * * * * * * * * *
0000             *                                                 *
0000 F3                DI           DISABLE INTERRUPTS
0001 31 FD 0B          LXI SP,0BFDH INITIALIZE STACK POINTER IN RAM
0004 CD AC 00          CALL CRLF    START A NEW OUTPUT LINE
0007 21 40 00          LXI H,0040H  LAST DASH LENGTH = 64; COUNTER = 0
000A 11 00 20          LXI D,2000H  LAST MARK LENGTH = 32; LAST MARK = DOT
000D 01 00 00          LXI B,0000   CLEAR DOT AND DASH REGISTERS
0010             *                                                 *
0010             * * * * * * * * * * * * * * * * * * * * * * * * * * *
0010             *                                                 *
0010             * * * * * * * * *    MAIN  PROGRAM    * * * * * * * * *
0010             *
0010 CD 04 01    WAIT  CALL VLDMK   IS THERE A VALID MARK YET?
0013 DA 10 00          JC WAIT      NO: WAIT
0016 CD 4B 00    NEWMK CALL MKTYP   YES: FIND MARK TYPE AND STORE IT
0019 26 00             MVI H,00     CLEAR MARK/SPACE COUNTER
001B CD 04 01    SPTYP CALL VLDMK   IS THERE A VALID MARK YET?
001E D2 16 00          JNC NEWMK    YES: PROCESS NEW MARK
0021 B7                ORA A        NO: CLEAR CY FLAG AND
0022 7C                MOV A,H      CHECK SPACE LENGTH
0023 17                RAL          REG. A = 2 * CURRENT SPACE LENGTH
0024 BD                CMP L        SPACE >= 1/2 LAST DASH? (CHAR. SPACE)
0025 DA 1B 00          JC SPTYP     NO: CONTINUE MEASURING SPACE LENGTH
0028 CD 7A 00          CALL CONVT   YES: CONVERT MORSE TO ASCII
```

```
002B CD BB 00              CALL OUT      AND PRINT IT, THEN
002E CD DB 00              CALL IPSTN    UPDATE PRINTER POSITION
0031 FE 3E                 CPI LEN-2     DO A CR/LF IF AT END OF LINE
0033 D4 AC 00              CNC CRLF
0036 CD 04 01       GENSP  CALL VLDMK    IS THERE A VALID MARK YET?
0039 D2 16 00              JNC NEWMK     YES: PROCESS NEW MARK
003C B7                    ORA A         NO: CLEAR CY FLAG AND
003D 7D                    MOV A,L       CHECK SPACE LENGTH
003E 1F                    RAR
003F 85                    ADD L         REG. A = 3/2 LAST DASH
0040 3D                    DCR A
0041 BC                    CMP H         SPACE >= 3/2 LAST DASH? (WORD SPACE)
0042 D2 36 00              JNC GENSP     NO: CONTINUE MEASURING SPACE LENGTH
0045 CD E3 00              CALL SPOUT    YES: PRINT A SPACE OR CR/LF
0048 C3 10 00              JMP WAIT      DONE; WAIT FOR A NEW CHAR. TO BEGIN
004B                *
004B                *
004B                * * * * * * * * * * * * * * * * * * * * * * * * * *
004B                * * * *             SUBROUTINES             * * * *
004B                * * * * * * * * * * * * * * * * * * * * * * * * * *
004B                *
004B                * MKTYP COMPARES THE NEW MARK WITH THE PREVIOUS MARK TO
004B                * SEE IF THE NEW MARK IS A DOT OR A DASH. IF THE NEW
004B                * MARK IS < 1/2 THE PREVIOUS ONE, IT IS A DOT. IF THE
004B                * NEW MARK IS >= 2 * THE PREVIOUS ONE, IT IS A DASH.
004B                * OTHERWISE THE NEW MARK IS THE SAME AS THE PREVIOUS MARK.
004B                *
004B 7A             MKTYP  MOV A,D
004C 17                    RAL           REG. A = 2 * LAST MARK LENGTH
004D 3D                    DCR A
004E BC                    CMP H         MARK >= 2 * LAST MARK LENGTH? (DASH)
004F D2 5F 00              JNC DOT       NO: GO SEE IF A DOT
0052 54             DASH   MOV D,H       YES: UPDATE LAST MARK LENGTH REGISTER
0053 6C                    MOV L,H       AND LAST DASH LENGTH REGISTER
0054 1E 01                 MVI E,01      UPDATE LAST MARK TYPE REGISTER
0056 78                    MOV A,B       SHIFT A "1" INTO DASH REGISTER
0057 07                    RLC
0058 F6 01                 ORI 01
005A 47                    MOV B,A
005B 79                    MOV A,C       SHIFT A "0" INTO DOT REGISTER
005C 07                    RLC
005D 4F                    MOV C,A
005E C9                    RET           A DASH WAS RECEIVED AND STORED; RETURN
005F 7C             DOT    MOV A,H
0060 17                    RAL           REG. A = 2 * CURRENT MARK LENGTH
0061 3D                    DCR A
0062 BA                    CMP D         IS MARK < 1/2 LAST MARK LENGTH? (DOT)
0063 D2 72 00              JNC SAME      NO: WAS THE SAME AS LAST MARK
0066 54             DOTT   MOV D,H       YES: UPDATE LAST MARK LENGTH REG.
0067 1E 00                 MVI E,00      AND LAST MARK TYPE REGISTER
0069 79                    MOV A,C       SHIFT A "1" INTO DOT REGISTER
006A 07                    RLC
006B F6 01                 ORI 01
006D 4F                    MOV C,A
006E 78                    MOV A,B       SHIFT A "0" INTO DASH REGISTER
006F 07                    RLC
0070 47                    MOV B,A
0071 C9                    RET           A DOT WAS RECEIVED AND STORED; RETURN
0072 7B             SAME   MOV A,E       GET LAST MARK TYPE
0073 1F                    RAR           WAS IT A DASH?
0074 DA 52 00              JC DASH       YES: GO TO DASH ROUTINE
0077 C3 66 00              JMP DOTT      NO: GO TO DOT ROUTINE
007A                *
007A                *
007A                * CONVT ASSEMBLES THE DOT AND DASH REGISTERS IN SUCH
007A                * A WAY THAT IT FORMS A NEW UNIQUE 8-BIT CODE. THEN
007A                * A TABLE OF THESE UNIQUE CODES IS SEARCHED FOR A MATCH,
007A                * AND THE CORRESPONDING ASCII CHARACTER IS RETURNED IN
007A                * THE ACCUMULATOR. IF NO MATCH WAS FOUND, AN ERROR CHAR.
007A                * IS RETURNED.
007A                *
007A 79             CONVT  MOV A,C       GET DOT REGISTER
007B 07                    RLC           MULTIPLY IT BY 2
007C 80                    ADD B         AND ADD DASH REGISTER
007D 01 00 00              LXI B,0000    READY DOT AND DASH REG. FOR NEXT CHAR.
0080 E5                    PUSH H        REG. A NOW HAS UNIQUE CODE
0081 21 19 01              LXI H,TABLE   POINT TO TABLE STARTING ADDRESS
0084 BE             NEXT   CMP M         FOUND CHARACTER?
0085 CA 94 00              JZ ASCII      YES: CONVERT TO ASCII
0088 F5                    PUSH PSW      NO: SAVE UNIQUE CODE AND
0089 7E                    MOV A,M       CHECK FOR END OF TABLE
008A B7                    ORA A         END OF TABLE?
008B CA 98 00              JZ ERROR      YES: NO MATCH WAS FOUND
008E F1                    POP PSW       NO: GET UNIQUE CODE BACK AND
008F 23                    INX H         BUMP REG. PAIR H TO NEXT
0090 23                    INX H         CHARACTER ADDRESS
0091 C3 84 00              JMP NEXT      AND TRY AGAIN
0094 23             ASCII  INX H         POINT TO ASCII CHAR. IN TABLE
0095 7E                    MOV A,M       AND PUT IT IN REG. A
0096 E1                    POP H
0097 C9                    RET           RETURN WITH IT
0098 F1             ERROR  POP PSW       ELSE RETURN WITH A "*"
0099 E1                    POP H         IF NO MATCH WAS FOUND
009A 3E 2A                 MVI A,'*'
009C C9                    RET
009D                *
009D                *
009D                * DLY1 IS A TIME DELAY USED WHEN MEASURING THE LENGTH
009D                * OF A MARK OR SPACE. THE VALUE OF REG. B ACTS AS A
009D                * "COURSE-ADJUST," WHILE THE VALUE OF REG. C ACTS MORE
009D                * LIKE A "FINE-ADJUST." THE PRESET VALUES FOR REGISTERS
009D                * B AND C MAY BE CHANGED FOR DIFFERENT CODE SPEEDS OR
009D                * CPU'S, BUT THESE VALUES ARE OPTIMUM FOR ON-THE-AIR USE
009D                * USING AN 8080, 8085, OR Z-80 CPU RUNNING AT 2 MHZ.
009D                * REG. H SHOULD NOT BE ALLOWED TO COUNT ABOVE 7FH DURING
```

```
009D              * A MARK MEASUREMENT, OR THE MORSE ALGORITHM WILL FAIL.
009D              * INCREASING THE VALUE OF REGISTER PAIR B INCREASES THE
009D              * LENGTH OF THE TIME DELAY, THEREBY DECREASING THE FINAL
009D              * COUNT OF REG. H FOR A GIVEN MARK OR SPACE LENGTH.
009D              *
009D C5           DLY1   PUSH B
009E 06 03               MVI B,03       PRESET VALUE FOR REG. B
00A0 0E 40               MVI C,40H      PRESET VALUE FOR REG. C
00A2 0D           LOOP1  DCR C          KILL SOME TIME...
00A3 C2 A2 00            JNZ LOOP1
00A6 05                  DCR B
00A7 C2 A2 00            JNZ LOOP1
00AA C1                  POP B
00AB C9                  RET
00AC              *
00AC              *
00AC              * CRLF OUTPUTS A CARRIAGE-RETURN LINE-FEED WHEN CALLED.
00AC              *
00AC 3E 0D        CRLF   MVI A,0DH      OUTPUT A CR
00AE CD BB 00            CALL OUT
00B1 3E 0A               MVI A,0AH      OUTPUT A LF
00B3 CD BB 00            CALL OUT
00B6 AF                  XRA A          SET PRINT POSITION COUNTER TO 0
00B7 32 FF 0B            STA PSTN
00BA C9                  RET
00BB              *
00BB              *
00BB              * OUT SENDS THE CHAR. TO BE PRINTED TO THE OUTPUT
00BB              * DEVICE (CRT, PRINTER, ETC.). THERE IS RESERVED
00BB              * STORAGE SPACE HERE FOR THE USER'S OWN OUTPUT ROUTINE.
00BB              *
00BB C5           OUT    PUSH B         MY OUTPUT DRIVER NEEDS THE CHAR.
00BC 47                  MOV B,A        IN REG. B
00BD CD 19 C0            CALL 0C019H    CALL MY MONITOR'S OUTPUT DRIVER
00C0 C1                  POP B          RESTORE REG. B
00C1 C9                  RET            AND WE'RE DONE!
00C2                     DS 4           HERE'S MORE STORAGE AREA FOR THOSE
00C6                     DS 4           LONGER OUTPUT ROUTINES...
00CA                     DS 4           THE CHAR. TO BE PRINTED IS IN REG. A
00CE                     DS 4           AND THE ROUTINE MUST END WITH A "RET."
00D2                     DS 4           ALL REGISTERS MUST BE UNALTERED UPON
00D6                     DS 5           RETURN, WITH THE EXCEPTION OF REG. A.
00DB              *
00DB              *
00DB              * IPSTN INCREMENTS THE PRINT POSITION COUNTER ONCE
00DB              * EACH TIME IT IS CALLED.
00DB              *
00DB 3A FF 0B     IPSTN  LDA PSTN       BUMP PRINT POSITION ONE COUNT
00DE 3C                  INR A
00DF 32 FF 0B            STA PSTN
00E2 C9                  RET
00E3              *
00E3              *
00E3              * SPOUT OUTPUTS EITHER A SPACE OR A CR/LF, DEPENDING
00E3              * ON IF WE ARE GETTING CLOSE TO THE END OF A LINE.
00E3              * IN THIS WAY WORDS ARE NOT BROKEN BETWEEN LINES
00E3              * OF OUTPUT.
00E3              *
00E3 3A FF 0B     SPOUT  LDA PSTN       GET PRINT POSITION
00E6 FE 36               CPI LEN-10     ARE WE NEAR END OF LINE?
00E8 DA EF 00            JC PRSP        NO: CONTINUE ON SAME LINE
00EB CD AC 00            CALL CRLF      YES: START A NEW LINE
00EE C9                  RET
00EF 3E 20        PRSP   MVI A,' '      PRINT A SPACE
00F1 CD BB 00            CALL OUT
00F4 CD DB 00            CALL IPSTN     UPDATE PRINT POSITION
00F7 C9                  RET
00F8              *
00F8              *
00F8              * MKLEN MEASURES THE LENGTH OF A MARK. THE LENGTH
00F8              * IS RETURNED IN REG. H, AND SHOULD NEVER BE
00F8              * ALLOWED TO BE GREATER THAN 7FH (SEE DLY1).
00F8              * REG. H IS INCREMENTED BY ONE IF A MARK IS NOT
00F8              * PRESENT (SPACE) WHEN THIS ROUTINE IS CALLED.
00F8              *
00F8 24           MKLEN  INR H          BUMP MARK LENGTH COUNT
00F9 CD 9D 00            CALL DLY1
00FC DB FC               IN CW
00FE E6 01               ANI MASK       END OF MARK?
0100 C2 F8 00            JNZ MKLEN      NO: BUMP COUNT AGAIN
0103 C9                  RET            YES: RETURN WITH MARK LENGTH
0104              *
0104              *
0104              * VLDMK CHECKS THE VALIDITY OF A MARK. ANY MARK LENGTH
0104              * LESS THAN 6 IS CONSIDERED NOISE, THE NOISE LENGTH
0104              * BEING ADDED TO THE PRESENT SPACE LENGTH BEFORE RETURN.
0104              * OTHERWISE THE VALID MARK LENGTH IS RETURNED IN REG. H.
0104              * THE CY FLAG IS CLEARED UPON RETURN IF A VALID MARK
0104              * WAS RECEIVED; OTHERWISE IT IS SET.
0104              *
0104 E5           VLDMK  PUSH H         SAVE SPACE LENGTH TEMPORARILY
0105 26 00               MVI H,00       SET UP TEMPORARY MARK COUNTER
0107 CD F8 00            CALL MKLEN     MEASURE MARK LENGTH
010A 7C                  MOV A,H
010B FE 06               CPI 06         VALID MARK? (BANDWIDTH IS SET HERE)
010D DA 13 01            JC SPACE       NO: ADD MARK LENGTH TO SPACE LENGTH
0110 33                  INX SP         YES: NEW MARK; DON'T WANT OLD
0111 33                  INX SP         SPACE LENGTH ON STACK
0112 C9                  RET            RETURN WITH NEW MARK LENGTH AND CY = 0
0113 7C           SPACE  MOV A,H        ADD INVALID MARK LENGTH TO
0114 E1                  POP H          SPACE LENGTH
0115 84                  ADD H
0116 67                  MOV H,A        REG. H HAS ADJUSTED SPACE LENGTH
```

```
0117 37        1480       STC           SET INVALID MARK FLAG (CY = 1)
0118 C9        1485       RET           AND RETURN WITH NEW SPACE LENGTH
0119           1490 *
0119           1495 *
0119 05        1500 TABLE DB 05H
011A 41        1505       DB 'A'
011B 16        1510       DB 16H
011C 42        1515       DB 'B'
011D 14        1520       DB 14H
011E 43        1525       DB 'C'
011F 0A        1530       DB 0AH
0120 44        1535       DB 'D'
0121 02        1540       DB 02H
0122 45        1545       DB 'E'
0123 1C        1550       DB 1CH
0124 46        1555       DB 'F'
0125 08        1560       DB 08H
0126 47        1565       DB 'G'
0127 1E        1570       DB 1EH
0128 48        1575       DB 'H'
0129 06        1580       DB 06H
012A 49        1585       DB 'I'
012B 17        1590       DB 17H
012C 4A        1595       DB 'J'
012D 09        1600       DB 09H
012E 4B        1605       DB 'K'
012F 1A        1610       DB 1AH
0130 4C        1615       DB 'L'
0131 03        1620       DB 03H
0132 4D        1625       DB 'M'
0133 04        1630       DB 04H
0134 4E        1635       DB 'N'
0135 07        1640       DB 07H
0136 4F        1645       DB 'O'
0137 18        1650       DB 18H
0138 50        1655       DB 'P'
0139 11        1660       DB 11H
013A 51        1665       DB 'Q'
013B 0C        1670       DB 0CH
013C 52        1675       DB 'R'
013D 0E        1680       DB 0EH
013E 53        1685       DB 'S'
013F 01        1690       DB 01H
0140 54        1695       DB 'T'
0141 0D        1700       DB 0DH
0142 55        1705       DB 'U'
0143 1D        1710       DB 1DH
0144 56        1715       DB 'V'
0145 0B        1720       DB 0BH
0146 57        1725       DB 'W'
0147 15        1730       DB 15H
0148 58        1735       DB 'X'
0149 13        1740       DB 13H
014A 59        1745       DB 'Y'
014B 12        1750       DB 12H
014C 5A        1755       DB 'Z'
014D 1F        1760       DB 1FH
014E 30        1765       DB '0'
014F 2F        1770       DB 2FH
0150 31        1775       DB '1'
0151 37        1780       DB 37H
0152 32        1785       DB '2'
0153 3B        1790       DB 3BH
0154 33        1795       DB '3'
0155 3D        1800       DB 3DH
0156 34        1805       DB '4'
0157 3E        1810       DB 3EH
0158 35        1815       DB '5'
0159 2E        1820       DB 2EH
015A 36        1825       DB '6'
015B 26        1830       DB 26H
015C 37        1835       DB '7'
015D 22        1840       DB 22H
015E 38        1845       DB '8'
015F 20        1850       DB 20H
0160 39        1855       DB '9'
0161 51        1860       DB 51H
0162 28        1865       DB '('
0163 72        1870       DB 72H
0164 3F        1875       DB '?'
0165 2C        1880       DB 2CH
0166 2F        1885       DB '/'
0167 69        1890       DB 69H
0168 2E        1895       DB '.'
0169 4B        1900       DB 4BH
016A 2C        1905       DB ','
016B 46        1910       DB 46H
016C 3A        1915       DB ':'
016D 54        1920       DB 54H
016E 3B        1925       DB ';'
016F 2D        1930       DB 2DH
0170 2D        1935       DB '-'
0171 FF        1940       DB 0FFH       ERROR
0172 5C        1945       DB '\'
0173 34        1950       DB 34H        END OF MESSAGE
0174 3C        1955       DB '<'
0175 28        1960       DB 28H        EXCLUSIVE INVITATION TO TRANSMIT
0176 23        1965       DB '#'
0177 36        1970       DB 36H        WAIT
0178 25        1975       DB '%'
0179 79        1980       DB 79H        END OF WORK
017A 3E        1985       DB '>'
017B 00        1990       DB 00         END-OF-TABLE FLAG
```

ASCII	0094	0830			
CONVT	007A	0435			
CRLF	00AC	0335	0455	1270	
CW	00FC	1350			
DASH	0052	0740			
DLY1	009D	1345			
DOT	005F	0595			
DOTT	0066	0745			
ERROR	0098	0850			
GENSP	0036	0500			
IPSTN	00DB	0445	1290		
LEN	0040	0450	1260		
LOOP1	00A2	1010	1020		
MASK	0001	1355			
MKLEN	00F8	1360	1425		
MKTYP	004B	0390			
NEWMK	0016	0405	0465		
NEXT	0084	0870			
OUT	00BB	0440	1060	1070	1285
PRSP	00EF	1265			
PSTN	0BFF	1080	1200	1210	1255
SAME	0072	0675			
SPACE	0113	1440			
SPOUT	00E3	0505			
SPTYP	001B	0430			
TABLE	0119	0820			
VLDMK	0104	0380	0400	0460	
WAIT	0010	0385	0510		

BY FRED BLECHMAN
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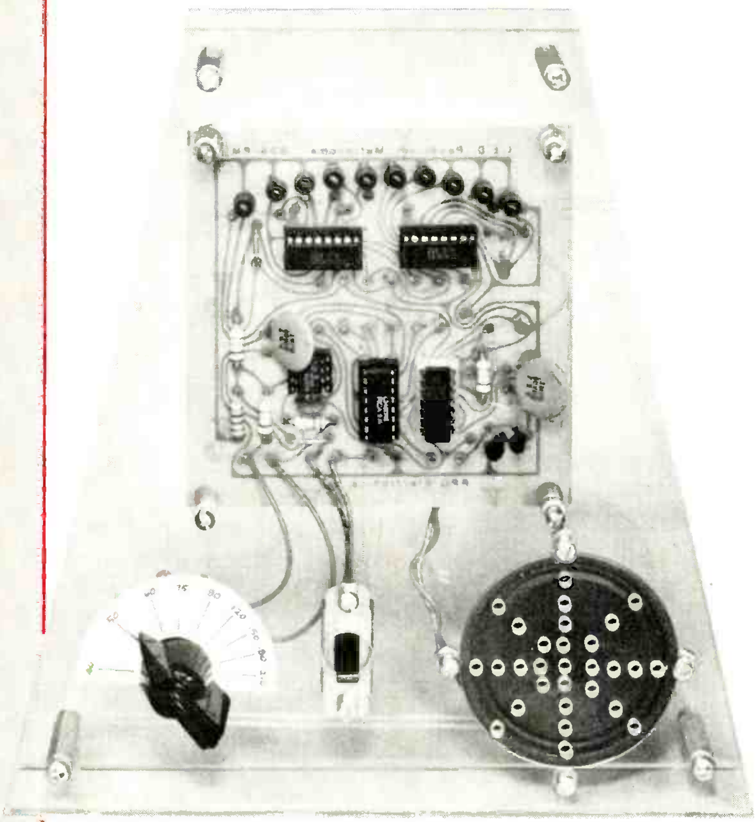
A LED PENDULUM METRONOME

An electronic replacement for the old mechanical music timer

The mechanical metronome, reputedly invented by Maezel in the 19th century, has been a familiar sight around musicians and music students for many years. It uses a wind-up clock mechanism to swing a weighted arm, generating a series of clicks as the escapement gears make contact. The clicking rate is conventionally adjustable from 40 to 210 beats per minute by positioning the weight on the calibrated oscillating arm to change the moment of inertia and the rate of the swing.

Redoubtable though it may be, Maezel's brainchild suffers from defects common to all mechanical devices: wear, drift of calibration, and the need for fairly frequent maintenance. In addition, it must be wound often. A battery-operated, solid-state electronic design, such as the LED Pendulum Metronome described here, circumvents or alleviates the problems of the mechanical metronome. It is stable in calibration and reliable.

Partly for nostalgic reasons, the pendulum movement of the mechanical metronome is simulated in the project as a flashing sequence of LEDs arranged in an arc. (A click from a loudspeaker occurs as the LED at either end of the string fires.) However, the LEDs offer the user the option of "reading" the metronome signal visually in circumstances where a click might be inaudible or objectionable to the user.



Circuit Operation. The "beats" are generated by *IC1*, which is used as an oscillator (Fig. 1). Resistors *R1*, *R3*, and capacitor *C1* limit the frequency of operation that can be set by means of potentiometer *R2*. Capacitor *C2* decouples the *IC1* modulation input. Each cycle of operation of *IC1* results in a positive-going pulse at pin 3, which is fed to the clock input of up-down counter *IC4*. This counter can be set to count from 0 to 9 (10 counts) or 0 to 15 (16 counts), depending on the status of pin 9. With pin 9 positive (as shown), *IC4* counts from 0 to 15. Counting up or down is controlled by pin 10; positive for up-counting, ground for down-counting. The A, B, C, and D outputs of *IC4* (pins 6, 11, 14, and 2) go positive in a 4-bit binary sequence with the D output (pin 2) low during counts 0 to 7 and high during counts 8 to 15.

Both *IC2* and *IC3* are identical 1-of-8 switches. Depending on the 3-bit binary input, one of eight outputs is connected to pin 3 through a low resistance (typically 120 ohms). This is called the "on" condition for this pin. The A, B, and C inputs to *IC2* and *IC3* (pins 11, 10, and 9) are addressed by the output pins (6, 11 and 14, respectively) of *IC4*. However, *IC2* or *IC3* must be enabled by a low on pin 6. For counts 0 to 7, pin 2 of *IC4* is low, enabling *IC2*. Notice, however, that pin 6 of *IC3* is high because of *IC5A*, one section of a quad 2-input NAND gate, wired as an inverter. This disables *IC3* while *IC2* is enabled.

As *IC4* counts from 0 to 7, the outputs of *IC2* are turned "on" in sequence. In this case, on is *not* ground, but is an internal low resistance to pin 3, which is grounded. This low resistance to ground allows the LED connected to an on pin to glow.

Only five LEDs are connected to the eight outputs, with *LED1* connected to three outputs, *LED2* to two outputs, and *LED3*, *LED4*, and *LED5* to one output each. This is done to simulate the swinging motion of a pendulum, which is fastest near the center but slows down near each end of its swing as it finally stops and reverses. By using multiple counts for the LEDs farthest from the center, the apparent motion of the pendulum seems to slow down, stop, and reverse at each end of its swing. This same technique is used for the five LEDs connected to *IC3*.

As *IC4* counts from 0 to 7, only *IC2* is enabled, with *IC3* cut off. When *IC4* reaches the count of 8, the D output at pin 2 goes high. This turns off *IC2*, but, via the inversion by *IC5A*, *IC3* is enabled, lighting LEDs 6 to 10 in sequence. Therefore, the first eight counts of *IC4* are used to command the *IC2* outputs, and the next eight counts command *IC3* outputs.

Up to this point, *IC4* was counting up since its pin 10 was high. This is controlled by the output of a flip-flop formed by NAND gates *IC5B* and *IC5C*. When power is first turned on by closing switch *S1*, pin 9 of *IC5B* is pulled high through *R6*, and pin 5 of *IC5C* is pulled low by pin 13 of *IC2*. Pin 4 of *IC5C* is therefore high since it has a low on at least one input. Pin 4 is connected to *IC4* pin 10, so *IC4* counts up. The flip-flop holds this high on pin 4 of *IC5C*, even though the first count changes pin 5 of *IC5C* to a high. On count number 15 (actually the sixteenth count, if you start at 1 instead of zero), pin 4 of *IC3* is switched on (low resistance to ground). This pin is directly connected to pin 9 of *IC5B*, pulling it low, so output pin 10 of *IC5B* goes high. This provides a high input to pin 6 of *IC5C*. Since pin 5 is already high, pin 4 of *IC5C* goes low to switch *IC4* to the down-counting mode. Even though *IC5B* pin 9 goes high on the next count, the flip-flop logic keeps pin 4 of *IC5* low.

When *IC4* gets down to the zero count, pin 13 is turned on, and pin 5 of *IC5C* is pulled low, making pin 4 of *IC5C* high, and thus putting *IC4* in the up-counting mode. The top count of *IC4* then causes the flip-flop to again change the output at pin 4 of *IC5C*. This flip-flop action keeps occurring at each end of the pendulum, causing it to "swing" back and forth. Capacitors *C4* and *C5* prevent noise from accidentally changing the up/down mode of *IC4*.

The clicking sound occurs at each end of the pendulum swing (as counts 0 and 15 are reached) by changing the state of *IC5D*. Pins 12 and 13 of *IC5D* are normally high, so pin 11 is in a low

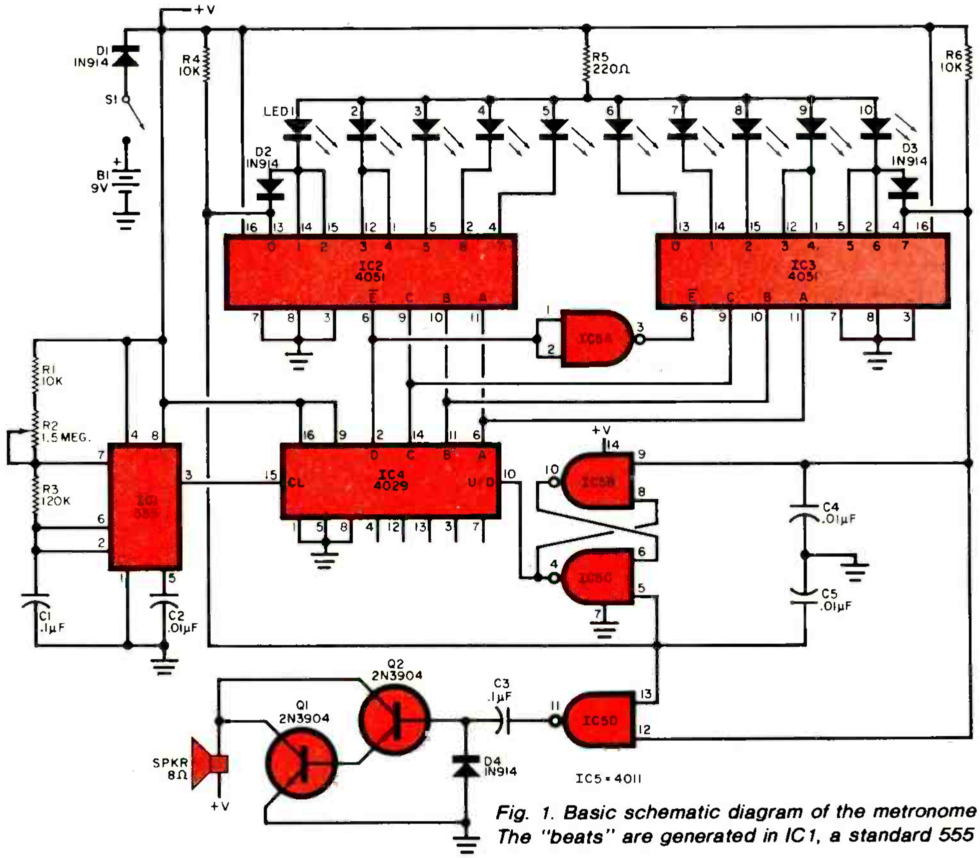


Fig. 1. Basic schematic diagram of the metronome circuit. The "beats" are generated in IC1, a standard 555 timer.

PARTS LIST

B1—6-to-9-volt battery (see text)
C1,C3—0.1-μF disc capacitor
C2,C4,C5—0.01-μF disc capacitor
D1 through D4—1N914 diode
IC1—555 timer
IC2,IC3—4051 1-of-8 switch
IC4—4029 up down counter
IC5—4011 quad 2-input NAND
LED1 through LED10—Jumbo red LED
Q1,Q2—2N3904 or similar transistor
R1,R4,R6—10-kΩ, ¼-W, 10% resistor
R2—1.5-MΩ, liner-taper potentiometer
R3—120-kΩ, ¼-W, 10% resistor
R5—220-Ω, ¼-W, 10% resistor
S1—Spst switch
SPKR—Miniature 8-Ω speaker
Misc.—IC sockets (optional), battery holder, knob, suitable enclosure, mounting hardware, etc.

Note: The following is available from PPG Electronics Co., Inc., Dept. B, 14663 Lanark St., Van Nuys, CA 91402 (213-988-3525): complete kit of parts including pc board (PM-K) at $14.95. Also available separately: plastic "cabinet" (PM-C) at $9.95; etched and drilled pc board (PM-B) at $5.95. Add $2 shipping and handling. California residents, add 6% sales tax. No foreign orders.

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state. When *IC2* pin 13 or *IC3* pin 4 is pulled low, on counts 0 or 15 respectively, pin 12 or 13 of *IC5D* is made low, and pin 11 of *IC5D*, following NAND logic, goes high. This positive voltage swing charges *C3*, causing a small positive pulse to forward-bias transistors *Q1* and *Q2*, which are arranged in a Darlington circuit. The small current pulse through the series-connected base-emitter circuits of *Q1* and *Q2* enables a larger current flow from the power source, through the speaker and the collector-emitter circuit of *Q1*. This is heard as a click. When pin 13 of *IC2* or pin 4 of *IC3* goes high on the next count, a high is put back on pin 12 or 13 of *IC5D*. Pin 11 goes low again, and capacitor *C3* is discharged through diode *D4*. Since transistor *Q2* is now reverse-biased, there is no sound from the speaker until the pendulum "swings" to the other end.

Diodes *D2* and *D3* block the low voltage from pins 14 and 15 of *IC2* and pins 5 and 2 of *IC3* so the count is not prematurely reversed. Diode *D1* prevents damage to the circuit from reversed power leads, or from inserting the battery backwards.

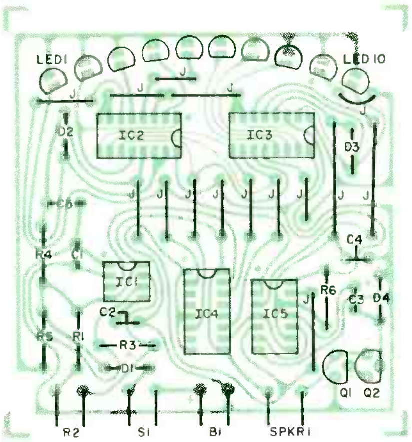
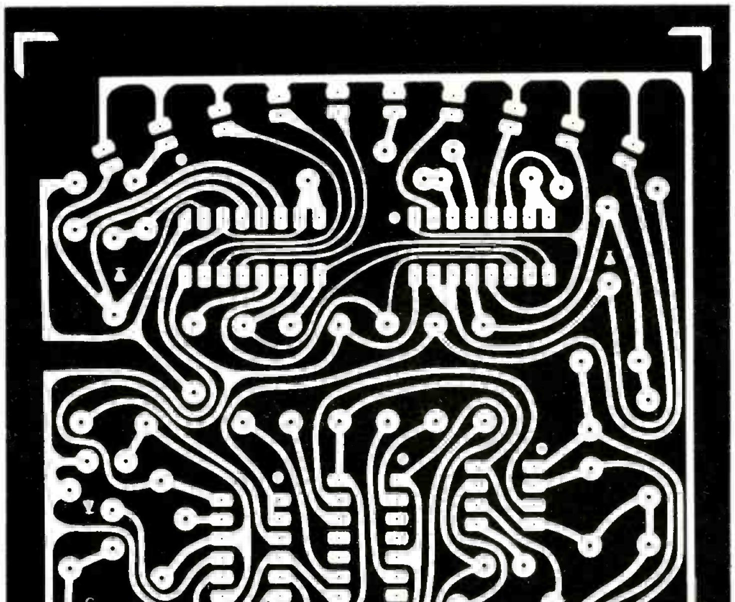


Fig. 2. An actual-size foil pattern for a printed-circuit board is shown below. Above is the component layout diagram. Install jumpers first.



Construction. The LED Pendulum Metronome circuit can be built on a perforated board with point-to-point wiring. However, there are 120 terminations for the ICs, resistors, capacitors, diodes, and transistors—and this doesn't count the external speaker, potentiometer, switch, and battery wiring. Thus, it is more convenient to use the printed-circuit pattern and parts layout shown in Fig. 2.

If you use the pc board, assembly is straightforward. A small 25-watt soldering iron and resin-core solder should be used. First, install the 15 jumpers shown in Fig. 2, cutting wires to the appropriate length and trimming about 1/4" of insulation from each end. Insert through the top of the board and solder on the foil side. Next, install and solder the resistors and diodes, making certain the bands (cathodes) on the diodes are properly oriented. Next, solder in the five sockets, but do *not* install the ICs yet. Now, solder in the three capacitors. The LEDs must be installed in the proper orientation. The cathode (bar of arrow symbol) is identified by a flat-spot or notch at the base of the LED, and the cathodes of all LEDs face the main portion of the circuit board. Next, solder in the transistors, with the flat side facing as shown, so the E, B, and C leads are properly placed. Solder two leads each for the speaker, switch, battery, and potentiometer, and your circuit board wiring is completed.

Your final packaging will dictate the placement of the external parts and the lengths of the leads. Double-sided tape can be used to mount the speaker to the foil side of the board. Potentiometer *R2* should be located below the circuit board to allow room for a calibrated scale and knob on whatever front panel you use. The switch and battery leads can be located wherever convenient.

A unique, modern package is provided by using two sheets of Plexiglas with spacers and screws used to mount the circuit board sandwich-fashion, as shown in the photo.

Since all the ICs have a broad voltage operating range (roughly 3 to 15 volts), you have a choice of what battery configuration to use. At 9 volts, the circuit draws an average of 30 mA, so it's practical to use a standard 9-volt transistor radio battery. Used 4 hours daily, a standard 9-volt zinc-carbon battery (such as Burgess 2V6) should last about 5 hours; an alkaline 9-volt cell should run at least 20 hours. For long, hard use, it would be less expensive to use four "AA" pen cells, "C" or "D" cells wired in series to provide 6 volts initially. Although the LEDs will not be quite as bright and the clicking not as loud, the average current drain is only about 20 mA. Four regular zinc-carbon pen cells should run the metronome for almost 50 hours, used 4 hours a day. Using zinc-carbon "C" cells under the same conditions you can expect 125 hours of use. Alkaline batteries will provide from 4 to 10 times as much useful life. Actually, the circuit will operate with as little as 3 volts, and only uses an average of 4 mA at that voltage—but it's not very loud or bright, so not as effective!

Testing & Calibration. It's a good idea to test and calibrate the unit before final installation in whatever cabinet you're using. Install the ICs carefully in their sockets, making sure they are oriented properly and that no pins are bent out or under. Since all the ICs except *IC1* are CMOS devices, take precautions to avoid static electricity when handling them. Solder the speaker, switch, potentiometer, and battery connector (if used) to the leads from the circuit board and don't forget the jumper across two of the potentiometer terminals.

Connect the battery power and turn on switch *S1*. If nothing happens, make sure that *D1* is not connected "backwards" and that battery polarity is correct. If any individual LED does not light, it may be soldered to the board backwards. If only one LED lights, the 555 (*IC1*) may not be operating. Check for the presence of positive voltage on pins 4 and 8, and see that pin 1 is grounded. Also make sure the values for resistors *R1* and *R3* and capacitor *C1* are correct. As always, solder connections should be checked. If the LEDs swing properly, but you hear no sound, check transistor installation and diode *D4* polarity. If you encounter problems beyond that, an ohmmeter, logic probe, and the circuit description should allow you to pinpoint the problem.

Calibration ideally requires a stopwatch, but a sweep-second watch or seconds-counting digital watch will do. You'll also need patience. The major calibration points are 60, 120, and 180 beats per minute (bpm), since these are 1, 2, and 3 beats per second. You can tell pretty closely in a 15-second timing period what the minute-rate will be for a particular pointer setting by just multiplying the number of beats by four. By trial and error, mark the pointer scale at these points. Next find the 90, 150, and 210 bpm points. Once you've found these points, space the other points equally between the calibrated points and you'll be close enough for all but precision use. If the clicking sound is too loud, add a resistor (up to 100 ohms) in series with either speaker lead. (A 100-ohm potentiometer or variable resistor can be used as a volume control if desired.)

The LED Pendulum Metronome is not intended to be used in precision-timing applications, but is a modern version of an established musical teaching aid. ◇

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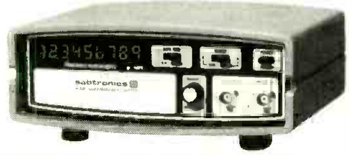

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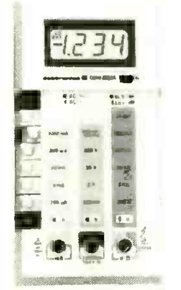

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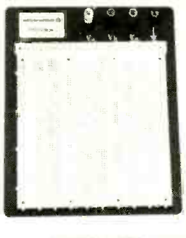

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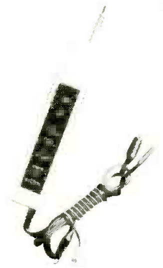

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IF YOU'VE been thinking about additional capacity for your H-89 microcomputer, you might want to consider the double-density floppy disk controller from Magnolia Microsystems (2812 Thorndyke Ave. W., Seattle, WA 98199. Tel. 800-426-2841).

The $595 unit comes with the PROMs, cables, CP/M, and documentation necessary to bring your system into the double-density world. The board supports up to 1210K bytes on a double-sided drive, and as much as 162K bytes on single-sided drives (such as those supplied in the Model H-77 disk system from Heath).

Other attributes of the controller include: the ability to work in concert with either the Heath single- or double-density controller, ease of configuration for a wide variety of systems, the ability to support as many as four 8″ single- or double-sided drives, as well as four 5″ single- or double-sided drives at the same time the Heath controller is supporting three 5″ single-sided drives.

You should be aware, however, that the Magnolia board does not support either HDOS or Heath/Zenith CP/M. The CP/M Ver 2.2 that comes with the controller is optimized to take advantage of the various board characteristics and drives that can be attached to it.

Installation. Installing the controller takes about an hour. Most of the time is spent removing the CPU and terminal boards in order to make the necessary PROM and power-supply changes.

Because many of the H-89s in current use have the original power supply whose regulator is incapable of meeting the necessary current loads, your first step is to adapt the regulator by adding the part supplied for that purpose.

Your next task is to change the monitor PROMs designed to support the controller, and provide a well-thought-out command structure. Specifically, besides boot, you have P for program counter, S (substitute), G (go execute), M (dynamic memory test), and T (test drive rotational speed). Unlike the split-octal used by Heath, numbers are displayed on the monitor in hexadecimal.

Once you've made the necessary hardware additions and checked out the monitor commands, you're ready to configure the drives. On the 5″ drives with your system, you only need to change the jumpers for head-load with motor. Incidentally, all the drives should be configured in this manner.

The 8″ drive I chose was the single-sided FDD-100, 48 tpi (tracks-per-inch) from Siemens. Magnolia sells and recommends Qume's Data Trak 8, which currently is the only drive referenced in the set-up manual. (As of this writing, a new manual is being prepared to address a wider variety; getting the proper jumpers can be troublesome.)

As configured, my H-89 uses the Heath controller for the terminal-mounted drive, while the H-77 outboard drives are on the Magnolia controller, as is the 8″ drive. The total system storage capacity is 1M byte: 80K bytes for the Heath drive, 160K bytes each for the 5″ drives on the Magnolia controller, and 600K bytes for the 8″ drive. All the drives are 48 tpi; but I could add 96-tpi drives in the daisy chain—either the 5″ or 8″ variety.

The Magnolia board is integrated into the system configuration via a specific program. This program is menu-driven and offers a number of selections, including density (single- or double-track), and one or two operational sides.

This way, the controller knows the bits per inch (bpi) are doubled; and for the 96-tpi drives, that you have more than 40 tracks to address. In addition, the configuration program permits logical and physical drive assignments in a lookup table. This technique maps the drives as they appear in your system. Moreover, you can set up a boot drive. I currently boot off a double-density 5″ drive and use the 8″ for maximum storage capacity.

During configuration, you can establish the density of a specific drive so that you can read a variety of disks. This is important since most software is delivered on single-density, IBM-compatible formats. Ideally, what you'd want is one 8″ drive in double-density, the other in single. Should you have only a single 8″ drive, prepare to make two systems disks, one configured for single-, the other for double-density.

Capabilities. The Magnolia controller achieves its double-density capability by the method it uses to record the data. With a 5″ single-sided drive, such as that offered by Heath, you have tracks laid out 48 to an inch. Typically, the effective number of available tracks is 40, since the head travels just a little under an inch for a full stroke. The next parameter of concern is the linear density, that is, number of bits recorded per inch. For the Siemens Model FDD 200-N, for example, the bit density is 2938 bpi for frequency-modulated (FM) recording. The total areal density (bpi × effective tracks) is equal to 125K bytes.

To double the amount of data that can be put on the drive, only one parameter can be changed—the number of recorded bits per inch. The track density (tpi) is a physical limitation of the drive, although newer drives do offer 96 tpi, with an effective number of tracks ranging from 77 to 80.

Consequently, some method of increasing the bpi must be found, and the usual course is to employ modified frequency modulation (MFM) or M^2FM. These two recording techniques reduce the size of the bit cell by applying a new definition of when a clock pulse starts or ends and data begins. The overall effect is to increase the number of bits per inch, thus increasing the overall real density of the drive. In the case of the Siemens drive, instead of 125K bytes you end up with 250K bytes. This is the technique employed by Magnolia.

You may have noted that I said the Magnolia controller gives you 160K bytes on the Heath drive, but that 250K bytes are specified with MFM recording techniques. The difference stems from the fact that the 250K bytes is not formatted, while the 160K bytes is. Formatting implies overhead, in this case about 90K bytes.

The overhead is from the space required to define the sectors, provide sufficient spacing, and implant information on a track as to how the operating system should handle the disk. All of this must be accounted for by the controller so that errors aren't introduced. The Magnolia controller does this without any problems.

The Magnolia controller is well worth the money: it adds flexibility to your Heath system without sacrificing functionality.

I encountered only two problems as a result of the addition of the board. The first was system power difficulty due to low line voltage. This is easily cured by moving the line switch on the H-89 to low; but be aware that if the line comes up to nominal (typically 112 V), you will need to switch back to high or have a power supply running hot.

The second problem was making the Diablo Model 630 daisy-wheel printer work correctly. To do this, it is necessary to open the printer up, change a jumper between pins 5 and 6 on the HYPRO interface board, and then employ a pin-to-pin cable. The problem I had was in using a cable wired for an RS-232C that carried a less-than-full signal, and, as a consequence, "clear-to-send" was not being monitored by the H-89, so buffer overflow resulted. Changing the cable fixed the problem.

Speaking of cables, I've found that no matter where you go to buy either a round or flat one, the prices range from $30 to $40 for a six-foot section with connectors. Interestingly, the actual cost to the manufacturer is only about $3.

Okidata Microline 83A Printer. With your storage needs solved, you might want to look at bettering your hardcopy output. One printer that deserves attention is the Microline 83A, made by Okidata Corp. (111 Gaither Dr., Mt. Laurel, NJ 08054).

The Microline 83A serial dot-matrix printer designed for applications requiring long-duty cycles, letter-quality printing, and full-size (15") paper.

Sporting both a 1200-bps RS232C serial interface and an 8-bit parallel interface, the Model 83A operates at 120 cps with a bidirectional print mechanism with shortline-seeking logic. In addition, standard characters are produced with a dense 9 x 9 dot pattern by a 9-wire, stored-energy print head. The Model 83A includes the full 96 ASCII character set (upper and lower case) plus 64 block graphics shapes. Furthermore, special character sets for British, German, French, Swedish, Danish, Norwegian, Dutch, Italian, and special-function TRS-80 codes are standard. A 136-character buffer is also standard.

The 64 graphics characters are similar to those of the TRS-80, and can be combined with the condensed and double-width functions to produce charts and graphs like those created on raster-type printers.

An optional 9600 bps is also available. The price for the high-speed interface Model HS-RS232, with a 256-byte buffer is $180; with a 2K-byte buffer the price is $270.

The printer with the optional $50 tractor feed supports paper widths up to 15" or 14" with friction feed. Standard throughput ranges from 232 lpm for a 20-character line to 47 lpm for a full 136 characters per line.

In addition, line spacing is program-selectable (either 6 or 8 lpi), with a standard character size of 0.081" W × 0.105" H, with spacing of 10 cpi. In the condensed mode, spacing is 16.5 cpi, and double width is 5 cpi.

The flexible printer permits the use of single-sheet plain paper with friction feed, or continuous paper with the tractor feed. In addition, the adjustable snap-on tractor accommodates four-part stock up to 15" in width.

The Microline 83A power requirements range from 100V to 240V at 50 or 60 Hz, with a maximum power dissipation of 150 W. The 20.2" x 12.9" x 5.2" printer weighs 30.9 lb, and is priced at $1195, with owners manual and interfacing guides. You can find it at most computer stores. ◇

COMPUTER SOURCES

By Leslie Solomon
Senior Technical Editor

Hardware

Apple Multifunction Card. The CPS MultiFunction Card provides all the capabilities of serial interface, parallel output, and a real time calendar/clock on a single slot Apple II plug-in card. Serial and parallel output may be used simultaneously. The card is configured from a set-up program on diskette which sets all desired parameters. Once configured, it need never be set again. **Address:** Mountain Computer Inc., 300 El Pueblo Rd., Scotts Valley, CA 95066.

Software

IBM Personal Computer OS. SB-86 is a proposed standard operating system for 16-bit systems and is completely compatible with the new IBM Personal Computer. It is written in 8086 assembly language. It has no 64K program space limitation, although a single model can exceed 64K. The relocatable linking loader can provide for separate segments thus making it a truly relocatable operating system. It supports advanced error recovery procedures and has a device-independent I/O. Interfacing with hardware is simplified by its variable physical disk sector size. Disk programs can specify any logical record size making large files very efficient. SB-86 has no file or disk size limitation (unlike CP/M) and includes such features as text editing template, no need to log in disks, variable length logical records, remembered EOF markers, and the stamping of the creation and last-access dates and times on each file. IBM will offer software running under SB-86. Future extensions include disk buffering, graphics and cursor positioning, Kanji support, XENIX compatibility, multiuser, hard disk, and networking. **Address:** Lifeboat Associates, 1651 Third Avenue, New York, NY 10028 (Tel: 212-860-0300).

ZX-80 Music. The Player ZX80 is a music synthesis for the Sinclair ZX-80 with 4K BASIC and 1K RAM. It is single voiced with a 2-octave range and can perform tunes up to 127 notes in length. It can be run at any tempo and continuously replays until interrupted. Space Muse-ak, a random sound program is also included. $6.95. **Address**: Wm. D. Maples, 688 Moore St., Lakewood, CO 80215.

Activity Scheduler. "Schedule" was developed for the North Star system, and is soon to be made available for other systems. In operation, it can record as many as 10 activities a day for a year, with exact times and reminders of activities with no set time. All activities are sorted with timed ones displayed in the proper order, and reminders displayed after timed activities. The output can be selected from a single date, or a span between dates. The data can appear on a CRT or printer. It is written in North Star BASIC, requires 8K of RAM, and a single-drive, single-density disk. $19.95. **Address**: Azimuth Associates, Box, 1636, Arlington, VA 22210.

Armored Attack. TANKTICS is a war game in which a human plays tank warfare against the computer. Five scenerios are provided. It comes with a 22″ by 16″ mapboard and over 240 counters depicting 15 different armored vehicles. Cassette version includes Atari 400/800 with 24K, Apple II with Applesoft and 16K, PET with 16K, and TRS-80 Level II with 16K; $24. Diskettes versions include TRS-80 with 32K, Apple II with 32K, and Atari 800 with 40K; $29. **Address**: Avalon Hill Game Co., 4517 Harford Rd., Baltimore, MD 21214 (Tel: 301-254-5300).

ZX-80 Games. Written for the Sinclair ZX-80 and MicroAce computers, A Night in Las Vegas contains Slot Machine, Roulette, Blackjack, and Craps, all with graphics. Comes with cassette, manual, guide cards, miniature layouts, chips, and full color keyboard overlays. $9.95. Address: Lamo-Lem, Box 2382, La Jolla, CA 92038 (Tel: 714-262-5681).

TRS-80 Mailing List. MAIL-M3 features multiple labels (up to 4) across a page, form input, report writer, multisort keys, duplicate label checking, random access, and search. Screen and edit functions allow cursor movement, and delete lines and characters. Fields include 9-digit zip codes, and remarks. The report writer allows specifying report formats without programming, multiple sort keys, filter criteria, field selection and record delete. It also allows unlimited report formats. The report generator allows for record range, selection code range, and sort field. You can also set the number of lines on a page. MAIL can store 500 records of 127 bytes each per diskette. It requires TRSDOS. 48K version is $79, 32K version is $59. **Address**: Micro Architect Inc., 96 Dothan St., Arlington, MA 02174 (Tel: 617-643-4713).

Reference Charts. Printed on durable credit-card plastic 8½″ × 11″ sheets, the MICRO CHARTS contain the instruction set, disassembly tables, ASCII, hex-to-decimal, compare vs jump, effect on flags, interrupt structure, pinout, cycle times, memory map, diagrams, addressing, powers of two, and more. These charts are available for the Z80, 6502 (65XX), 8080A, 8085A, and relatives. $5.95 plus $1 postage/handling. **Address**: Micro Logic Corp., Dept. PE, Box 174, Hackensack, NJ 07602 (Tel: 201-342-6518).

Applesoft Compiler. This product translates standard Applesoft BASIC programs into true machine code that runs up to 12 times faster than the interpreter. Programs can be written in Applesoft BASIC, then compiled with the advantage of machine language. It requires 48K RAM, Applesoft, Autostart ROM, and at least one disk drive. It can also operate in a 64K environment with RAMcard. All Applesoft features, except dynamic array dimensioning and interpreter statements such as List and Trace, are supported. The 3.3 DOS version will soon be available. $200. **Address**: Hayden Book Co., 50 Essex St., Rochelle Park, NJ 07662 (Tel: 201-843-0550).

TRS-80 Bowling. TENPINS is a machine-language bowling game for one to four players on a Model I/II system. The game features realistic action and sounds. Scoring, pinsetting, and ball return are all automatic, and the scoresheet is readily available. Cassette is $14.95, disk for Model I is $20.95. Disk version for Model III soon to be available. **Address**: Acorn Software Products Inc., 634 North Carolina Ave., SE, Washington, DC 20002 (Tel: 202-544-4259).

TRS-80 Compiler. The RSBASIC (26-2204) compiler is designed for the TRS-80 Model I and Model III machines, having 48K dual-disk drives. It will not convert programs written in the BASIC interpreter. The software features sequential, random and single-key ISAM file access; direct calls to machine language programs; full program chaining capabilities with common variable storage; numerical accuracy to 14 significant digits for real numbers; step and trace debugging; printer and disk utilities; strings, arithmetic, trigonometric and bit operations; conversion between data types; and full editing. $149. Model II Compiler BASIC (26-4705) requires a 64K single disk Model II and is priced at $199. **Address**: Radio Shack stores and Computer Centers.

FP FORTH. Floating point FORTH is available for Z80/8080/8085 systems with CP/M or CDOS and must be ordered as an option with any version of Timin FORTH. It is written in 8080 code and requires a minimum of 24K. This product allows the user to work with decimal numbers similar to BASIC and FORTRAN. The 16-bit and 32-bit integer capability of FIG FORTH is retained, but a floating point mode is added. These are single precision floating-point numbers with approximately 7 significant decimal digits. Addition, subtraction, negation, multiplication, division, integer conversion, and comparison are supported. $100 plus cost of Timin FORTH). **Address**: Timin Engineering Co., 9575 Genesee Ave., Suite E-2, San Diego, CA 92121 (Tel: 714-455-9008).

Baseball Program. Major League Baseball contains statistics on every major league player and the rules of baseball. The user is the team manager and you can play a game, recreate a season, series, or World Series. A box score is provided at the end of each game, and season's statistics are provided for each player used. TRS-80 Model I, Level II 16K cassette is $25; Apple II 32K cassette is $25; TRS-80 Model I, Level II 32K diskette is $30; Apple II 48K diskette is $30. Atari 800 version upcoming. **Address**: Avalon Hill Game Company, 4517 Harford Rd., Baltimore, MD 21214 (Tel: 301-254-5300).

TRS-80 Medical Program. The Medical Office Management program maintains 10,000 active patients and can schedule up to 19,000 current and future appointments. The system can be expanded to handle multiples of 10,000 active patients in a clinic setting and can provide an appointment horizon as long as 40 months. It can handle about 190 patients per physician a day with up to 600 transactions. A complete billing and report system are included as well as a complete payment, billing, label printing, appointment reminders and changes, and a help function. The program requires two or three disk drives, 130-column printer, and a 48K TRS-80 Model I (Level II) or TRS-80 Model III (Basic III) with TRSDOS. $449.95 **Address**: Charles Mann and Associates, Micro Software Div., 55722 Santa Fe Trail, Yucca Valley, CA 92284 (Tel: 714-365-9718). ◊

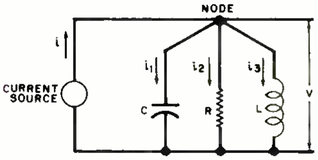
FUNDAMENTAL FACTS

By Walter Buchsbaum

The Basic Network Laws

THE NAMES Kirchhoff, Thevenin, and Norton are known to anyone who has ever studied the principles of electricity. In the complexity of modern electronics, we tend to forget that any circuit can be understood in terms of the basic network laws laid down by these men. In analyzing a new circuit, we can apply them to gain an understanding of how the circuit is supposed to operate.

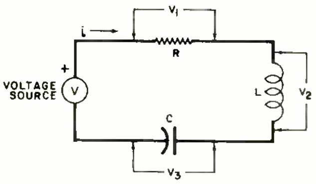
Kirchhoff's Current Law. This law states that the algebraic sum of all currents toward a node is zero. In other words, all current flowing into a node must also flow out of it. As illustrated in Fig. 1, the sum of the currents flowing from the node to the resistor, the capacitor and the inductor must be exactly equal to the current flowing into that node from the source. In the case of varying currents, we use the operators p and 1/p. These are simply shorthand notations for the ac response of C and L. When considering sine waves, these operators become $2\pi f$, with the frequency given in hertz.



$$i = i_1 + i_2 + i_3$$
$$= CpV + V/R + V/Lp$$
$$= (Cp + 1/R + 1/Lp)V$$
$p = d/dt$ (derivative operator)
$1/p = \int dt$ (integral operator)

Fig. 1. Kirchhoff's current law.

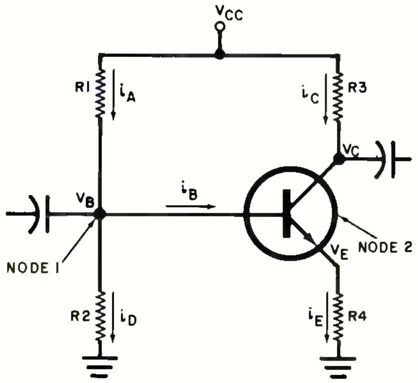
Kirchhoff's Voltage Law. This states that the algebraic sum of all the voltages around a closed loop of a network is zero. Thus, the applied voltage must equal the sum of all the voltage drops. This law, too, is based on the conservation of energy, one of the fundamental principles of physics. As illustrated in Fig. 2, it means that we can determine an unknown voltage drop by knowing the applied voltage and the other drops in the circuit. As in the current law, the time-varying characteristics of the capacitor and the inductor are represented by the operators p and 1/p.



$$V = V_1 + V_2 + V_3$$
$$= Ri + Lpi + i/Cp$$
$$= (R + Lp + 1/Cp)\, i$$

Fig. 2. Kirchhoff's voltage law.

Examples. In the small-signal, linear-transistor amplifier shown in Fig. 3 there are two nodes, and Kirchhoff's current law can be used to check that the base-bias current, i_B, will produce an emitter current, i_E, that adds up to the sum of the i_C and i_B.



Kirchhoff's Current Law:
$i_A = i_B + i_D$
$i_E = i_B + i_C$
If, $V_{CC} = 12$ V; $V_B = 7.5$ V; $V_C = 8$V; $V_E = 0.45$V and R1 = 2.7 kΩ; R2 = 6.8 kΩ; R3 = 1 kΩ; R4 = 100Ω
Then: $i_A = 4.5/2.7 = 1.65$ mA
$i_D = 7.5/6.8 = 1.10$ mA
$i_C = 4.0/1 = 4.0$ mA
$i_E = 0.45/100 = 4.5$ mA
And: $i_B = i_A - i_D = 1.65 - 1.10$
$= 0.55$ mA

Fig. 3. Example using current law.

In the high-voltage bleeder network of a CRT power supply (Fig. 4), to determine the anode voltage, it is necessary to measure only the focus voltage. Since the value of each bleeder resistor is known, the drops across them can be subtracted from the focus voltage.

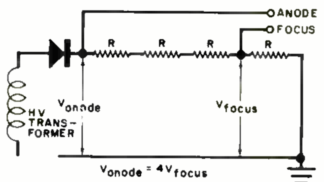
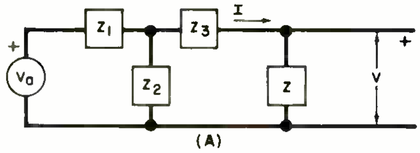
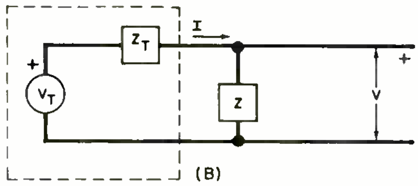


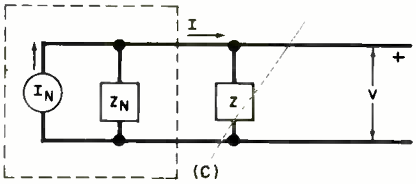
Fig. 4. Example using voltage law.

Thevenin and Norton Equivalents. These two theorems offer a means to simplify complex networks by consolidating them into an equivalent voltage source with a series impedance (Thevenin) or into an equivalent current source with a shunt impedance (Norton). The





$$V_T = V_A Z_2/(Z_1 + Z_2)$$
$$Z_T = Z_3 + Z_2 \| Z_1$$



$$I_N = V_a Z_2/[Z_3(Z_1 + Z_2) + Z_1 Z_2]$$
$$= (Z_1 + Z_2)/[Z_3(Z_1 + Z_2) + Z_1 Z_2]$$

For example:
If, $V_a = 12$ V
and $Z_1 = Z_2 = Z_3 = 1$ kΩ
Therenin equivalent:
$V_T = (12 \times 1)/2 = 6$ V
$Z_T = 1 + 0.5 = 1.5$ kΩ
Norton equivalent:
$I_N = (12 \times 10^3)/(2 \times 10^6 + 10^6)$
$= 12/(3 \times 10^3) = 4$ mA
$Y_N = 2/(3 \times 10^3)$
$= 0.667$ millimhos

Fig. 5. At (A) is a typical network. Solution at (B) uses Thevenin equivalent; at (C), Norton equivalent.

network in Fig. 5A consists of a voltage source, a Y-connected set of impedances, and a load or terminal impedance, Z. In actual applications, much more complicated networks, including those with multiple voltage sources, can be simplified by applying Norton's or Thevenin's theorems. The Thevenin equivalent is shown in Fig. 5B, together with the formulas for the Thevenin voltage source, V_T, and the Thevenin series impedance, Z_T. Another way to represent the network example would be through Norton's equivalent, illustrated in Fig. 5C. The current source, I_N, and the shunt admittance, Y_N, have somewhat more complex formulas than the Thevenin equivalents, but this is due to the particular example we have chosen.

Anyone doing network analysis soon learns which network features lend themselves to a voltage (Thevenin) or a current (Norton) transformation. Once either equivalent is obtained, it is relatively simple to get impedence matching solutions for any kind of Z. ◊

Popular Electronics Tests

Global Model 4401 Frequency Standard

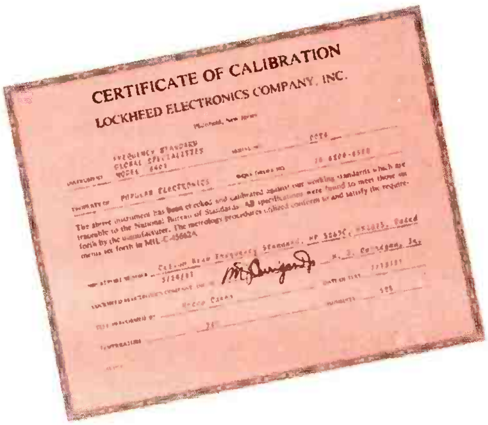
THE Global Specialties Corporation's Model 4401 Frequency Standard is a low-cost, line-powered instrument capable of generating 24 frequencies of very stable, 50% duty cycle square waves between 0.1 Hz and 5 MHz. It measures 3″H x 10″W x 7″D and weighs 2 pounds. Suggested retail price is $288.

General Description. All controls, indicators, and output connections are made on the front panel. There is a row of eight LEDs indicating output at 0.1, 1, 10, and 100 Hz; 1, 10, and 100 kHz; and 1 MHz. These LEDs glow in accordance with the selection made via the FREQUENCY SELECT pushbutton. Multiplication of the base frequency (X1, X2, and X5) is made via the FREQUENCY MULTIPLIER rotary switch. Another LED is used to indicate OVEN READY conditions. The 10-MHz crystal oscillator is maintained at a constant temperature within this oven to provide accuracy and long-term stability despite ambient changes.

Two BNC connectors provide outputs at 10 MHz and the selected frequency. The POWER toggle switch is on the left side. The case is supported on four skid-proof bumpers and ventilation slots are provided on both the upper and lower surfaces of the enclosure.

The 10-MHz output provides a 50-ohm, TTL-compatible square wave, buffered to drive up to 10 TTL loads. It is short-circuit protected and the rise and fall times of the output waveform are 20 nanoseconds into a 50-ohm load. The selected output frequency is also 50-ohm, TTL-compatible and can drive up to 10 TTL loads. It too is short-circuit protected, with 20-nanosecond rise and fall times into 50 ohms.

The basic frequency reference is a 10-MHz crystal mounted within an oven maintained (as long as power is turned on) at 55°C. Stability is ±0.5 ppm (parts per million) and aging is less than 1 ppm/year. An accessible, internal control can be used to calibrate the instrument against station WWVB. Power requirement is 105-135 volts, 57-63 Hz, 5 VA maximum. A 215-230-volt, 50-60-Hz version also is available.



Comments. The Model 4401 Frequency Standard was checked by the Lockheed Electronics Instrumentation Measurement Laboratory against a cesium-beam frequency standard (HP5062C) traceable to the National Bureau of Standards. The Model 4401 met or exceeded its claimed specifications in all respects.

The Model 4401 is an excellent source of discrete, selectable, square waves that can be used as an oscilloscope time-base calibrator, precision clock source for digital circuits including microprocessors, a frequency counter calibrator, or any other application where a precise frequency source is required.

Once power is turned on, the 4401 should be allowed to "sit" for 15 to 20 minutes with the OVEN READY indicator glowing. (This indicates that the internal crystal oven has come up to temperature.) During this period, the default frequency is 0.1 Hz as indicated by its glowing LED. The FREQUENCY SELECT pushbutton is then depressed to step the glowing LED indication to the desired frequency. The FREQUENCY MULTIPLIER rotary switch is used to select either X1 (the front-panel LED indicated frequency), X2, or X5. This arrangement allows for 24 frequencies between 0.1 Hz and 5 MHz.

While the 4401 was warming up, we checked the accompanying well-written and profusely illustrated manual. Besides giving full details of installation, operation, and testing of the 4401, the manual provides some examples of application for the instrument.

The first use we made of the 4401 was to check out our frequency counters and scopes. The two frequency counters were "on the head," but one of our expensive scopes was found to require some work in the horizontal section to improve the linearity. Any measurements (frequency or period) made with this scope would have been almost 10% off! With the information provided by the manual, we used the output square waves to check some audio equipment. Square waves can be used for audio testing since, in order to reproduce, say a 10-kHz square wave, the amplifier must resolve at least 10 harmonics, making it good to 100 kHz. This is an excellent and fast test for audio systems, since it also shows the effect (and confirms operation) of bass/treble controls, and any variable equalizers in the circuit. In an instant, you can see the reaction of the input square wave to the adjustable frequency response of the system. A small value capacitor can be connected across the audio input terminals to "slow down" the 20-μs risetime.

The manual section on testing of transmission lines sparked quite a bit of interest since we often use long lengths of coaxial cable. The tests show whether a short, open, or "kink" in the line can affect performance. Various impedance discontinuities show up when using the 4401 with a scope, and the technique will even measure the length of cable when the cable is still on the spool!

We did not use the 4401 to clock a microprocessor, but we did use it to trigger some digital logic circuitry we were working on. We experimented with raising the clock rate, then hand-selecting the input TTL logic, until we could run the circuit at almost double the clock rate we had originally intended to use.

We are using the model 4401 as a frequency standard to check many of our bench instruments. We turn the standard on first thing in the morning and allow it to keep warm all day in the interest of stability. Frequency counters and scopes are checked each morning to make sure that all measurements made during the day will be "on the head." Using the 4401, a scope, and Lissajous patterns, we also check the dial calibration of our audio and r-f signal generators. About the only thing we cannot check with the 4401 is our DMMs.

We routed the SELECT output signal, via a switch, to our audio bench, where it was terminated in a 50-ohm resistor, and used for fast audio system checking. This same source is used to check digital circuits that require clocking, since a wide variety of clock rates is available.

Although an accurate frequency standard may appear as a luxury item at first glance, given the state-of-the-art of most modern electronic appliances, a service bench without some type of standard against which instruments can be checked, is an instrument bench that may be giving false data.

—*Les Solomon*

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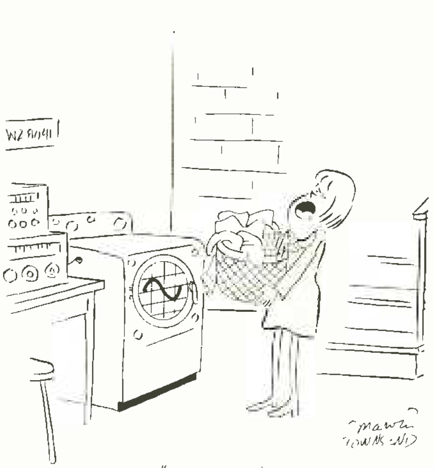


"HENRY!"

SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

Liquid Crystals

IF LIQUIDS flow and crystals are solid, then how can a crystal be a liquid? The answer to this question provides the key to why liquid crystals can be used in such important applications as temperature measurement, pressure detection, electro-optical shutters and various kinds of displays.

A liquid crystal is a viscous fluid containing rodlike molecules aligned in a recognizable order. Many organic compounds fit this description.

Liquid crystals are categorized, according to the alignment of their molecules, into three major types: nematic, smectic and cholesteric. Figure 1 illustrates the molecular alignment of the three types.

The molecules in the nematic liquid crystal are parallel to one another. The word "smectic" comes from the Greek word for soap, the most common representative of this kind of liquid crystal. Its molecules are arranged in layers. Adjacent layers can slide over one another since the molecules in one layer cannot move into an adjacent layer.

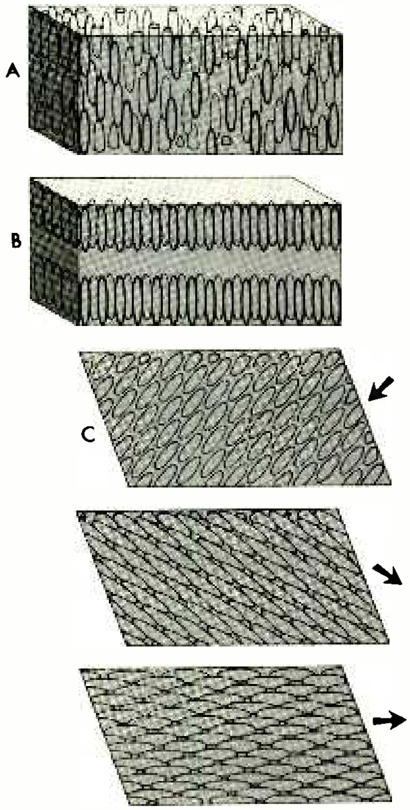


Fig. 1. How molecules are organized in liquid crystals: (A) nematic, (B) smectic, and (C) cholesteric.

The molecules in cholesteric liquid crystals are also in layers. However, in each layer, they are parallel to one another and so the crystals resemble nematic material. The orientation of the molecules in a layer is displaced slightly from the layer above and the one below. Plotting the orientation of the molecules in each layer along a vertical axis shows how the molecules rotate to give a helical pattern.

Applications for Liquid Crystals. Cholesteric and nematic liquid crystals have several important applications in solid-state electronics. All liquid crystals exhibit temperature sensitivity, but cholesteric crystals indicate temperature differences by changing their color. Nematic crystals, which are normally transparent, can be made opaque by the application of a low voltage. Both these effects are caused by the movement of molecules in the liquid crystal.

There are two principal ways of using cholesteric liquid crystals to detect temperature. In one method the liquid crystal is mixed with a solvent called a carrier and sprayed or brushed over a black, water-soluble lacquer which has previously been applied to the object being tested. The solvent quickly evaporates, leaving behind a thin film of cholesteric fluid.

Depending upon the cholesteric material used, temperatures ranging from 0° C to 200° C can be detected. Within this broad range, the liquid crystal will indicate a temperature interval as narrow as 0.5° C by a change in color from red (coolest temperature) to blue (warmest temperature). The crystal will appear black, the color of the underlying paint, at temperatures above and below the sensitive region. The sensitive region of some materials may be several tens of degrees wide.

Often, color photographs are made of a cholesteric liquid-crystal temperature monitoring test. The resolution of the process is high enough to permit thermal mapping of some integrated circuit chips. This permits hot spots to be pinpointed. A cholesteric coating can also reveal the location of conductors in an opaque material, cracks in metal and flaws in honeycomb structures.

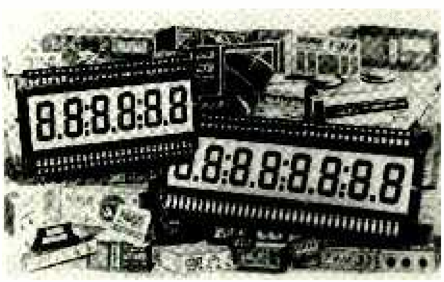
Even though a coating of cholesteric liquid crystals can be removed with water, the application and removal of the material is messy and takes time. I know from firsthand experience because I've used cholesteric liquid crystals on mylar films to visualize the cross-section of infrared laser beams.

A far better approach is to encapsulate the liquid-crystal compound in spherical capsules about 10 to 30 microns in diameter using a process perfected by the National Cash Register Company (Dayton, OH 45409). NCR sells encapsulated crystals in a water-based slurry suitable for direct application over a black background. This precludes the need for the solvent which is required in direct application of the material.

NCR also makes paper and plastic sheets coated with encapsulated, and therefore dry, crystals. These temperature-sensitive sheets can be used to make disposable thermometers, temperature indicators for power transistors and ICs and many kinds of novelty devices.

You can buy liquid-crystal thermometers at department and specialty stores. Edmund Scientific (101 E. Gloucester Pike, Barrington, NJ 08007) sells assorted sheets of encapsulated liquid crystals. They offer at least six different temperature ranges.

The major application for nematic liquid crystals is alphanumeric displays for



Large-format LCD readouts from Beckman Instruments operate on 3 to 15 V rms and require as little as 50 microwatts.

clocks, watches, calculators and other devices with digital readouts. This technology has come a long way in the ten years since I first experimented with a homemade nematic crystal electro-optical shutter. In those days commercial nematic liquid-crystal displays were unavailable and it was necessary for experimenters to place drops of greasy nematic compound on small sheets of glass coated with a conductive layer of tin oxide. Air bubbles and leakage were the two biggest problems—assuming the experimenter was able to hold everything together with tape or glue.

Today a wide range of both digital and alphanumeric nematic liquid-crystal display (LCD) devices are available. Recently several companies have begun offering high-density dot-matrix LCDs which permit low-resolution graphic displays. The availability of these and other kinds of LCD readouts has made a great impact on the market for light-emitting diode (LED) displays. Since both LCD and LED displays are widely used in applications requiring miniature readouts, it's instructive to compare their advantages and disadvantages.

LED Displays. LEDs can be directly driven by most ICs, although CMOS chips may require buffering if high current levels are desired. They operate at less than 2 volts and possess the long life, reliability and robust nature of most other solid-state devices. And they are readily multiplexed.

On the other hand, the manufacture of LED readouts involves a complex series of fabrication steps. Light-emitting semiconductors are much more costly than liquid crystals. A single segment or element of a LED readout consumes from 0.5 to 5 milliamperes. Also, LED displays are difficult or even impossible to read in bright sunlight.

Liquid Crystal Displays. LCDs are easier to make and less costly than their LED counterparts. They are easily read in bright sunlight. They consume minuscule amounts of power (typically 1 to 5 microamperes per square centimeter of display area). And they can be made in much larger formats than LED versions of the same display.

Beckman Instruments, Inc. (2500 Harbor Blvd., Box 3100, Fullerton, CA 92634) makes large-format, 7-segment LCD readouts that can be driven directly by suitable CMOS circuitry and can operate at 3 to 20 volts rms. Normally all segments are transparent. Applying a voltage to a segment causes the nematic crystal to become opaque and the segment to appear dark.

Power consumption of the Model 740 6-digit readout is only 50 microwatts. A comparable LED readout would consume some 70 milliwatts assuming a forward voltage of 2 volts, a drive current of 5 milliamperes per segment and a multiplexing scheme wherein only one of the six digits is on at any time.

Operating advantages like these are

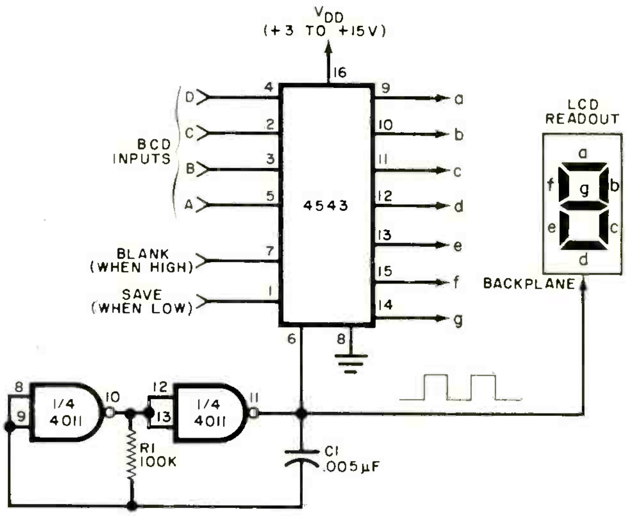


Fig. 2. How to use the 4543 CMOS LCD 7-segment latch/decoder/driver.

accompanied by several drawbacks. One is that LCD readouts cannot be read in the dark. For this reason some LCD readouts include a miniature incandescent lamp. Another disadvantage is that LCD readouts must be powered by an ac, not dc, voltage (usually 3 to 15 V). The driving requirements preclude direct drive of LCDs by standard ICs. Instead, special driving circuits or LCD compatible chips are required.

Operating temperature is another drawback since nematic liquid crystal will both freeze and boil. This gives a typical useful operating temperature range from about −10° C to +70° C. Finally, LCD readouts have much slower turn-on and turn-off times than LEDs. This and their driving requirements make multiplexing difficult.

Their disadvanatages notwithstanding, LCD readouts have all but replaced LED displays in watches and calculators. One of the main reasons is their ultra-low power consumption. Couple this with CMOS circuitry and you have, for example, a watch that continuously displays the time for up to two years before battery replacement is required!

Of course LED readouts still have an important role to play, particularly when a self-illuminating display is required. In addition, LEDs are inherently sturdier than their glass-encased LCD counterparts.

For this reason, some IC makers cater to *both* kinds of displays. For example, Intersil makes two versions of a single-chip panel meter. The ICL 7106 is designed to drive LCDs while the ICL 7107 is designed to drive LEDs. They are available from Intersil (10710 N. Tantau Ave., Cupertino, CA 95014).

An LCD Driver Chip. Many different clock and watch chips designed specifically for driving LCDs are now available. But what if you want to interface a circuit of your own design with an LCD? One approach is shown in Fig. 2. Here a 4543 CMOS BCD-to-7-segment latch/decoder/driver is used to drive a 7-segment LCD display. Though the 4543 can drive various kinds of displays, it is specifically designed for driving LCD readouts.

When used to drive an LCD display, a square wave must be applied to both the phase input (pin 6) of the 4543 and the backplane of the LCD readout. This provides the ac driving voltage required by the LCD. The decoded outputs from the 4543 are connected directly to the LCD segment pins.

Note how two NAND gates are used in Fig 2 to make a simple square-wave generator for the 4543. Be sure to tie unused inputs to V_{DD} or ground. For more information about the 4543, see the data sheets published by Motorola, National and other CMOS companies. The National data sheet for its version of the 4543 (CD4543BM/CD4543BC) includes the circuit for a 3½-digit DVM with an LCD readout.

Reader Mail. I would like to thank Walter S. Swift of Boynton Beach, FL, for suggesting the topic of this month's column. Walter wrote to ask about the possibility of a liquid-crystal indicator much like the LED variety. He then suggested I cover the subject of liquid crystals in a forthcoming column.

As a result this month's column does not include news about new chips and components. And we've just barely begun to cover the subject of LCDs. For more information about liquid crystals, consult the hundreds of articles and technical papers on the subject that have been published since about 1965. You will find most of them at your local library. If you would like to suggest a topic for coverage in this column, jot down your idea on a postcard. Though the volume of mail makes it impossible to answer individual suggestions, I will try to schedule coverage of the suggestions which have potential. ◇

EXPERIMENTER'S CORNER

By Forrest M. Mims

Experimenting With a Joystick
Part 2. Some Typical Applications

LAST MONTH we learned about and experimented with a few basic applications for single and two-axis joysticks. This month we'll experiment with several analog and digital applications for this very important type of control device.

The joystick I used with the experimental ciruits we'll be discussing, each of which I assembled and tested, contains two 100-kΩ linear-taper potentiometers. It's available from Radio Shack for $4.95 (catalog number 271-1705). Other joysticks may also be used. Those containing logarithmic-taper potentiometers, for example, are usually better suited for audio control applications. Other sources for joysticks include some of the mail order electronic parts supply companies that advertise in this magazine. You can also salvage used joysticks from discarded video games and remote-control transmitter systems.

A Joystick-Controlled Mixer. A *summing amplifier* allows two or more signals to be simultaneously amplified. When used for audio applications, summing amplifiers are usually called *mixers*.

A typical mixer is a relatively simple circuit that allows two or more microphones to be connected to a single power amplifier. The mixer may or may not include a stage of preamplification. More elaborate mixers have half a dozen or more inputs, each having its own gain and, perhaps, other signal controls.

You can make a simple, but functional mixer by connecting several resistors, one for each channel, to one of the inputs of an operational amplifier. If potentiometers are used instead of fixed resistors, it is possible to control the amplitude of the signal from each channel.

This is where the joystick comes in. Normally, a separate potentiometer is required for each channel. Since the joystick incorporates two or four pots in a single structure, the signal amplitude of two to four channels can be controlled by moving a single control.

Figure 1 shows a very simple joystick-controlled mixer. The simplicity of this circuit will allow you to appreciate the versatility of a dual-channel mixer having a single mixing control. For example, I fed two audio channels (music and a tone) into the two inputs and was able to control the mixture with one hand while making other changes with the other hand.

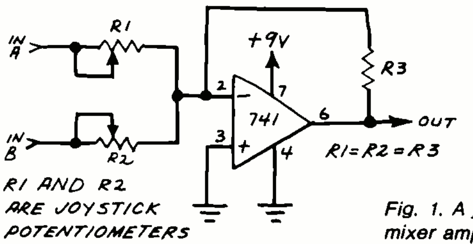


Fig. 1. A joystick-controlled mixer amplifier.

I used a joystick containing 100-kΩ linear-taper potentiometers in this circuit. Logarithmic-taper pots would be better. You can try the basic resistive summer with many different op amps and audio amplifier chips. Joysticks containing four pots are hard to find, but they permit four channels to be simultaneously controlled.

Joystick-Controlled Tone and Amplitude. Figure 2 shows an experimental joystick tone- and amplitude-controlled amplifier. In operation, *R1* controls the amplitude of the signal while *C1* and *R2* serve as a simple, but adjustable, tone-control filter.

To experiment with this circuit, connect an audio-frequency tone source to the input. A sine wave works better than fast-rising square waves. Move the stick so that *R1* is rotated and the amplitude of the tone from the speaker will be altered.

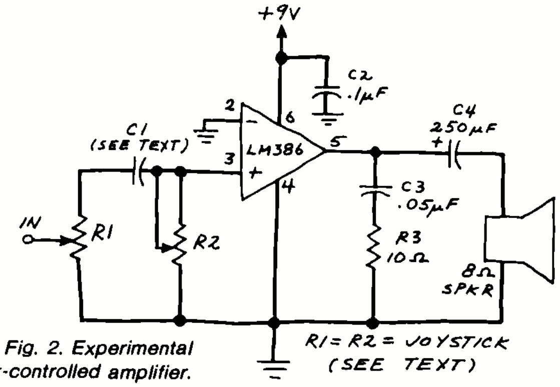


Fig. 2. Experimental joystick-controlled amplifier.

Move the stick so that *R2* is rotated and the amplitude of the tone will also be altered; but in this case, the change in amplitude is dependent upon the frequency of the incoming signal.

The first-order, high-pass Butterworth filter formed by *C1* and *R2* has a half-power frequency cutoff that is the reciprocal of 6.28*R2C1* or 0.159/*R2C1*. The actual cutoff frequency you obtain may differ from that predicted by the formula. For example, when *R2* is 50,000 ohms and *C1* is 0.0001μF, the formula predicts a half-power frequency cutoff of 3,185 Hz. I measured a half-power frequency cutoff of about 1,000 Hz.

In any event, this simple circuit demonstrates how a single control can alter both the gain and frequency response of an amplifier. If you wish to design your own joystick-controlled amplifiers, there are several excellent books which contain helpful design guidelines. Among them are: *The Design of Active Filters, With Experiments* by Howard Berlin (E&L Instruments, 1977); *Handbook of Operational Amplifier Circuit Design* by David Stout and Milton Kaufman (McGraw-Hill, 1976); and Don Lancester's *Active-Filter Cookbook* (Sams, 1975). You can find these and other books on the design of suitable filters in better libraries. You can also find some design information in application notes published by various op-amp manufacturers. See, for example, National's *Audio/Radio Handbook* and *Linear Applications Handbook*. (Due to the volume of mail I receive, I will be unable to design custom joystick-controlled circuits for individual readers.)

Dual-Tone Mixer. Figure 3 is an experimental joystick-controlled dual-tone mixer with which I've been experimenting. The circuit is designed around a 556 dual timer chip.

The 556 is functionally identical to two 555 timers on a single chip. Each half of the circuit in Fig. 3 is connected as an astable multivibrator whose frequency of oscillation is controlled by one of the two 100-kΩ potentiometers in a joystick. The frequency is also controlled by *C1* and *C2*.

Both halves of the circuit will oscillate without *C3* and *C4*; but the capacitors are necessary to prevent uncontrolled interactions between the two oscillators.

The output from each tone generator is coupled into a simple audio mixer made from *R5*, *C6* and a 741 op amp. Potentiometer *R5* also serves as a balance control.

Capacitor *C5* is not part of the mixer, but serves to stretch the fast rising and falling pulses from the two tone generators. This causes the sounds produced by this circuit to be more tolerable than they normally are.

For initial experiments, connect an external amplifier to pin 6 of the 741. The values of *C1* and *C2* should be similar or identical. Move the joystick off center, apply power and adjust *R5* until the two simultaneous tones have approximately the same amplitude. You can then move the joystick in various directions to produce a wide range of unusual tone combinations.

The tones produced by this circuit are for the most part very unpleasant. Nevertheless, the circuit nicely demonstrates how a single control device can regulate two independent circuits. If you would like to follow up with circuit ideas of your own, consider substituting the 4046 CMOS phase-locked loop for the 556 (see the July and August 1980 installments of this column). The following circuit shows just one way the 4046 can be used in conjunction with a joystick.

Percussion Synthesizer. The sound produced by percussion instruments such as drums and wood blocks can be simulated by a damped op-amp oscillator. Changing one or two component values permits a variety of percussion sounds to be synthesized.

The circuit in Fig. 4 permits many different percussion

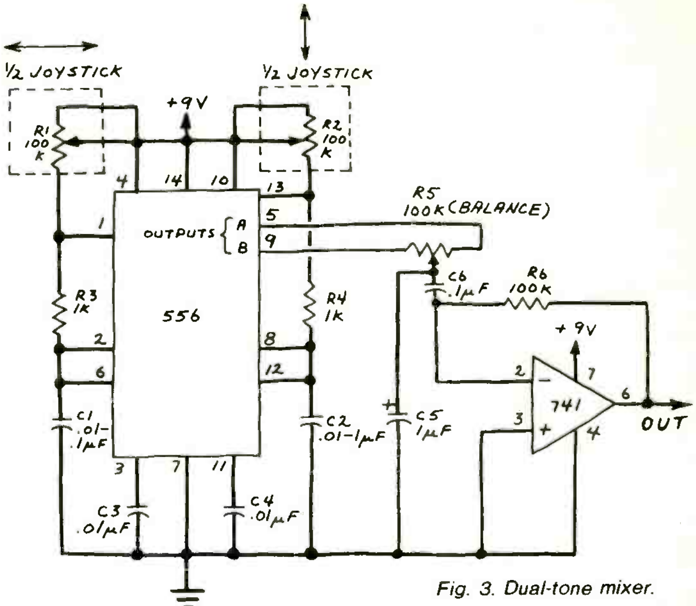


Fig. 3. Dual-tone mixer.

sounds to be generated under complete manual control. Percussion synthesizers described previously in this column operate when a switch is closed and released. The percussion effects produced by the circuit in Fig. 4 can be controlled in real time simply by moving a joystick back and forth. Wide, circular movements of the joystick produce sounds ranging from that emitted by a plucked violin string to a tapped glass. Various bell-like sounds can also be produced.

Referring to Fig. 4, note that *R1* is the horizontal-axis pot in a two-pot joystick and is connected as a voltage divider which provides a variable voltage to the input of the voltage-controlled oscillator (vco) section of a 4046 phase-locked loop. The vco output is coupled into a 741 op amp through gain control *R2*. Capacitor *C3* enhances the percussion sounds by stretching the incoming signal from the 4046.

The vertical-axis pot in the joystick, *R3*, can be adjusted along with *R2* to alter the gain of the 741. Experimenting with the resistance of *R2* will help provide a full range of percussion sounds. The sounds themselves are produced when the joystick is moved in various patterns.

To create percussion sounds, for example, orient the joystick so that back and forth movements control the amplitude pot (*R3*). Push the stick *away* to its outermost limit, and the sound will cease as the noninverting input of the 741 is brought to ground through *R2*. Pull the stick straight back to achieve the percussion effect. You'll hear a sudden tone followed by rapid damping as the stick reduces the amplitude of the signal. For different tone frequencies, move the stick to the left or right before pulling it back. This will let you quickly change from plucking sounds to bells, etc.

If the joysticks are connected as shown in Fig. 4, the sound will cease when the stick is pulled back and rotated to the *left*. This allows you to fully recover and prepare for a new sound cycle without the presence of an intermediate (and highly distracting) tone.

For tinkling bell or plucked string effects, rapidly rotate the stick in a *clockwise* direction. You can experiment with the values of *C1* and *C3* and of *R2* for different effects.

Digitizing the Output from a Joystick. Joysticks provide a very important interface between computers and their operators. The practical implementation of this interface generally requires some form of analog-to-digital conversion.

Some joystick interfaces utilize software to detect the various tones produced by a joystick-controlled tone generator.

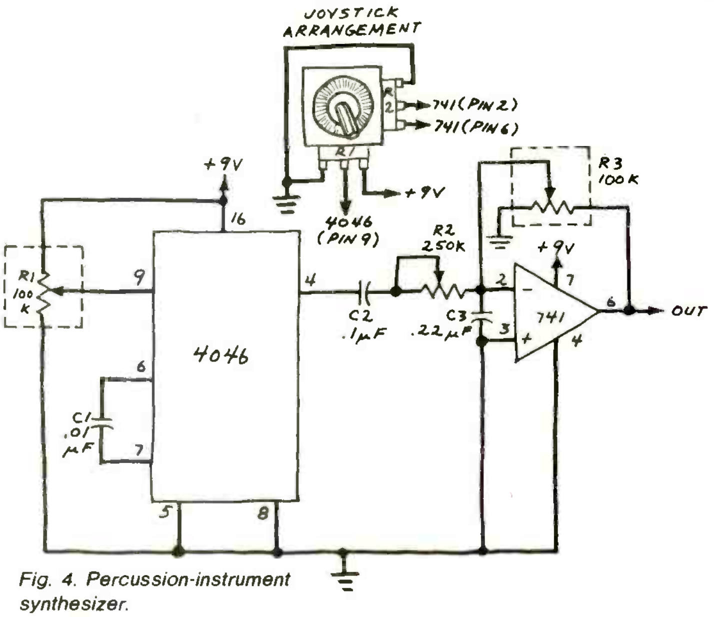


Fig. 4. Percussion-instrument synthesizer.

Figure 5 shows a straightforward hardware approach. This circuit digitizes the status of one of the pots in a joystick. The joystick pot is connected as a voltage divider which provides a variable voltage to the input of the analog-to-digital (A/D) converter chip. Many different A/D chips can be used in this application. The 8703, a product of Teledyne Semiconductor (1300 Terra Bella Ave., Mountain View, CA 94043), is a 24-pin DIP which provides 8 bits of conversion. Since the chip is a CMOS device, its power dissipation is a very low 20 mW.

The 8703 has three-state outputs and is thus ideally suited for connection to microcomputer buses. Pin 24 controls the outputs; when it is low, the outputs are enabled. When pin 24 is high, the outputs assume the high impedance (off) state.

Eight bits per joystick pot is probably all or even more than you will need. If you need even higher resolution, you can select the 8704 (10-bit) or 8705 (12-bit) chips. These chips are essentially identical to the 8703 with the addition of more outputs.

When the circuit in Fig. 5 is connected as shown, the output will indicate an 8-bit binary count of 0000 0000 to 1111 1111 as the joystick pot is rotated from one extreme to another. Since joystick pots are usually limited by a plastic or metal template to only a portion of their maximum rotation, you may not obtain the full range of conversion. However, you can connect the joystick pot to a higher voltage to enhance the overall range.

Having spent some time experimenting with the circuit in Fig. 5, I would urge you to obtain the 8703 data sheet before using the chip in an actual circuit. ADC chips are sometimes a little tricky to use (certainly more so than op amps and unclocked logic), and the data sheet will help you understand their operation.

For example, you can vary the rate at which the 8703 performs conversions by connecting an external clock to pin 21. Each time the clock sends a positive pulse to pin 21, the 8703 will begin a new conversion cycle unless it is busy performing an existing cycle. When pin 21 is connected to V_{DD} (pin 19), the 8703 goes into a free-running mode in which conversions are automatically performed at a rate of approximately 800 per second.

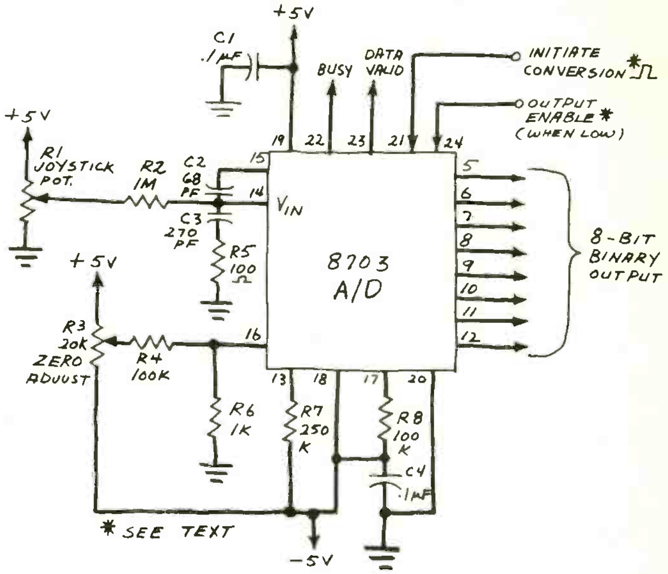


Fig. 5. Digitizing the output from a joystick with an A/D converter.

Decoding the Output from an ADC. The binary output from a joystick with an ADC can be connected directly to a digital data bus. Or it can be decoded for a real-time indication of the position of the joystick. Figure 6 shows one way to decode half the output from the 8703 A/D converter.

The 4049 buffers provide CMOS-to-TTL interfacing for the 8703. (The 8703 will interface directly with CMOS and LS chips.) The 74154 is a 4-to-16-line decoder which transforms a 4-bit input into its hexadecimal equivalent. When the joystick is swept from one extreme to another, the LEDs light

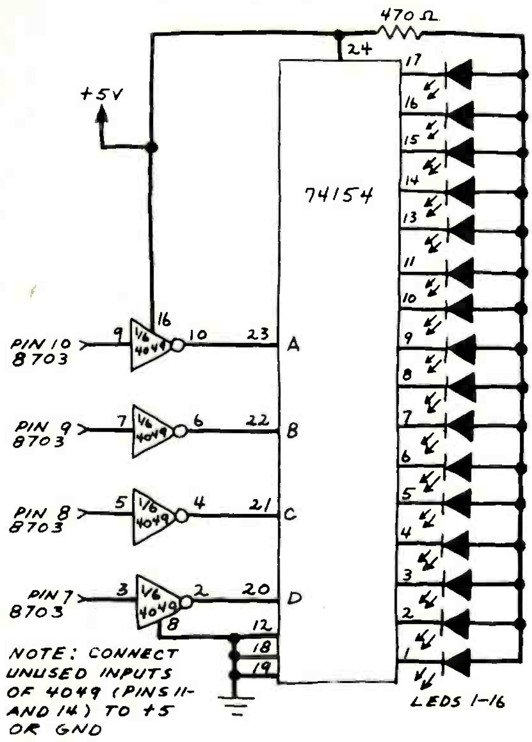


Fig. 6. How to decode the four lowest-order bits from the 8703 A/D.

up in succession. By placing the axis of the joystick pot perpendicular to the row of LEDs, the position of the glowing LED will track the position of the joystick.

Going Further. This two-part series on joysticks has provided only a hint at what you can do with these important interface devices. Now that you know something about them, perhaps you can think of some circuits and applications of your own.

For example, try connecting a pair of circuits like the one in Fig. 5 to both pots in a two-axis joystick. This will provide you with a digitized indication of the real position of the joystick. You can place this data on a 16-bit microcomputer bus. Or you can place the same data on an 8-bit bus by using the four highest-order bits from each A/D.

You might want to experiment with applications which do not involve manual movement of the joystick. For example, if the joystick is inverted and connected to a weight, it will indicate movements of the potentiometer assembly by appropriate changes in resistance (or voltage). This application can be used in automatic leveling equipment, low-frequency vibration detection and anywhere you desire to measure the change in position or attitude of an object large enough to support the joystick assembly.

Finally, you might wish to design your own video games or radio-control devices using a joystick interface. One possibility for the latter application is a dual-tone two-channel control scheme. One pot varies the tone for one channel from, say, 50 to 500 Hz while the second pot varies the tone for a second channel from, say, 5,000 to 10,000 Hz. The receiver is designed with two output stages, one of which passes only the low-frequency tone range and the second only the high-frequency tone range. Separate frequency-to-voltage converters at each output provide the desired control signals. This, of course, is only one possibility. You can think of others. ◇

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By Forrest M. Mims

A Light-Sensitive Tone Generator

IF YOU like circuits which respond to light, you'll love the light-sensitive tone generator shown in Fig. 1. Most light-sensitive tone generators have a single light-sensitive component. The circuit in Fig. 1 has *two*. This provides an unusual up-down audible tone.

In operation, the 741 is connected as an oscillator which produces a clipped sine wave at its output. The output waveform therefore resembles a square wave with slow rise and fall times.

Photocells *PC1* and *PC2* control the frequency of oscillation of the 741. For best results, use cadmium sulfide photocells having a very low resistance when illuminated and a high dark resistance. Most of the photocells available from electronics part suppliers that cater to hobbyists and experimenters fall in this category.

When both *PC1* and *PC2* are dark, the frequency of the 741 oscillator will fall to about 700 Hz. If *PC1* is illuminated with a small flashlight while *PC2* remains dark, the frequency will suddenly fall to a few Hz and then rise quickly to 1 kHz or more.

If *PC2* is illuminated with the flashlight while *PC1* remains dark, the frequency will suddenly rise to 3 kHz or more. When both *PC1* and *PC2* are illuminated, the frequency will level off at about 1.2 kHz.

I made these measurements when the wiper of balance potentiometer *R3* was at its center position. The setting of *R3* can be altered to produce a wider range of tone frequencies.

The signal from the 741 is converted into an audible tone by an LM386 audio amplifier. Potentiometer *R4* serves as a gain control. When you first apply power to the circuit, make sure *R4's* wiper is rotated toward the ground connection. Otherwise the tone from the speaker may be uncomfortably loud. **Caution**: Don't substitute an earphone for the speaker! The sound level may be too high.

This circuit has more than its obvious novelty value. You can, for example, use it as a light-controlled sound effects generator. For this application both photocells should be placed at one end of individual plastic or cardboard tubes which have been coated on their inside with black paper or paint. The circuit can then be "played" by flashing light down the tubes or by blocking a continuous light source with your finger tips.

The circuit has educational value as well. It nicely demonstrates the feedback which makes possible the conversion of an amplifier into an oscillator. And it demonstrates the "memory effect" of cadmium sulfide photocells. You'll quickly notice this phenomenon while experimenting with the circuit. A cadmium sulfide photocell requires several seconds or even minutes to resume equilibrium following the removal of light, and this gives rise to a gradually changing tone even when the light source is removed.

Finally, you can replace the two photocells with two potentiometers in a joystick to obtain full manual control of the circuit. Pushing the stick back and forth will sweep the output frequency across its full spectrum. Moving the stick in a circular fashion will produce a sound like a siren. ◇

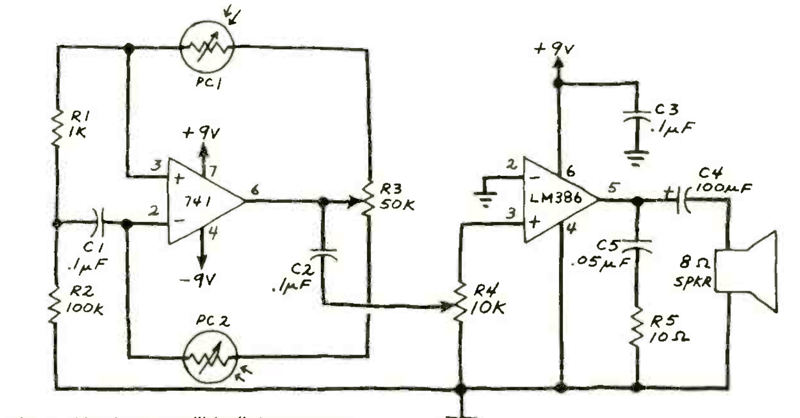

Fig. 1. Up-down audible light sensor.

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SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
SN7445N	.89	SN74143N	3.49	SN74276N	1.95
SN7446N	.79	SN74144N	3.49	SN74279N	.79
SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

74LS00	.29	74LS92	.75	74LS192	1.15
74LS01	.29	74LS93	.75	74LS193	1.15
74LS02	.29	74LS95	.99	74LS194	1.15
74LS03	.29	74LS96	1.15	74LS195	1.15
74LS04	.35	74LS107	.45	74LS197	1.19
74LS05	.35	74LS109	.45	74LS221	1.19
74LS08	.35	74LS112	.45	74LS240	1.49
74LS09	.35	74LS113	.49	74LS241	1.49
74LS10	.35	74LS114	.49	74LS242	1.49
74LS11	.39	74LS122	.89	74LS243	1.49
74LS12	.35	74LS123	1.25	74LS244	1.49
74LS13	.59	74LS125	.59	74LS245	2.95
74LS14	.99	74LS126	.59	74LS247	1.19
74LS15	.35	74LS132	.99	74LS248	1.19
74LS20	.35	74LS133	.89	74LS249	1.19
74LS21	.35	74LS136	.49	74LS251	.99
74LS22	.35	74LS138	.89	74LS253	.99
74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.69
74LS28	.35	74LS153	.89	74LS260	.69
74LS30	.35	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	.89	74LS273	1.95
74LS33	.59	74LS156	.89	74LS279	.89
74LS37	.45	74LS157	.89	74LS283	.89
74LS38	.39	74LS158	.89	74LS290	.99
74LS40	.35	74LS160	1.15	74LS293	.99
74LS42	.89	74LS161	1.15	74LS298	1.25
74LS47	.89	74LS162	1.15	74LS352	1.29
74LS48	1.15	74LS163	1.15	74LS353	1.29
74LS49	1.15	74LS164	1.15	74LS365	.69
74LS51	.35	74LS165	1.15	74LS366	.69
74LS54	.35	74LS168	1.19	74LS367	.69
74LS55	.35	74LS169	1.19	74LS368	.69
74LS73	.45	74LS170	1.95	74LS373	1.95
74LS74	.45	74LS173	.99	74LS374	1.95
74LS75	.59	74LS174	.99	74LS375	.89
74LS76	.45	74LS175	.99	74LS386	.69
74LS78	.49	74LS181	2.95	74LS393	2.49
74LS83	.89	74LS190	1.25	74LS399	2.49
74LS85	1.25	74LS191	1.25	74LS670	2.49
74LS86	.49			81LS95	1.95
74LS90	.69			81LS97	1.95

74S

74S00	.45	74S124	3.95	74S243	3.25
74S02	.45	74S133	.55	74S244	3.25
74S03	.45	74S134	.69	74S251	1.45
74S04	.55	74S135	1.19	74S253	1.45
74S05	.55	74S136	1.75	74S257	1.35
74S08	.50	74S138	1.35	74S258	1.35
74S09	.50	74S139	1.35	74S260	.79
74S10	.45	74S140	.79	74S280	2.95
74S11	.45	74S151	1.35	74S287	3.25
74S15	.45	74S153	1.35	74S288	2.75
74S20	.45	74S157	1.35	74S373	3.49
74S22	.45	74S158	1.35	74S374	3.49
74S30	.45	74S160	2.95	74S387	2.95
74S32	.55	74S174	1.59	74S471	10.95
74S38	1.25	74S175	1.59	74S472	10.95
74S40	.50	74S188	2.95	74S473	10.95
74S51	.45	74S194	1.95	74S474	12.95
74S64	.50	74S195	1.95	74S475	12.95
74S65	.50	74S196	1.95	74S570	5.95
74S74	.75	74S240	2.95	74S571	5.95
74S86	.75	74S241	2.95	74S572	9.95
74S112	.79	74S242	2.95	74S573	9.95
74S113	.79			74S940	3.15
74S114	.79			74S941	3.15

CA–LINEAR

CA3010H	.99	CA3060N	3.25	CA3089N	3.75
CA3013H	2.15	CA3080H	1.25	CA3096N	3.95
CA3023H	3.25	CA3081N	2.00	CA3130H	1.39
CA3035H	2.49	CA3082N	2.00	CA3140H	1.25
CA3039H	1.35	CA3083N	1.60	CA3160H	1.25
CA3046N	1.30	CA3086N	.85	CA3401N	.59
CA3059N	3.25			CA3600N	3.50

CD–CMOS

CD4000	.39	CD4041	1.49	CD 4098	2.49
CD4001	.39	CD4042	.99	CD4506	.75
CD4002	.39	CD4043	.89	CD4507	.99
CD4006	1.19	CD4044	.89	CD4508	3.95
CD4007	.25	CD4046	1.79	CD4510	1.39
CD4009	.49	CD4047	2.50	CD4511	1.29
CD4010	.49	CD4048	1.35	CD4512	1.49
CD4011	.39	CD4049	.49	CD4514	3.95
CD4012	.25	CD4050	.69	CD4515	2.95
CD4013	.49	CD4051	1.19	CD4516	1.49
CD4014	1.39	CD4052	1.19	CD4518	1.79
CD4015	1.19	CD4053	1.19	CD4519	.89
CD4016	.59	CD4056	2.95	CD4520	1.29
CD4017	1.19	CD4059	9.95	CD4526	1.79
CD4018	.99	CD4060	1.49	CD4528	1.79
CD4019	.49	CD4066	.79	CD4529	1.95
CD4020	1.19	CD4068	.39	CD4543	2.79
CD4021	1.39	CD4069	.45	CD4562	11.95
CD4022	1.19	CD4070	.55	CD4566	2.79
CD4023	.29	CD4071	.49	CD4583	2.49
CD4024	.79	CD4072	.49	CD4584	.75
CD4025	.23	CD4073	.39	CD4723	1.95
CD4026	2.95	CD4075	.39	CD4724	1.95
CD4027	.69	CD4076	1.39	MC14409	17.95
CD4028	.89	CD4078	.55	MC14410	18.95
CD4029	1.49	CD4081	.39	MC14411	15.95
CD4030	.49	CD4082	.39	MC14412	15.95
CD4034	3.49	CD4093	.99	MC14419	7.95
CD4035	.99			MC14433	15.95
CD4040	1.49			MC14538	2.49
				MC14541	1.95

Phone Tunes

As Seen on "Good Morning America"

Replaces the Telephone Ringer Bell with a Selection of 30 Familiar Tunes

Each Unit will play any of the following tunes:

- Rule Brittania
- O Canada
- Colonel Bogey
- Westminister Chimes
- Mexican Hat Dance
- Twinkle, Twinkle Little Star
- Deutschlandlied
- God Save the Queen
- Close Encounters
- Happy Birthday
- Wedding March
- Jingle Bells
- Auld Lang Syne
- Soldiers Chorus
- Sailor's Hornpipe
- Chargel
- Greensleeves
- Lorelei
- Eyes of Texas
- Star Spangled Banner
- Oranges and Lemons
- Wilhelmus
- Mozart Sonata
- Pomp & Circumstance
- William Tell Overture
- Bach Toccata in D Minor
- Shave and a Haircut
- Blue Danube Waltz
- Beethoven's 5th
- La Marseillaise

FEATURES

Replaces monotonous telephone ringer bell. Easily connects to any standard telephone. Can be used alongside regular phone or replace a remote ringer elsewhere in building or outside. FCC approved. Can be used on any telephone system — worldwide. Use a different tune to identify extension phones. Microprocessor controlled. Adjustable volume control and variable tune speed control. Operates on two 9-volt batteries or AC Adapter (not included).

PT030 Phone Tunes $49.95
AD30 AC Adapter $8.95

DISCRETE LEDS

XC556R	.200"	red	5/$1	MV50	.085"	red	6/$1
XC556G	.200"	green	4/$1	XC209R	.125"	red	5/$1
XC556Y	.200"	yellow	4/$1	XC209G	.125"	green	4/$1
XC556C	.200"	clear	4/$1	XC209Y	.125"	yellow	4/$1
XC22R	.200"	red	5/$1	XC526R	.185"	red	5/$1
XC22G	.200"	green	4/$1	XC526G	.185"	green	4/$1
XC22Y	.200"	yellow	4/$1	XC526Y	.185"	yellow	4/$1
MV10B	.170"	red	4/$1	XC526C	.185"	clear	4/$1

.200(T1¾) Red/Green

Diffused Bi-Color LED

Part No.	1-99	100+
XC5491	.79	.69

XC556 RED LED, METAL MTG. HDW. 2-6" LEADS.

RL-2 . . $.39 ea. or 3/$1.00

DISPLAY LEDS

C.A. — Common Anode
D.D. — Double Digit
C.C. — Common Cathode
RHD — Right Hand Decimal

Type	Polarity	Ht	Price	Type	Polarity	Ht	Price
MAN 1	C.A.—red	.270	2.95	DLG507	C.A.—green	.500	1.25
MAN 2	5x7 D.M.—red	.300	4.95	DL704	C.C.—red	.300	1.25
MAN 3	C.C.—red	.125	.25	DL707	C.A.—red	.300	1.25
MAN 52	C.A.—green	.300	.99	DL728	C.C.—red	.500	1.49
MAN 54	C.C.—green	.300	.99	DL741	C.A.—red	.600	1.25
MAN 71	C.A.—red	.300	.75	DL747	C.A.—red	.600	1.49
MAN 72	C.A.—red	.300	.75	DL750	C.C.—red	.600	1.49
MAN 74	C.C.—red	.300	1.25	DLO847	C.A.—orange	.800	1.49
MAN 82	C.A.—yellow	.300	.49	DLO850	C.C.—orange	.800	1.49
MAN 84	C.C.—yellow	.300	.99	DL33B	C.C.—red	.110	.35
MAN 3620	C.A.—orange	.300	.49	FND358	C.C. ± 1	.357	.99
MAN 3630	C.A.—orange ± 1	.300	.99	FND357	C.C.	.357	.75
MAN 3640	C.C.—orange	.300	.99	FND500	C.C. (FND503)	.500	.99
MAN 4610	C.A.—orange	.400	.99	FND507	C.A. (FND510)	.500	.99
MAN 6610	C.A.—orange—DD	.560	.99	HDSP-3401	C.A.—red	.800	1.50
MAN 6630	C.A.—orange ± 1	.560	.99	HDSP-3403	C.C.—red	.800	1.50
MAN 6640	C.C.—orange—DD	.560	.99	HDSP-3406	C.C. red +1	.800	1.50
MAN 6650	C.C.—orange ± 1	.560	.99	5082-7751	C.A., R.H.D.—red	.430	1.25
MAN 6660	C.A.—orange	.560	.99	5082-7760	C.C., R.H.D.—red	.430	1.25
MAN 6710	C.A.—red—DD	.560	.99	5082-7300	4x7 Numeric (RHD)	.600	22.00
MAN 6740	C.C.—red—DD	.560	.99	5082-7302	4x7 Numeric (LHD)	.600	22.00
MAN 6750	C.C.—red ± 1	.560	.99	5082-7340	4x7 Hxdcl. (0-9/A-F)	.600	22.50
DLO304	C.C.—orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.69
DLO307	C.A.—orange	.300	1.25	LIT-1	Photo Xsistor Opto-Isol.		.69
DLG500	C.C.—green	.500	1.25	MOC3010	Optically Isol. Triac Driver		1.25

COMPUTER GRADE CAPACITORS

MFD	WVDC	PRICE	MFD	WVDC	PRICE	MFD	WVDC	PRICE
250	150	1.95	10,000	15	2.95	24,000	20	2.95
500	200	2.49	10,000	18	3.95	27,000	10	2.95
1,250	3	.99	11,000	19	4.95	32,500	25	4.95
1,500	25	1.95	11,000	55	5.48	40,000	25	5.95
1,500	50	2.95	11,000	60	5.95	43,000	10	5.95
2,000	10	2.95	13,000	16	2.95	50,000	20	7.95
2,250	100	3.95	14,000	13	2.95	52,000	20	5.95
2,300	33	2.95	14,000	35	3.95	55,000	15	5.95
3,300	15	2.95	15,000	15	3.95	58,000	20	5.95
3,600	25	1.95	18,000	25	4.95	65,000	10	7.95
3,600	40	3.95	20,000	15	3.95	73,800	5	7.95
4,500	50	3.95	20,000	20	2.95	80,000	15	9.95
5,500	25	4.49	21,000	15	3.95	90,000	10	8.95
6,100	40	2.49	23,000	7	1.95	160,000	10	8.95
6,500	50	4.95	23,000	15	2.95			
			23,000	20	3.95			

OVER 200 OTHER VALUES AVAILABLE — CALL OR WRITE FOR YOUR REQUIREMENT

LOW PROFILE (TIN) SOCKETS

	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

	1-24	25-49	50-100
14 pin ST	.27	.25	.24
16 pin ST	.30	.27	.25
18 pin ST	.35	.32	.30
24 pin ST	.49	.45	.42
28 pin ST	.99	.90	.81
36 pin ST	1.39	1.26	1.15
40 pin ST	1.59	1.45	1.30

SOLDERTAIL (GOLD) STANDARD

	1-24	25-49	50-100
8 pin SG	.39	.35	.31
14 pin SG	.49	.45	.41
16 pin SG	.54	.49	.44
18 pin SG	.59	.53	.48
24 pin SG	.79	.75	.69
28 pin SG	1.10	1.00	.90
36 pin SG	1.65	1.40	1.26
40 pin SG	1.75	1.59	1.45

WIRE WRAP SOCKETS (GOLD) LEVEL #3

	1-24	25-49	50-100
8 pin WW	.59	.54	.49
10 pin WW	.69	.63	.58
14 pin WW	.79	.73	.67
16 pin WW	.85	.77	.70
18 pin WW	.99	.90	.81
20 pin WW	1.19	1.08	.99
22 pin WW	1.49	1.35	1.23
24 pin WW	1.39	1.26	1.14
28 pin WW	1.69	1.53	1.38
36 pin WW	2.19	1.99	1.79
40 pin WW	2.29	2.09	1.89

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5 ea.	10 Ohm 12 Ohm 15 Ohm 18 Ohm 22 Ohm 27 Ohm 33 Ohm 39 Ohm 47 Ohm 56 Ohm	50 pcs.	$1.95
ASST. 2	5 ea.	68 Ohm 82 Ohm 100 Ohm 120 Ohm 150 Ohm 180 Ohm 220 Ohm 270 Ohm 330 Ohm 390 Ohm	50 pcs.	$1.95
ASST. 3	5 ea.	470 Ohm 560 Ohm 680 Ohm 820 Ohm 1K 1.2K 1.5K 1.8K 2.2K 2.7K	50 pcs.	$1.95
ASST. 4	5 ea.	3.3K 3.9K 4.7K 5.6K 6.8K 8.2K 10K 12K 15K 18K	50 pcs.	$1.95
ASST. 5	5 ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	50 pcs.	$1.95
ASST. 6	5 ea.	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	50 pcs.	$1.95
ASST. 7	5 ea.	1M 1.2M 1.5M 1.8M 2.2M 2.7M 3.3M 3.9M 4.7M 5.6M	50 pcs.	$1.95
ASST. 8R		Includes Resistor Assts. 1-7 (350 pcs.)		$10.95 ea.

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INTERSIL

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7045EV/Kit*	Stopwatch Chip, XTL	24.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter	12.95
7218CIJI	8-Digit Univ. LED Drive	10.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
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7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.95
8212CPA	Volt Ref/Indicator	2.95

74C

74C00	.39	74C95	1.59	74C221	1.95
74C02	.39	74C107	1.89	74C240	2.25
74C04	.39	74C151	2.95	74C244	2.25
74C08	.39	74C154	3.95	74C373	2.49
74C10	.39	74C157	2.25	74C374	2.59
74C14	.75	74C160	1.39	74C901	.69
74C20	.39	74C161	1.60	74C903	.69
74C30	.39	74C162	1.49	74C911	10.95
74C42	1.39	74C163	1.69	74C912	10.95
74C48	1.95	74C164	1.59	74C915	1.69
74C73	.79	74C173	1.39	74C917	10.95
74C74	.79	74C174	1.39	74C922	5.49
74C85	1.95	74C175	1.19	74C923	5.75
74C86	.99	74C192	1.69	74C925	7.50
74C89	6.95	74C193	1.69	74C926	7.50
74C90	1.29	74C195	1.59	80C95	.79
74C93	1.29			80C97	.79

LINEAR

LH0002CN	6.85	LM340T-5	1.25	LM702H	.79
LM10CLH	4.50	LM340T-12	1.25	LM703CN	.89
LM11CLH	4.75	LM340T-15	1.25	LM709N	.29
LH0070-OH	4.95	LM341P-5	.75	LM710N	.79
TL071CP	.79	LM341P-12	.75	LM711N	.79
TL072CP	1.39	LM341P-15	.75	LM723N	.69
TL074CN	2.49	LM342P-5	.69	LM733N	1.00
LH0082CD	35.80	LM342P-12	.69	LM739N	1.19
TL082CP	1.19	LM342P-15	.69	LM741CN	.35
TL084CN	2.19	LM348N	1.25	MC1741SCG	3.00
LH0094CD	36.80	LM350K	5.75	LM747N	.79
LM300H	.99	LF351N	.60	LM748N	.59
LM301CN	.35	LF353N	1.00	LM1014N	2.75
LM302H	1.95	LF355N	1.10	LM1310N	1.95
LM304H	1.95	LF356N	1.10	LM1458CN	.59
LM305H	.99	LM358N	1.00	LM1488N	1.25
LM307CN	.45	LM359N	1.79	LM1489N	1.25
LM308CN	1.00	LM370N	4.49	LM1496N	1.95
LM309H	1.95	LM373N	3.25	LM1556V	1.75
LM309K	1.25	LM377N	2.95	LM1800N	2.95
LM310CN	1.75	LM380N	1.25	LM1871N	5.49
LM311/CN	.90	LM381N	1.95	LM1872N	5.49
LM312H	2.49	LM382N	1.79	LM1877N-9	3.25
LM317MP	1.15	LM384N	1.95	LM1889N	3.20
LM317T	1.75	LM386N-3	1.29	LM1896N	1.75
LM317K	3.95	LM387N	1.45	LM2002T	1.49
LM318CN	1.95	LM389N	1.35	LM2877P	2.05
LM319N	1.95	LM392N	.69	LM2878P	2.25
LM320K-5	1.35	LF398N	4.00	LM2896P-1	2.25
LM320K-12	1.35	LM399H	5.00	LM3189N	2.95
LM320K-15	1.35	TL494CN	4.49	LM3900N	.69
LM320T-5	1.25	TL496CP	1.75	LM3905CN	1.25
LM320T-12	1.25	NE510A	6.00	LM3909N	1.15
LM320T-15	1.25	NE529A	4.95	LM3914N	3.95
LM323K	5.95	NE531H	3.95	LM3915N	3.95
LM324N	.99	NE536H	6.00	LM3916N	3.95
LM329DZ	.65	NE540H	6.00	RC4136N	1.25
LM331N	3.95	NE544N	4.95	RC4151NB	3.95
LM334Z	1.30	NE550A	1.30	RC4194TK	6.95
LM335Z	1.40	NE555V	.39	RC4195TK	5.49
LM336Z	1.75	NE556N	.99	LM4500A	3.25
LM337T	1.95	NE564N	3.95	ICL8038B	4.95
LM337MP	1.15	NE565N	1.25	LM13080N	1.29
LM338K	6.95	LM566CN	1.95	LM13600N	1.49
LM339N	.99	LM567V	1.25	75138N	1.95
LM340K-5	1.35	NE570N	4.95	75450N	.89
LM340K-12	1.35			75451CN	.39
LM340K-15	1.35			75492	.89

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
10 pf	.08	.06	.05	.001µF	.08	.06	.05
22 pf	.08	.06	.05	.0047µF	.08	.06	.05
47 pf	.08	.06	.05	.01µF	.08	.06	.05
100 pf	.08	.06	.05	.022µF	.09	.07	.06
220 pf	.08	.06	.05	.047µF	.09	.07	.06
470 pf	.08	.06	.05	.1µF	.15	.12	.10

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (Solid) CAPACITORS

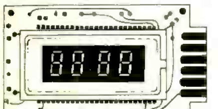
.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/25V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29	22/6V	.79	.69	.55

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial	1-99	100-499	500+	Radial	1-99	100-499	500+
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.16	.14	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.25	.23	.20	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.45	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

National Semiconductor

Clock Modules



12VDC AUTOMOTIVE/ INSTRUMENT CLOCK

APPLICATIONS:
- In-dash autoclocks
- After-market auto/ RV clocks
- Aircraft-marine clks.
- 12VDC oper. Instru.
- Portable/battery powered instruments.

Features: Bright 0.3" green display. Internal crystal time-base. ±0.5 sec./day accur. Auto. display brightness control logic. Display color filterable to blue, blue-green, green & yellow. Complete—just add switches and lens.

MA1003 Module (3.05"Lx1.75"Hx.98"D) . . **$16.95**

CLOCK MODULES

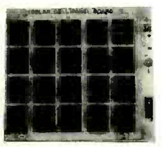
MA1023	.7" Red Digital LED Clock Module	8.95
MA1026	.7" Dig. LED Alarm Clock/Thermometer	18.95
MA5036	.3" Red Digital LED Clock/Timer	6.95
MA1002	.5" Red Digital LED Clock & Xformer	9.95
MA1010	.8" Red Digital LED Clock	7.95
MA1032	CBA .5" Digital LCD Clock	17.95
MA1043	.7" Green Digital LED Clock	8.95

TRANSFORMERS

102-P20	Xformer for MA1023, 1043 & 5036 Mods.	3.49
102-P22	Xformer for MA1026 Clock Modules	3.49
102-P24	Xformer for MA1010 Clock Modules	3.49

NEW!

Sun Power Your Electronics! SOLAR CELL PANEL KIT

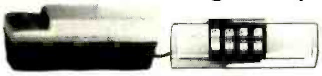


Features:
- **Output: 10VDC, to 100mA in Series 5VDC, to 200mA in Parallel**
- **Panel may be easily connected for Series or Parallel out**
- **Over 11 square inches of active cell surface**
- **Voltage line tap @ 0.5V increments**
- **Provision for charging batteries**
- **Overall panel size: 4¾"L x 4½"H x ½"D**

The JE305 Solar Cell Panel Kit contains 20 each solar cells. On the panel board are power line taps which allow the user to select voltages (one voltage at a time) from 0.5VDC to 10VDC. The applications of each panel can be further expanded by coupling additional panels in series for more voltage or in parallel for more current. The premium grade solar cells provide the current necessary for the operation of most portable transistor radios, small battery powered cassette tape players and unlimited experimental solar projects.

JE305 . . . . $39.95

EPROM Erasing Lamp

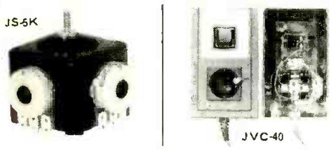


- **Erases 2708, 2716, 1702A, 5203Q, 5204Q, etc.**
- **Erases up to 4 chips within 20 minutes.**
- **Maintains constant exposure distance of one inch.**
- **Special conductive foam liner eliminates static build-up.**
- **Built-in safety lock to prevent UV exposure.**
- **Compact — only 7-5/8" x 2-7/8" x 2"**
- **Complete with holding tray for 4 chips.**

UVS-11EL Replacement Bulb $16.95

UVS-11E $79.95

JOYSTICKS



JS-5K	5K Linear Taper Pots	$5.25
JS-100K	100K Linear Taper Pots	$4.95
JVC-40	40K (2) Video Controller in case	$4.95

ALLIGATOR CLIP TEST LEADS

Heavy-duty leads, color coded. Insulated alligator clip on each end. 15" long. Two each black, red, blue, white and yellow.

#ALCP (10 per pack) . . . . $2.95/pkg.

NEW!

JE215 Adjustable Dual Power Supply

General Description: The JE215 is a Dual Power Supply with independent adjustable positive and negative output voltages. A separate adjustment for each of the supplies provides the user unlimited applications for IC current voltage requirements. The supply can also be used as a general all-purpose variable power supply.

FEATURES:
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC.
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
- Heat sink regulator cooling
- LED "on" indicator
- Printed Board Construction
- 120VAC input
- Size: 3-1/2"w x 5-1/16"L x 2"H

JE215 Adj. Dual Power Supply Kit (as shown) . . $24.95

(Picture not shown but similar in construction to above)

JE200 Reg. Power Supply Kit (5VDC, 1 amp) . .	$14.95
JE205 Adapter Brd. (to JE200) ±5, ±9 & ±12V .	$12.95
JE210 Var. Pwr. Sply. Kit, 5-15VDC, to 1.5amp .	$19.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A	CPU	4.95
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	6.95
DP8253	Prog. Interval Timer	8.95
DP8255	Prog. Peripheral I/O (PPI)	5.95
DP8257	Prog. DMA Control	9.95
DP8259	Prog. Interrupt Control	9.95
DP8275	Prog. CRT Controller	39.95
DP8279	Prog. Keyboard/Display Interface	9.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95
DP8310	Octal Latched Peripheral Driver	5.25
DP8311	Octal Latched Peripheral Driver	5.25

6800/6800 SUPPORT DEVICES

MC6800	MPU	7.95
MC6802CP	MPU with Clock and RAM	14.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	17.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	11.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	13.95
CDP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MCS6502	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	7.95
INS8039N-6	CPU—Sgl. Chip 8-Bit (128 bytes RAM)	9.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	9.95
TMS9900JL	MPU—16-Bit	39.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	1.95
MM5013N	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	1.95
MM5034N	Octal 80-Bit	1.95
MM5035N	Octal 80-Bit	1.95
2504V (1404A)	1024-Bit Dynamic	1.95
2518N	Hex 32-Bit Static	3.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Band Filter	19.95
AF122-1CJ	Touch Tone High Band Filter	19.95
LM308CH	Super Gain Op Amp	1.15
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/C°)	5.00
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8-Bit A/D Converter (8-Ch. Multi.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch. Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1006LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	1.19
AY-5-1013	30K BAUD UART	6.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
21L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	3.25
2114L	1024x4 Static 450ns Low Power	3.49
2114-2	1024x4 Static 200ns	3.95
2114L-2	1024x4 Static 200ns Low Power	4.95
74S200	256x1 Static	6.95
4116N-4 (UPD416)	16K Dynamic 250ns (MM5290N-4)	2.95
4164N-3	64K Dynamic 200ns	19.95
MM2147J	4096x1 Fast 70ns	7.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.49
MM5280/2107	4096x1 Dynamic	4.95
MM5290N-2 (4116)	16K Dynamic 150ns (UPD416C-3)	3.95
MM5298J-3A	8K Dyn. 200ns (lower ½ of MM5290J)	1.95
HM6116-4	16K (2Kx8) Static 200ns	14.95
82S25	64 Bit RAM (16x4OC)	3.49
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	9.95
TMS4045	1024x4 Static	9.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	4.95
TMS2716	16K EPROM (-5V, +5V, +12V)	9.95
2716 Intel (2516) TI	16K EPROM (Single +5V)	8.95
2732 Intel TI	32K EPROM	17.95
2758	8K EPROM (450ns) (Single +5V)	7.49
2764Q	64K EPROM (Hitachi HN462764)	49.95
5203	2048 PROM	14.95
82S23 (74S188)	32x8 PROM (Open Collector)	3.95
82S115	4096 Bipolar PROM	14.95
82S123 (74S288)	32x8 Tri-State Bipolar PROM	3.95
82S185	8K PROM	16.95

— Over 30 More PROMS Listed in Our Catalog —

ROM'S

2513 (2140)	Character Generator (Upper Case)	9.95
2513 (3021)	Character Generator (Lower Case)	9.95

NMOS READ ONLY MEMORIES

MCM6671OP	128x9x7 ASCII Shifted w/Greek	13.50
MCM6674OP	128x9x7 Math Symbol & Pictures	13.50
MCM6675OP	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

M-Z80	User Manual	7.50
M-CDP1802	User Manual	7.50
M-2650	User Manual	5.00

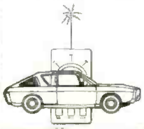
SPECIAL FUNCTION

OS0025CN	Dual MOS Clock Driver (5MZ)	3.50
OS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.49
COP470N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
74C923	Keyboard Encoder (20 keys)	5.75
MM53190N	Push Button Pulse Dialer	7.95
MM57499N	96/144-Key Serial Keyboard Encoder	8.95

RADIO CONTROL CIRCUITS



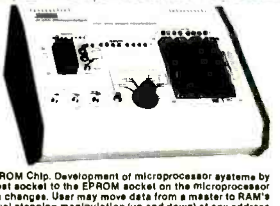
Ideal to use for Toys, hobby crafts, robots, trains, burglar alarms, IR data link, remote slide projector control, consumer remote data links, energy-saving remotely switched lighting systems.

LM1871N R.C. Encoder/Transmitter Chip $5.49
A complete 6 channel dig. encoder and R.F. transmitter, low power, at freq. of 27MHz or 49MHz, a field strength of 10,000uV meter at 3 meters. 9V operation on chip RF oscillator/transmitter. On chip 4.6V reg. Up to 80MHz carrier freq. operation.

LM1872N R.C. Receiver/Decoder Chip $5.49
A complete R.F. receiver/decoder, used at either 27, 49 or 72MHz. It provides 4 independent channels when used w/LM1872 (2 analog, 2 dig.) operates from 4-1.5V cells. Crystal controlled.

SRX1504 49.435MHz Crystal (LM1872N)	$4.95
SRX1505 49.890MHz Crystal (LM1871N)	$4.95

JE608 PROGRAMMER
2704/2708 EPROM PROGRAMMER



GENERAL APPLICATIONS:
- To program EPROMS 2704 and 2708.
- Developmental system for microcomputer circuits
- To read the contents of a pre-programmed EPROM
- To compare EPROM(s) for content differences
- To emulate a programmed EPROM
- To store program in RAMS for alterations
- Three separate Display Registers: 8 LED's for Hex Key entries, 10 LED's (2^0-2^9) for Address Register and 8 LED's for Data Memory Register. The Data Memory Register displays the content of the RAMs from the EPROM Chip. Development of microprocessor systems by means of a ribbon cable from the programmer panel test socket to the EPROM socket on the microprocessor board. Rapid checking verification of programmed data changes. User may move data from a master to RAM's or write into RAM's with keyboard entries. Allows manual stepping manipulation (up and down) at any address location. Stand-alone EPROM Programmer consisting of: A 19-key Hexadecimal Keyboard assembly, Programmer Board assembly with 4 power supplies and a LED/Test Socket Panel Board assembly. The Test Socket is zero force insertion type. Power requirements: 115VAC, 60Hz, 6W. Compact desk-top enclosure: Color coordinated designer's case with light tan panels and molded end pieces in mocha brown. Size: 3¼"H x 11"W x 8¾"D. Weight: 5 lbs.

The JE608 EPROM Programmer is a completely self-contained unit which is independent of computer control and requires no additional systems for its operations. The EPROM can be programmed from the Hexadecimal Keyboard or from a pre-programmed EPROM. The JE608 Programmer can emulate a programmed EPROM by the use of its internal RAM circuits. This will allow the user to test or pretest a program for a system, prior to programming a chip. Any changes in the program can be entered directly into the memory circuits with the Hexadecimal Keyboard so that rewriting the entire program will not be necessary. The JE608 Programmer contains a Programmer/Board w/25 IC's & Includes power supplies of: -5V, +5V, +12V and +26V. The Hexadecimal Keyboard and LED/Test Socket Panel board are separate assemblies within the system.

JE608K Kit $399.95
JE608A Assembled and Tested $499.95

JE608-16K ADAPTER BOARD
FOR 2716/2758 EPROMS

GENERAL DESCRIPTION:
The JE608-16K Adapter Board allows the JE608 Programmer to be modified for the additional programming of the 2716 and 2758 EPROMS. The adapter provides for adding an address switch for the 2^{11} bit and also for selecting the proper power and timing pulses to be applied to the EPROM. Programming and emulating the 2716 (16K) EPROM is done separately to each half (1024x8) of the EPROM because of the existing 8K RAM capacity in the JE608 Programmer.

JE608-16K	Adapter Board Kit	$29.95
JE608-Upgrade	(Send assembled JE608 to factory for adapter installation of the JE608-16K Adapter Board Kit)	$99.95
JE608A-16K Mod.	Assembled JE608 w/Adapter (JE608-16K) Installed	$599.95

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30001	National CMOS Data Book (640 pages) 74C, CD4000, and A/D Converters	$5.95
30002	National Interface Data Book (704 pages) DP, DS8000, DS3600, DS75000, etc.	$5.95
30003	National Linear Data Book (1376 pages) LM, LF, ADC, DAC, LH Series	$8.95
30004	National Series 80 — Board Level Computer (224 pages)	$4.95
30005	National TTL Logic Data Book (624 pages) 7400, LS, L, H, S, and DM8000 Series	$8.95
30008	Buy above (3) 30001,3,5 as a set	$19.95/lot
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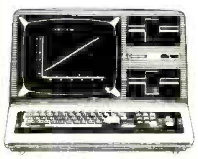

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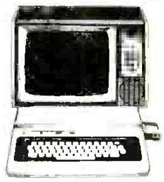

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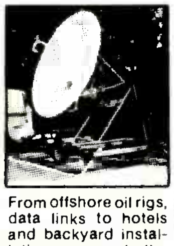

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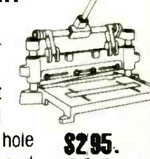

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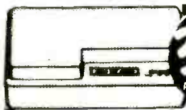

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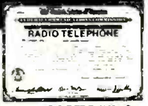

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ACCESS TO COMPUSERVE DATA NETWORK will be available to owners of Sorcerer computers when they buy an Exidy Systems Terminal Pac™ cartridge. Through a marketing agreement between Exidy and Compuserve, the purchaser will receive one free hour of connect time between 6:00 p.m. and 5:00 a.m. weekdays and 24 hours on weekends. The Terminal Pac contains software to configure the Sorcerer as a standard ASCII terminal so that it can receive data from the network's offerings of news, home economics, entertainment, and personal computing services. The Exidy (Sunnyvale, CA 94086) terminal sells for $99.

THE FCC has been asked by the National Association of Broadcasters to clarify and modify two provisions of its new radio operator licensing requirements. NAB favors delegating some of the duties of a chief operator to subordinates acting under the chief operator's supervision. It also asked the FCC to clarify whether AM directional stations must continue to have First Class duty operators. For example, if an operator's license is renewed as a General Radiotelephone License, will this be adequate for the holder to be considered the operator on duty? If so, would the station continue to be exempt from the proof of performance requirements?

WEATHER PICTURES FROM SATELLITES can be received on a display system developed by University of Minnesota scientists and marketed by SynSat Communications Inc. (Minneapolis, MN 55436). Selling for under $7000 and including a two-meter dish antenna, the radio receiving and video display system will store satellite pictures on audio cassettes and has a 2X zoom feature to allow the user to examine satellite images closely. It can also display standard weather facsimile information from land-line sources.

LOCAL NETWORK WITHOUT MODEMS has been announced by Electrosound Systems, Inc., Phoenix, AZ. (914-347-3707). Called the Data Loop Exchange, it brings data terminals, word-processing work stations or personal computers, or a combination of these devices together into a local area network. Range is a half-mile radius, which can be increased with loop extenders. The network interconnects or communicates with a common computer without requiring more software. Installation is simple, using twisted-pair loop wiring, thus eliminating the cost of modems and telephone lines. No protocol, line discipline, or mixing of data rates is necessary with the network. Designed for small systems, with an RS232C interface, the company's DLX10 System uses time-division multiplexing.

VCR MOVIE RENTAL from a local store will start in the spring of '82 when Warner Home Video launches new outlets to market its cassettes. Surveys made by WHV have shown that, for every video cassette sold in recent months, there were at least 12 rentals. So it plans to offer over 150 films, including Superman II, The Shining, and Excalibur, for rental. WHV will license the cassettes to the rental outlets (including supermarkets, drug chains, and other mass merchandisers).

AN EXPERIMENTAL RADIO NET whose mission will be to disseminate information on "Trends in the Communications and Electronics Industry" will be sponsored by the Long Island, NY, chapter of IEEE and the Long Island Mobile Amateur Radio Club (LIMARC). Topics will include direct broadcast satellites, satellite earth stations, cable TV, electronic warfare and countermeasures, spread spectrum communication, and more. The net will operate at a frequency of 147.375 MHz, and reception should be possible throughout most of Long Island and southern Connecticut. Target date for start-up is Wednesday, Nov. 11, at 8:30 p.m. Thereafter, the net will operate on the second Wednesday of each month. For more information contact Ed Piller at 516-349-2484.

PE IS A CONVERSATION STARTER, according to a story in the New York Times. One young lady carried a copy of the magazine into a singles bar with her and soon became the center of male attention, said the story. It did not give any details on what happened thereafter nor did it attempt to draw a moral therefrom.

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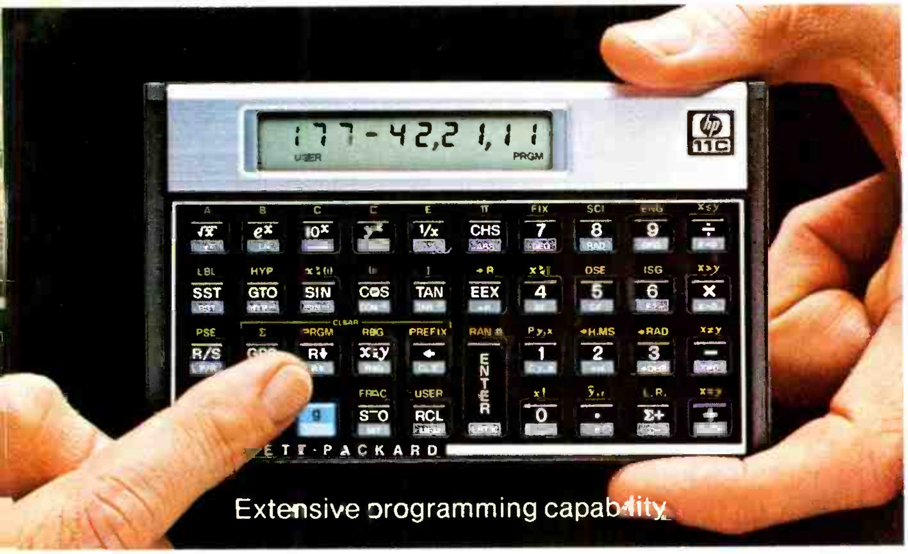
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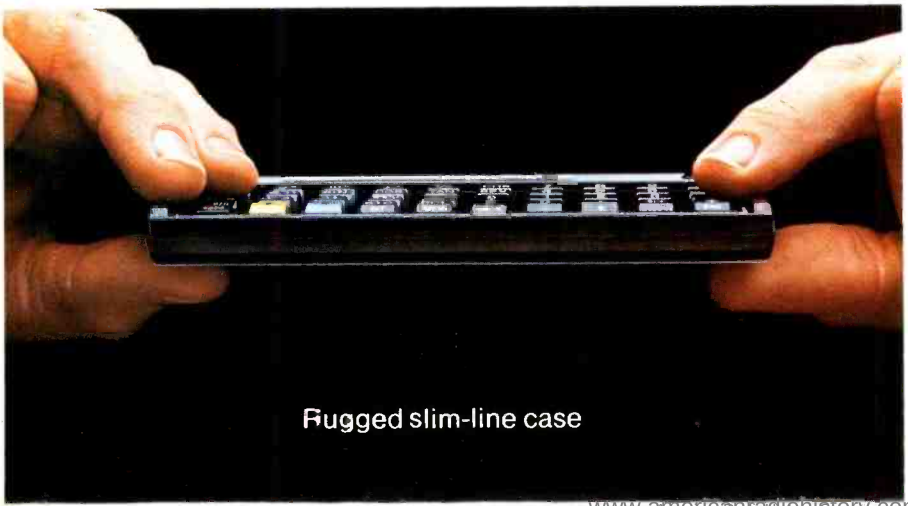
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