Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE NOVEMBER 1979/$1.25

Humidity Controller Saves Heating Fuel
Radioteletype Reader for Shortwave Receivers

Focus on Microcomputers:

- Personal & Very-Small-Business Computers
- CP/M — The Software Bus
- A Guide to Printers

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Popular Electronics

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Issu

Yamaha C-4 Preamplifier

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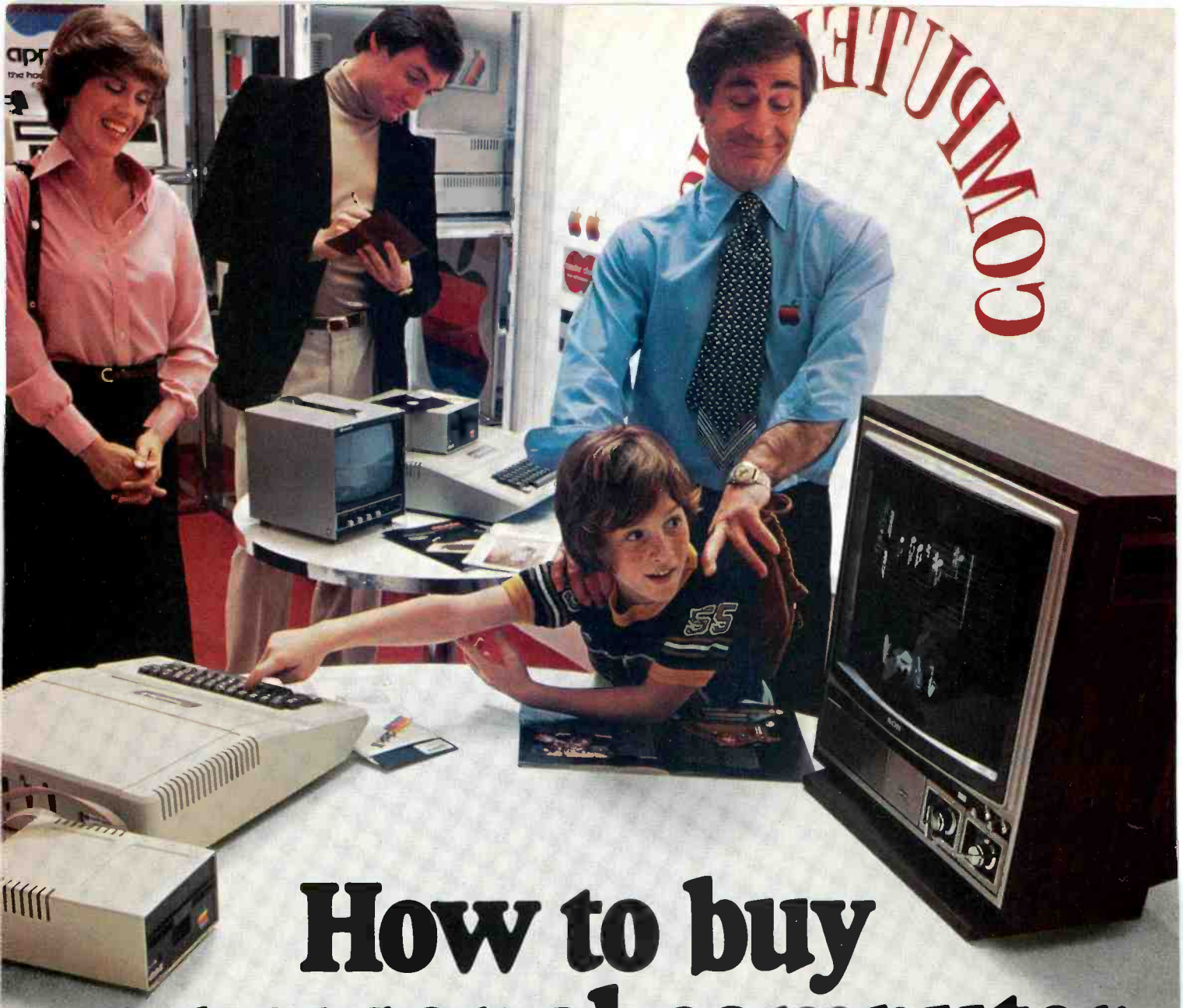
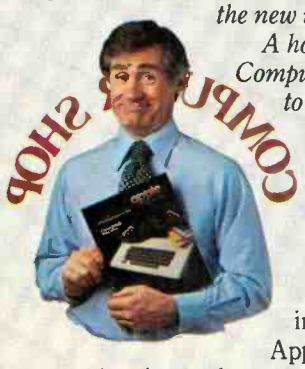


How to buy a personal computer.

In California, a store owner charts sales on his Apple Computer. On weekends though, he totes Apple home to help plan family finances with his wife. And for the kids to explore the new world of personal computers.

A hobbyist in Michigan starts a local Apple Computer Club, to challenge other members to computer games of skill and to trade programs.



Innovative folks everywhere have discovered that the era of the personal computer has already begun—with Apple.

Educators and students use Apple in the classroom. Businessmen trust Apple with the books. Parents are making Apple the newest family pastime. And kids of all ages are learning how much fun computers can be.

Visit your local computer store

The excitement starts in your local computer store. It's a friendly place, owned by one of your neighbors. He'll show you exactly what you can use a personal computer for.

What to look for

Your neighborhood computer store has several different brands to show you. Chances are the salesman will recommend an Apple Computer. Apple's the one you can program yourself. So there's no limit to the things you can do. The more you use your Apple the more uses you'll discover. So it's important that Apple is the computer with more expansion capability. You can't outgrow Apple.

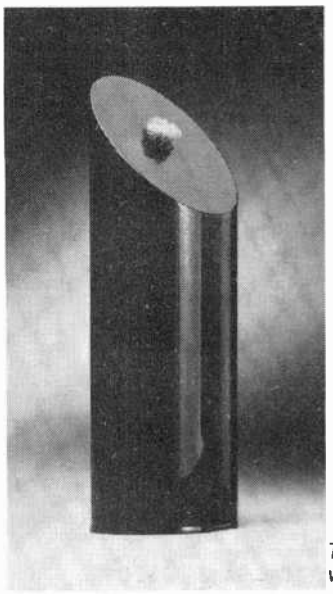
It's your move

Grab a piece of the future for yourself—we'll give you the address of the Apple dealer nearest you when you call our toll-free number. Then drop by and sink your teeth into an Apple.

(800) 538-9696.
In California,
(800) 662-9238.

apple computer

CIRCLE NO. 7 ON FREE INFORMATION CARD



Miracle Fuzz

A new space-age invention and the same effect as lightning combine to create the world's first home oxygen regeneration system.

The new Energaire ionized oxygen generator will make a handsome addition to any desk.

You need oxygen to live. You can live without food for 60 days, without water for seven days, but without oxygen, you won't make it past two minutes.

That small piece of fuzz located on top of the cylinder shown above emits negatively-charged electrons which attach themselves to molecules of oxygen, thus creating ionized oxygen.

You are already familiar with ionized oxygen if you've smelled the air after a thunderstorm. You feel great, revitalized, and alert. The lightning from the storm adds a small negatively-charged electron to each oxygen molecule in a process called ionization.

SCIENTISTS DISCOVER

Scientists discovered that air quality can actually affect your moods, your feelings and your sense of well being. Air that is positively charged caused people to be depressed, moody and tired. Negatively-charged air made people feel good. We have all experienced air that is positively charged in air-conditioned buildings or in a polluted environment.

Scientists looking for a way to turn positively charged air into negatively charged air developed the negative ion generator—a product that produces negatively charged particles that attach themselves to air molecules and thus create the same fresh feeling you get after a thunderstorm.

The new space-age product shown above is an ionized oxygen generator called the Energaire air purifier. The copper mesh fuzz on top of the unit is one of the secrets of the system.

Although it has no moving parts, you can actually feel a wind of ionized oxygen produced from the fuzz which spreads to fill an average-sized room in one minute.

CIGARETTE SMOKE TEST

To show the dramatic effect of ionized oxygen, you can take the Energaire, blow cigarette smoke into a clear bowl, and hold the bowl inverted over the system. The smoke will vanish. The charged oxygen particles appear to dissolve the smoke particles, precipitating them from the air.

In a room, the Energaire air purifier surrounds you with these oxygen ions and cleans and purifies the air so that even in a smoke-filled room, you will be breathing cleaner, country-fresh air all day long.

WALL TEST

Take our unit and place it next to a wall. Also put a large piece of paper on the wall. Within a few days notice how black the paper gets. That black film is finite carbon particulate matter—the same pollutants you would normally breathe and that would pass through most air filters. By placing the unit in the center of a room or away from a wall, that same matter falls to the ground as dust.

A trip into the mountains exposes you to nature's freshly ionized oxygen. The Energaire produces this same effect. It will clean your room of odor-causing bacteria and stale, musty, or smoky air.

Ionized oxygen should not be confused with ozone. Ozone has a molecular formula of O_3, whereas the molecular formula for ionized oxygen is O_2 with a negatively-charged ion.

DON'T BE CONFUSED

After we announced the Energaire last year, many companies came out with their own ion generators. We purchased a unit from each company and tested them at an independent laboratory. The results are shown below:

Name	*Ions	Price
Energaire	438,000	$79.95
Omega 700	63,000	245.00
AirCare	72,000	149.95
Modulion	75,000	79.95
EnvironAire	-0-	119.50

The one unit mentioned above that produced no ions actually produced ozone—15 times the maximum ozone concentration allowed by federal government standards.

**Measurements indicate total number of ions per cubic centimeter per second at one meter. These figures may vary by plus or minus 10%.*

USED IN HOSPITALS

Many hospitals are now using ionized oxygen systems in their operating rooms and burn centers. Their units not only purify the air, but they also eliminate pollen and other irritants.

Working in a clean air environment, you think clearer, are more alert, and you function better. The Energaire is actually a miniature lightning machine. The minute you plug it in, energy is converted into ionized oxygen. This efficient system uses one watt of power or less than a penny per day to operate, so you leave it plugged in continuously.

We are so impressed with the pleasant effect of Energaire that we urge you to personally test it yourself in your home or office. Order one at no obligation. Put it by your desk, or in any room where you spend a great deal of time. See if it doesn't rid your room of odor-causing bacteria and stale, musty or smoky air. Try the smoke and paper tests mentioned in this advertisement.

SLEEP FASTER

At home, use the Energaire by your bed and see how country-fresh air allows you to sleep easier, deeper, and more relaxed.

You should notice the difference within one day—especially in a work environment. But use the Energaire for a full month. Then, if you do not feel totally convinced of the positive effects of ionized oxygen, return your unit for a prompt and courteous refund.

The Energaire is manufactured by the Ion Foundation, a leading ion research and development company.

Service should never be required, but if it is, there's a prompt service-by-mail center as close as your mailbox. JS&A is America's largest single source of space-age products—further assurance that your modest investment is well protected. The Energaire measures 9" high by 3" in diameter and weighs 24 ounces.

To order your Energaire ionized oxygen generator, send **$79.95** plus $3.00 for postage and handling (Illinois residents, please add 5% sales tax) to the address shown below or credit card buyers may call our toll-free number below. We will send your Energaire ion generator complete with 90-day limited warranty on the electronics, a five-year warranty on the fuzz, and complete instructions.

Let space-age technology revitalize your life with the world's first home ionized oxygen generator. Order one at no obligation today.

JS&A® PRODUCTS THAT THINK®

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Northbrook, Ill. 60062 (312) 564-7000
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In Illinois Call ..... (312) 564-7000

The World's biggest Bearcat® scanner sale!

Communications Electronics,™ the world's largest distributor of radio scanners, celebrates the introduction of four new *Bearcat* brand monitors with the world's largest scanner sale. From now, until January 31, 1980, you can save hundreds of dollars during our ***two-million dollar Bearcat sale.*** Even the new *Bearcat* models 300, 220 and Eight Track scanners are on sale. If you've previously purchased a *Bearcat* scanner from **Communications Electronics,** then you *already* know you're getting all the real, live excitement that a television program or newspaper can't provide. If you don't have at least one *Bearcat* scanner, the time to buy is now! Since we distribute more scanners worldwide than *anyone* else, we can sell the newest factory production models with the *latest* engineering updates, at rock bottom prices. Our warehouse facilities are equipped to process over 1,000 *Bearcat* orders per week and our order lines are always staffed 24 hours. We also export *Bearcat* scanners to more than 300 countries and military installations. Almost all items are **in stock for immediate shipment,** so **save now** and get a *Bearcat* scanner during the ***world's largest*** two-million dollar scanner sale!

NEW! Bearcat® 300

Available February - March, 1980

List price $499.95/**CE price $329.00**

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, 420-512 MHz.

The new *Bearcat* 300 is the most advanced automatic scanning radio that **Communications Electronics** has ever offered to the public. Since the *Bearcat* 300 has over 2,100 active frequencies in memory, you can touch one button and search any of many preprogrammed services such as police, fire, marine and government. Of course, you still can program your own frequencies and monitor up to 50 channels at once. Since the *Bearcat* 300 uses a bright green flourescent digital display, 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 and a new vacuum fluorescent digital display. Reserve your *Bearcat* 300 now for February - March, 1980 delivery.

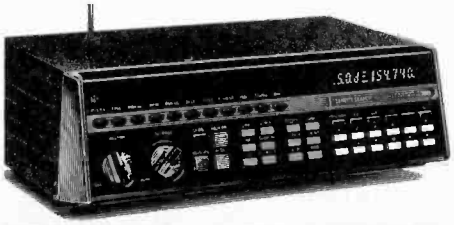
Bearcat® 250

List price $399.95/**CE price $259.00**

50 Channels • Crystalless • Searches Stores • Recalls • Self-Destruct • Priority channel • 50 Channel • 6-Band.

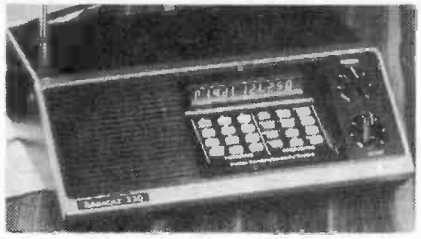
Frequency range 32-50, 146-174, 420-512 MHz.

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, at your convenience. Automatic "count" remembers how often frequencies are activated by transmission—so you know where the action is. Decimal display shows the channel, frequency and other programmed features. The priority feature samples your programmed frequency every two seconds. Plus, a digital clock shows the time at the touch of a button. This is the only monitor radio that has received the **Communications Electronics** quality control approval rating #1. Our highest quality grade for technologically sophisticated equipment. The *Bearcat* 250. Scanning like you've never seen or heard before. Now in stock!



NEW! 50-Channel Bearcat 300

NEW! Aircraft Bearcat 220



Aircraft Bearcat® 220

List price $399.95/**CE price $259.00**

Aircraft and public service monitor. *Frequency range 32-50, 118-136 AM, 144-174, 420-512 MHz.*

The *Bearcat* 220 is one scanner which can monitor all public service bands plus the exciting aircraft band channels. Up to twenty frequencies may be scanned at the same time.

Not only does this new scanner feature normal search operation, where frequency limits are set and the scanner searches between your programmed parameters, it also searches marine or aircraft frequencies by pressing a single button. These frequencies are already stored in memory so no reprogramming is required. The *Bearcat* 220 also features a Priority channel, Dual scanning speeds, Patented track tuning and Direct channel access and AC/DC operation.

New! Bearcat® 211

List price $339.95/**CE price $229.00**

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

The *Bearcat* 211. It's an evolutionary explosion of features and function. 18-channel monitoring. With no-crystal six-band coverage. Dual scan speeds. Color-coded keyboard. Even a digital clock. All at a modest price. More scanning excitement than you bargained for.

Bearcat® 210

List price $299.95/**CE price $199.00**

10 Channels • 5 Bands • Crystalless

Frequency range: 30-50, 146-174, 416-512 MHz.

Use the simple keyboard to select the 10 channels to be scanned. Automatic search finds new frequencies. The 210 features patented selectable scan delay, push button lockout, single antenna, patented track tuning, AC/DC operation. With no crystals to buy. Evel

NEW! Bearcat® 8 Track

List price $99.95/CE price $79.00

4 Channels • 2 Bands • Plays off any AC or DC Powered 8 Track Tape Player. *Frequency range: 33-49, 151-165 MHz.*

The *Bearcat* 8 Track Scanner. It converts any 8 track tape player into a live-action scanning radio instantly.

This incredibily compact 4-channel/2-band crystal scanner plugs into the tape player where an 8 track cartridge normally goes. Police, fire, emergency calls—as-it-happens scanning excitement—from an existing home entertainment center, in-car/in-boat system or portable 8 track tape player. The *Bearcat* 8 Track Scanner plugs live-action into any 8 track player. Anywhere. Crystal certificates # A-135cc are $4.00 each.

Bearcat® Four-Six

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

The first 4 Band, 6 Channel, Hand-Held Scanner.

Frequency range: 33-47, 152-164, 450-512 MHz.

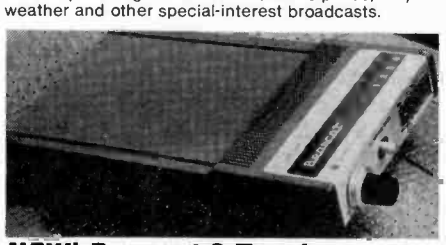
The *Bearcat* Four-Six offers "hip pocket" access to police, fire, weather and special interest public service broadcasts. Lightweight. Extremely compact. The *Bearcat* Four-Six—with its popular "rubber ducky" antenna and belt clip— provides "go anywhere/hands-off" scanning.

NEW! Aircraft and UHF Bearcat® ThinScan™

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

World's smallest scanner!

The *Bearcat* ThinScan.™ High-performance scanning has never been this portable. There are now **three** models available. The **BC 2-4 L/H** receives 33-44 and 152-164 MHz. The **BC 2-4 H/U** receives 152-164 and 450-508 MHz. The new high-performance Aircraft ThinScan model **BC 2-4 AC** receives 118-136 and 450-470 MHz. Go ahead, size it up. *Bearcat's* ThinScan™ measures 2¾" across. Just 1" deep. And 5⅝" high. Four crystal-controlled channels are scanned every ½ second providing immediate access to police, fire, weather and other special-interest broadcasts.



NEW! Bearcat 8 Track scanner

CIRCLE NO. 1 ON FREE INFORMATION CARD

INCREASED PERFORMANCE ANTENNAS

If you want the utmost in performance from your *Bearcat* scanner, it is essential that you use an external antenna. We have four 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 and #A70 is an all band base station antenna. All antennas are $25.00 and $3.00 for UPS shipping in the continental United States.

OTHER BEARCAT ACCESSORIES

SP50 AC Adapter	$12.00
SP51 Battery Charger	$12.00
SP55 Carrying Case for Four-Six	$15.00
SP57 Carrying Case for ThinScan	$15.00
SM210 Service manual for *Bearcat* 210	$15.00
SM220 Service manual for *Bearcat* 220	$15.00
SM250 Service manual for *Bearcat* 250	$15.00
B-31.2 V AA Ni-Cad's for Four-Six (Pack of 4)	$15.00
B-41.2 V AAA Ni-Cad's for ThinScan (Pack of 4)	$15.00
B-5 Replacement memory battery for Bearcat 210	$5.00
A-135cc Crystal certificate	$4.00

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

TEST A BEARCAT SCANNER FREE

Test any *Bearcat* brand scanner from **Communications Electronics™** for 31 days before you decide to keep it. If you do, you'll own the most sophisticated and technologically advanced scanner available. If for any reason you are not completely satisfied, return it in new condition with all accessories in 31 days, for a courteous and prompt refund (less shipping charges).

NATIONAL SERVICE

With your *Bearcat* scanner, we will send all accessories, a complete set of simple operating instructions and a one-year limited warranty. If service is ever required on any *Bearcat* scanner purchased from **Communications Electronics,™** just send your receiver to a CE approved *Bearcat* national service center. Another *Bearcat* service is the frequency information hotline. After you get your scanner from CE, you may call 317-894-1230 and get up to the second information on active frequencies in your area. If you ever need engineering assistance, feel free to call the factory during the day at 317-894-1440.

BUY WITH CONFIDENCE

All *Bearcat* scanners are extraordinary scanning instruments. They provide virtually any scanning function that the most professional monitor could require. To ***get the fastest delivery*** of any *Bearcat* scanner, send or phone your order directly to our Scanner Distribution Center.™ 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 well rated firms at a 10% surcharge for net 30 billing. All sales are subject to availability. Prices 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 $10.00 surcharge for special handling in addition to shipping charges. All shipments are F.O.B. Ann Arbor, Michigan. No COD's please. Cashier's checks will be processed immediately and receive an order priority number. Personal checks require three weeks bank clearance. Mail orders to: **Communications Electronics,™** Box 1002, Ann Arbor, Michigan 48106 U.S.A. Add $5.00 per scanner for U.P.S. *ground* shipping, $9.00 for faster U.P.S. *air* shipping or $30.00 for *overnight delivery* to most major U.S. cities via Airborne Air Freight. If you have a Master Charge or Visa card, you may call anytime and place a credit card order. **Order toll free** 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.

Since this ***two-million dollar Bearcat sale*** is the world's largest, please order today at no obligation to assure a prompt order confirmation and delivery.

When you follow the leader to real excitement, your journey ends at Communications Electronics.

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25TH ANNIVERSARY

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NOVEMBER 1979

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There's a wide choice of computer equipment, software, and books for personal and business applications.

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Focus on Microcomputers

Feature Articles

Construction Articles

Columns

Julian Hirsch Audio Reports

Electronic Product Test Report

Departments

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Editorial

LET THE GOOD TIMES ROLL

With all the pessimistic talk about tightening our belts, entering an age of diminishing expectation, and so on, there are still many happenings to generate a sense of optimism. This is especially true for a trained person who is working. In essence, that's you, since our studies show that 72% of PE readers are college educated and only 0.3% of those in the work force are unemployed. That means that you have some discretionary income to take advantage of good buys.

What's a good buy? It's an undervalued commodity that will doubtlessly cost more in the near future. For example, if one always yearned to own a Cadillac automobile, they're available at this writing for almost what a dealer pays for them. Moving closer to an area within our editorial charter, there's a great opportunity to take advantage of slumping stereo component sales. The decline can be attributed to a variety of reasons, with high gasoline prices being one. But there's more to it. Expanding from $1.7 billion in 1975 factory sales to almost $4 billion in 1978, stereo attracted many new manufacturers and more equipment was produced to meet the sales growth challenge.

So, in essence, there's a natural oversupply at this particular time. This is bad for the companies and dealers, but very good for consumers. It causes dealers to offer bigger discounts in order to move out inventory for which they pay about 14% in interest rates! It also prompts audio manufacturers to offer cash discounts, extended payments, etc., which aggressive dealers pass on to the buying public.

Now let's briefly look at the computer field, the subject of a special focus this month. A small computer's CPU and main memory accounted for about 80% of the total price only a few years ago; now it amounts to only about 30%. Computer memory chip prices have declined fifty-fold since 1974. Dynamic RAMs have slid from two-cents/bit in '74 to 35-*millicents*/bit in '79! Some computer makers have been able to reduce costs owing to higher production volume. It all adds up to bargains for the buyer.

Price aside, there are technological advances that make today's electronic equipment vastly superior to earlier models. For instance, RCA just introduced a color TV receiver with a comb filter IC that eliminates the often distressing problem of shifting color on such objects as a man's bright multicolor tie . . . there are video cassette recorders with six hours recording time on one cassette . . . General Electric debuted a microprocessor-controlled AM/FM clock radio with keypad frequency selection and six intermixed (AM-FM) stations in memory.

So clearly there is a strong, bright economic light for many people who can afford to spend carefully now for merchandise they would likely buy at a later date, when it will cost so much more.

Art Salsberg

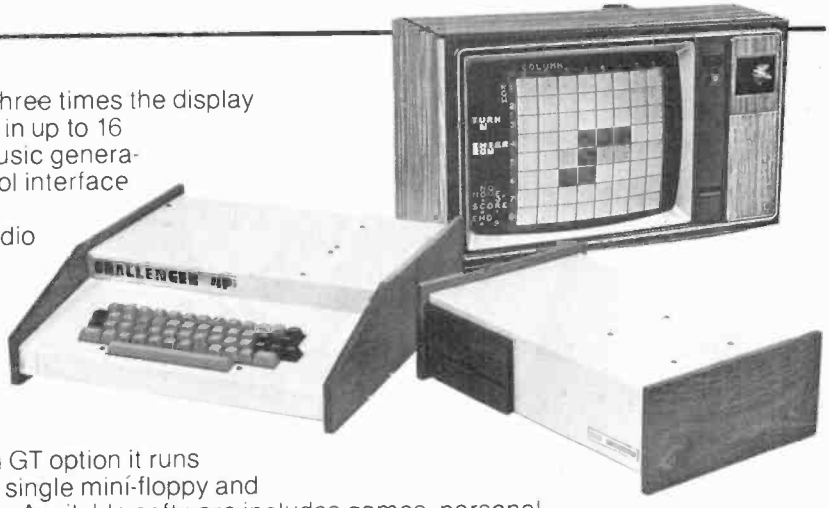
The Personal Computer Line by OHIO SCIENTIFIC

Personal Computers

C1P: $349 A dramatic breakthrough in price and performance. Features OSI's ultra-fast BASIC-in-ROM, full graphics display capability, and large library of software on cassette and disk, including entertainment programs, personal finance, small business, and home applications. It's a complete programmable computer system ready to go. Just plug-in a video monitor or TV through an RF converter, and be up and running. 15K total memory including 8K BASIC and 4K RAM—expandable to 8K.

C1P MF: $995 First floppy disk based computer for under $1000! Same great features as the C1P plus more memory and instant program and data retrieval. Can be expanded to 32K static RAM and a second mini-floppy. It also supports a printer, modem, real time clock, and AC remote interface, as well as OS-65D V3.0 development disk operating system.

Professional Portables



C4P: $698 The professional portable that has over three times the display capability of C1Ps. Features 32 x 64 character display in up to 16 *colors*, graphics, audio output, a DAC for voice and music generation, key pad and joystick interfaces, AC remote control interface and much more. Utilizes a 4-slot BUS (2 used in base machine), 8K BASIC-in-ROM, 8K of *static* RAM and audio cassette interface. Can be directly expanded to 32K static RAM and two mini-floppy disks.

C4P MF: $1695 The ultimate portable computer has all the features of the C4P plus real time clock, home security system interface, modem interface, printer interface, 16 parallel lines and an accessory BUS. The standard machine operates at twice the speed of currently available personal computers (with GT option it runs even faster!). The C4P MF starts with 24K RAM and a single mini-floppy and can be directly expanded to 48K and two mini-floppies. Available software includes games, personal, business, educational and home control applications programs as well as a real time operating system, word processor and a data base management system.

*Monitors and cassette recorders not included. Ohio Scientific offers a combination TV/Monitor (AC-3P) for $115.

Home/Small Business Systems

C8P: $895 Same great features as the C4P in a tremendously expandable "mainframe package." Features over three times the expansion capability of the C4P for advanced home and demanding business applications. Can be expanded to 48K RAM, dual 8" floppies, hard (Winchester) disks and multiple I/O devices such as Voice I/O and a universal telephone interface.

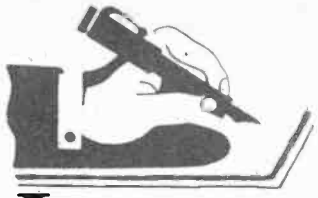
C8P DF: From $2597 The ultimate Home/Very Small Business Computer at a personal computer price. Features 32K RAM (expandable to 48K) and dual 8" floppy disks (stores eight times as much information as a mini-floppy). Has all personal computer capabilities including 32 x 64 display, color graphics, sound, DAC, joystick interfaces, home features including real time clock, AC remote interface, home security and fire detection interface and can be expanded to include voice I/O and a universal telephone system for answering and initiating calls! Its large memory capability and 8" floppies allow it to run most Ohio Scientific business system software including a compete accounting system, word processor and information management system.

The C8P DF is designed to be the "Brains" of the home of the future and the small business office of the future!

OHIO SCIENTIFIC

1333 S. CHILLICOTHE RD., AURORA, OHIO 44202 (216) 562-3101

CIRCLE NO. 48 ON FREE INFORMATION CARD



Letters

CAUTION

In Part One of "Space-Age Electronic Projects for Boats" (July 1979) an error was made in the instructions for fabricating the fresh-water probe pictured in Fig. 5. One should never use silicone-rubber adhesive or epoxy cements in any drinking or eating container. Silicone-rubber adhesive gives off arsenic and many epoxies give off a variety of toxic chemicals. One should only use aquarium-seal silicone (but not immersing it in the container for at least four days from the time the probe is fabricated to render it nontoxic) or an epoxy cement that specifically states on the package that it is nontoxic.—*Bob Dormer, Philadelphia, PA.*

The answer to this problem is contained in the reader's last statement, ". . . an epoxy (or silicone) cement that specifically states on the package that it is nontoxic." In checking with the General Electric Co., we find that its silicone adhesive products are marked according to the state laws in which they are sold as to usability in connection with containers of potable liquids. If there is any question concerning use of a silicone adhesive, the Engineering Department of the Silicone Products Dept., General Electric Co., Waterford, NY, will be able to supply the answer.—Ed.

ANNIVERSARY CONGRATULATIONS

Congratulations on reaching your silver anniversary, POPULAR ELECTRONICS! From your first issue back in October 1954 to the present, PE has consistently represented the forefront of the electronics hobby. If the past 25 years is any indication of the future, I'm sure the next 25 years will be equally stellar. —*Will Hobbs, Portland, OR.*

Out of Tune

OUT OF TUNE

In "Audio Power Meter," October 1979, the resistor connected to pin 5 of *IC2B* should be *R27* and there should be no connection between its other end (point L) and *R26*. The pc pattern is correct. The meter, *M1*, should be 0–1 mA as in the Parts List, not 0–1 μA. Also, in the Parts List, *S3* should be listed as a spdt not spst switch. Under Calibration, in the text on page 67, at the top of the third column, after applying the 6.0-V signal to *R3* and *R4*, add the instruction to adjust *R8* to obtain a null on the meter. Then remove the signal from *R3* and *R4* and remove power.

In "NASA Motor-Control Circuit Cuts Electric Cost" (October 1979), in Fig. 2, the center tap of *T1* should be connected to the bottom of R1, not the top.

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Blue Ridge Summit, Pa. 17214

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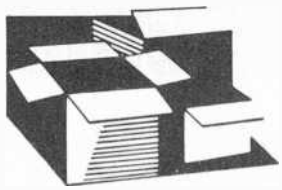
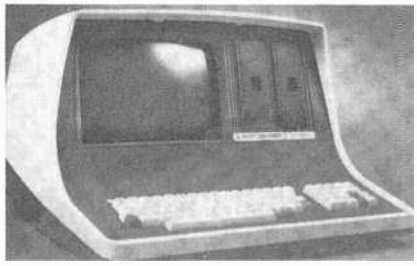


New Products

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.

"Smart" Video Terminal

The SuperBrain Video Computer, an intelligent video terminal system, has been introduced by Intertec Data Systems. Designed around twin Z-80 microprocessors SuperBrain is a complete microprocessor



system aimed at small-business applications. Standard features include, two double-density 5¼" floppy-disk drives with 320,000 bytes of storage, 48K bytes of user-programmable RAM expandable to 64K, an S-100 bus adaptor, an RS-232C communications port, a full ASCII keyboard with numeric pad and function keys, and a CP/M-based disk operating system with text editor, assembler, and debugger. Compatible software is available in BASIC, FORTRAN, COBOL, and APL. $2,995.

CIRCLE NO. 88 ON FREE INFORMATION CARD

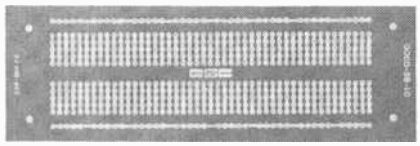
Automatic Multiple/Single-Play Turntable

Garrard's new GT-350 is designed to play one record or a stack of records fully automatically while maintaining rumble of 68 dB (DIN B) and wow and flutter of 0.06%. Its tonearm and headshell together weigh 12 grams. Using a dc, servo-controlled motor coupled to a die-cast aluminum alloy platter by a precision-ground elastic belt, the GT-350 features electronically variable speed. The use of Delglide (a special self-lubricating plastic) in the system that controls automatic functions is said to produce extremely smooth changing cycles. Controls are grouped on the front panel.

CIRCLE NO. 89 ON FREE INFORMATION CARD

Printed-Circuit Breadboard

Continental Specialties Corporation has introduced a product to ease the transition from breadboard to final circuit. The Experimentor Matchboard is a printed-circuit



version of the company's solderless breadboard, emulating the hole and contact pattern with the hole-indexing letters and numbers that are molded into the breadboard silkscreened instead on the component side of the pc board. The EXP-300PC Matchboard, geometrically equivalent to the EXP-300 solderless breadboard, costs $2.69.

CIRCLE NO. 91 ON FREE INFORMATION CARD

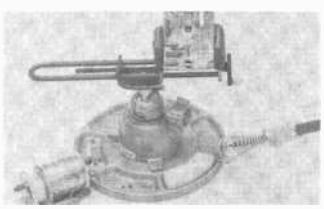
Counter with Computer Control

Model PM6667, a portable microprocessor-based frequency counter, has been introduced by Philips Test and Measuring Instruments. The counter spans the range from 10 Hz to 120 MHz, offering 15 mV sensitivity and automatic triggering on all waveforms. Measuring time can be set for one second (with seven-digit resolution) or 200 ms (with six-digit resolution). For low-frequency measurements, the microprocessor eliminates the customary ±1-Hz error and makes long gate times unnecessary. Aging of the internal crystal oscillator causes frequency drift of less than 5 parts in 10^7 per month. In addition, the counter contains self-diagnostic capabilities. $425.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Solder Station

A combination soldering-iron stand and controlled-feed holder for standard spools



of solder or wire has been introduced by PanaVise Products. The Solder Station can be used as a free-standing unit attached to a bench or wall or can be attached to a PanaVise Tray Base and used in conjunction with a PanaVise pc board holder to form a work center. Able to accommodate a 25-watt iron, the Solder Station can easily be adapted to left-handed use. $5.00

CIRCLE NO. 93 ON FREE INFORMATION CARD

(Continued on page 10)

Cordless Wonder

For $89.95 the Mura cordless telephone sounds like a bargain. But wait until you hear about its many disadvantages.

The Mura cordless telephone represents a major breakthrough in telephone technology.

It's about time. For years you've seen ads for cordless telephones selling for between three and four hundred dollars.

Now through some very clever planning and a sprinkle of new technology, Mura Corporation has come up with a cordless telephone that sells for $89.95. However, it has major disadvantages that could totally discourage you from buying the system—but more on that later.

ONLY IN AMERICA

The Mura weighs only 12 ounces and measures 1½"x 2¾"x 6½". The system includes a base unit that plugs into your telephone jack. You carry your cordless telephone with you and when your phone rings, you press a button and answer. And you can talk to anyone as long as you remain within 400 feet of the base unit.

But wait. We mentioned that the phone had major disadvantages. And it does. But first, let's outline some of its major advantages.

Convenience You don't need an extension telephone. With the Pocket Phone you have an extension phone that you can take with you—in the bath, in the den, in the garden, or to your neighbors.

Intercom You can use the base unit to page the person holding the cordless telephone. For example, if you're in your office and someone outside has the unit, you can press a button on the base unit and buzz the portable phone—just like on an intercom. Simply by talking on the phone plugged into your base unit, you can talk with someone on the remote phone. It's ideal for home or factory use.

Price The cost of the Mura remote telephone is only $89.95. Compare this price not only with the cost of other $300 remote telephones but with conventional phones as well, and you can appreciate what a major breakthrough the Mura system represents. But there's more.

You can plug any conventional phone into the base unit and carry on a three-way conversation. You can answer a call at the base unit and signal the remote unit to pick up the line. You can cut out the remote phone from the base unit if you want to keep a conversation private.

TALK OF VALUE

You can carry the cordless telephone with you with its antenna collapsed and the battery on standby. When a call beeps your unit, you simply extend the antenna, turn the power on, and start to talk.

The unit is FCC approved for connection directly into your telephone line. If you don't have a four-pronged jack or a modular connector, simply call your telephone company. They'll promptly install a jack for you and the cost will be around $15 or less depending on your location.

NOW THE CATCH

We mentioned that there was a catch—a few major disadvantages that you, as the consumer, should know about before you consider purchasing this product. Here they are:

Forget About Dialing The new Mura Pocket Phone can't dial out. It only receives calls. To many people, this doesn't matter because 90% of remote phones are used to receive calls and not to place them. By eliminating the dial, Mura has cleverly saved consumers hundreds of dollars.

Forget About Steel Walls The Mura unit won't penetrate them. This means that if you want to use your phone in a factory with metal walls, your unit won't work. But for most factories and practically all homes, the unit is ideal.

Forget About Snooping The unit has only a 400 foot range. At first this might seem awfully short, but nobody can snoop in on your conversations if that person is beyond this range, and 400 feet is more than enough for most applications. Most cordless telephones operate in the 27 megahertz range—the same frequency area used for citizen band radios.

The base unit for the Mura can also be used as a personal paging system or intercom.

The Mura uses the 49 megahertz range. This frequency has clearer reception with practically no interference.

The above are the disadvantages. For 90% of you, they don't mean a thing. For those 10% of you who need a dial, we would recommend the more expensive cordless telephones.

But for those of you who will accept its disadvantages, you'll be in store for the greatest idea in telephone convenience since the cordless telephone was first introduced. In fact, rather than install an extension phone, why not consider the Mura instead?

TRY IT FIRST

We suggest you try the Mura Cordless telephone system in your own home, office or factory. Use it for 30 days. Take the phone to your next door neighbor's house or with you to the bathroom while you take a shower or bath. Take it with you on your patio or balcony, or bring it in your garden as you work. Use it in your factory as an intercom or in your office as a remote telephone.

After you've given it a thorough test, then decide if you want to keep it. If not, no problem. Simply return your system for a prompt and courteous refund including your $3.50 postage and handling. You can't lose.

HERE'S THE WAY

To order your unit for a 30-day test, simply send your check for **$89.95** plus $3.50 postage and handling to JS&A Group, Inc., One JS&A Plaza, Northbrook, Illinois 60062. (Illinois residents please add 5% sales tax.) Credit card buyers, call our toll-free number below. We'll send your base unit, cordless telephone, rechargeable batteries, recharger, complete instructions, our 90-day limited warranty, and the address of the closest Mura Service Center or service-by-mail station.

Your unit is backed by Mura Corporation, a 17-year old company famous for their microphones, headsets, and other audio products. JS&A is America's largest single source of space-age products—further assurance that your modest investment is well-protected.

Very often when a product's disadvantages aren't made clear to the consumer, that product ends up being a disappointment. By explaining the major disadvantages of the Mura cordless telephone, not only are we avoiding a possible disappointment, we're proving just how great a product it really is. Order a Mura cordless telephone at no obligation today.

DC Integrated Amplifier

Leading Akai's new line of integrated amplifiers is the Model Am-2850, rated at 85 watts per channel continuous power into 8 ohms, 20-20,000 Hz with no more than 0.08% total harmonic distortion. Capable of accommodating three speaker systems, the amplifier includes a power meter, audio muting, low- and high-cut filters, loudness compensation, and tone controls for bass, treble, and midrange. The unit weighs 34.5 lb (15.7 kg) and measures 17.3" W × 6.7" H × 16.9" D (440 × 170 × 429 mm). $465.

CIRCLE NO. 94 ON FREE INFORMATION CARD

25-54-MHz Mobile Antenna

Antenna Inc.'s Model 41919 is a quarter-wave low-band (25-54 MHz) mobile antenna for business and municipal applications. Featuring a swivel ball, spring, and 96" (2.43-m) whip, all of stainless steel, the

unit is supplied with 20 ft (6.1 m) of RG-58/U coaxial cable and connectors. Performance specifications include 200-watt power capability, unity gain, nominal impedance of 50 ohms, and VSWR of 1.5:1 or less.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Miniature Loudspeaker

Qysonic Research has introduced the Qysonic Spree, a miniature loudspeaker with a rated frequency response of 55-22,000 Hz, ±3 dB under free-field (anechoic) conditions. Rated to handle 40 watts per channel continuous power and 100 watts peak, the Spree is said to be able to operate with as little as 10 watts per channel continuous. The system, whose impedance is given as 4 to 10 ohms (6 ohms nominal), measures 17" × 6" × 5½" (432 × 165 ×140 mm). The Spree is a two-way design using a pair of woofers and a single tweeter. $139.

CIRCLE NO. 96 ON FREE INFORMATION CARD

(continued on page 12)

NASA PATENT 4,052,648

NASA Hits

A new invention by America's space agency will help all Americans save energy and make some companies very wealthy.

Exxon has it. So does about a dozen other manufacturers. And if our hunches are correct, a new space-age product invented by NASA may not only save Americans millions of dollars but make fortunes for the companies that sell it.

The new NASA invention uses the latest space-age technology to save energy. Your refrigerator for example, is a major energy user. With this new device, your refrigerator compressor will run quieter, there will be considerably less heat generated from the motor, and it will run more efficiently saving at least 30% in energy.

The invention requires no installation. Just plug it into your outlet and plug your refrigerator into the device.

OVER PRICED UNIT

But there's a catch. Most manufacturers sell the device for as much as $200. Using it with your refrigerator, it will take many years before it will pay dividends. On a powerful motor, however, the device will pay for itself in a matter of months.

Manufacturers who have announced their units are selling them like hot cakes. Although you may have heard a great deal of publicity about the product, you may not have seen any advertising because most manufacturers are currently sold out.

Watch for it! We predict great success for all those associated with the product. The power-saving device invented by NASA is a big hit. It will grow in popularity and save energy and make many companies very successful.

A SMALL COMPANY

There is one small company however, that is credited with improving the device and developing it for the consumer market. Called ERI (Electronic Relays, Inc.) the company has developed several models to service specific products such as a refrigerator, a washing machine, dishwasher, swimming pool and a typewriter.

This small company actually improved the NASA invention by adding its own refinements. ERI had a great deal of experience in solid state relays which use TRIACs and integrated circuits—two important elements in the NASA invention. A TRIAC is a bidirectional thyristor which controls AC from a single control input. TRIACs also produce a great deal of heat.

ERI's experience taught them how to control the TRIAC and its heat dissipation and thus they were able to reduce the device's cost through more efficient handling of the heat problem. They were already one of the nation's largest purchasers of TRIACs—thus their costs were already low.

NATIONAL PUBLICITY

They called their product, the Power Chopper and sent a sample to a national magazine for their review. In several tests, the device out-performed even the claims made by the manufacturer and the magazine ran a glowing article on their findings.

The manufacturer felt that the product might at first be misleading. Although it does save 30% on energy and in many cases up to 60%, ERI felt most consumers would expect a 30% reduction in their total electric bill—which of course the product will not do. Consumers will only get a 30% savings on the particular appliance used with the Power Chopper.

STILL PESSIMISTIC

The manufacturer also felt that the product was primarily for the industrial market—restaurants with large banks of refrigerators. The consumer must wait over one year before the device would pay for itself. And finally, the manufacturer did not feel that the consumer would respond in great numbers to the article which ran in the July, 1979 edition of a popular magazine.

Well, the consumer did respond. So much so that the small manufacturer, with absolutely no marketing staff, was buried with mail. The president of ERI called JS&A to help him out.

TEST ONE YOURSELF

We agreed to offer the Power Chopper to the consumer market for $29.95—a major price breakthrough for the product.

Even if Exxon lowers their prices considerably, they'll never come close to the low cost of the Power Chopper. ERI's expertise with the TRIAC and JS&A's direct-to-consumer marketing, make the new NASA invention a practical power-saving accessory for every home.

The sophisticated electronics of the Power Chopper consist of a TRIAC, two integrated circuits and several solid-state devices.

We urge you to simply test just the refrigerator module. Order one from JS&A on a 30-day no-obligation trial. In the meantime, while you are waiting for your unit, feel the heat generated from the bottom of your refrigerator. Listen to the sound level of your compressor.

When the Power Chopper arrives, plug it in and notice how much quieter and cooler your refrigerator runs. See how much less time the compressor must run. The compressor not only will run more efficiently but will save energy every day you use it.

AWARD WINNER

If after 30 days you are not convinced that the Power Chopper will save you energy and money while making your refrigerator run smoother, then just unplug it and send it back for a prompt and courteous refund, including the $2.50 postage and handling. But if you've definitely noticed the difference, you'll want to purchase more units for the remainder of your motor-based appliances.

JS&A feels that ERI's technology, their improved NASA design and their low manufacturing costs will catapult them to the forefront of those introducing the new NASA invention. ERI's Power Chopper is one of the nation's major new innovative products and just recently won the Industrial Research IR-100 Award.

To order your Refrigerator Power Chopper, send **$29.95** for each unit plus $2.50 for postage and handling to JS&A Group, Inc., One JS&A Plaza, Northbrook, Illinois 60062. (Illinois residents please add 5% sales tax.) Credit card buyers may call our toll-free number below. We'll send your Refrigerator Power Chopper, one-year limited warranty and you'll be ready to save. If you wish to order additional units for other appliances at $29.95, you may, but we suggest you test the refrigerator module first and totally convince yourself.

GOVERNMENT REBATE

Purchase of the Power Chopper entitles you to a full 15% energy tax credit on your income tax return. It's like having the government give you a $4.50 rebate.

JS&A is America's largest single source of space-age products—further assurance that your purchase will be backed by service for years to come.

NASA technology was responsible for the development of the integrated circuit and many other space-age products. Their latest product could not have been developed at a better time. Start saving and order a Power Chopper at no obligation, today.

JS&A® PRODUCTS THAT THINK®

Dept.PE One JS&A Plaza
Northbrook, Ill. 60062 (312) 564-7000

Call TOLL-FREE 800 323-6400
In Illinois Call ..... (312) 564-7000

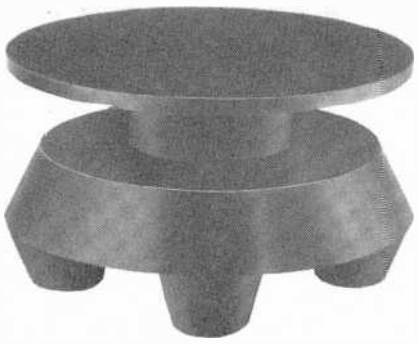
"No-Frills" Personal Computer

The Model One Benchmark computer from Interact Electronics is designed around the same 16K-memory processor as the company's more expensive machines, but is tailored for the first-time user. It includes a full-sized keyboard, a built-in cassette deck, and a TV connector cable and r-f switchbox. Included with the computer is a program tape for Edu-Basic, a simplified form of BASIC that uses normal English to introduce the neophyte to programming. Peripheral interface, raised keyboard, entertainment controllers, and additional program tapes can be added as options to expand the machine's capabilities. $450.

CIRCLE NO. 97 ON FREE INFORMATION CARD

Turntable Isolators

DiscFoot, Discwasher's latest turntable accessory, is said to be unique in that it is the only isolation system that works in conjunction with the turntable's own feet. The system comprises four of the following: isolation feet, furniture protection sheets, platform caps (for attachment to turntable feet), and foam damping pads (to accommodate certain turntables). According to the manufacturer, DiscFoot reduces airborne acoustic feedback by up to 25 dB



and structure-borne vibrations by as much as 20 dB. $22.

CIRCLE NO. 98 ON FREE INFORMATION CARD

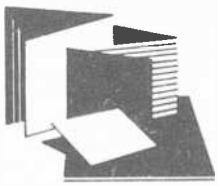
Compander for Tape Recording

Sanyo has made available a new compander system designed for use with cassette decks. Offering a claimed 40 dB of noise reduction, the new device is said to have frequency response of 10-30,000 Hz, ± 1 dB and total harmonic distortion of 0.08%. The Plus N-55 Super D, as the unit is called, splits the incoming audio signal into two bands before processing it. This is said to allow attack and decay times to be optimized and minimize "breathing" (modulation of noise components). Compression/expansion ratio is 2:1 (in decibels), and no matching to a standard level is required. According to Sanyo, any cassette deck with S/N of 50 dB or better will achieve the full 40 dB of noise reduction. $361.

CIRCLE NO. 99 ON FREE INFORMATION CARD

Wire-Wrap Jumpers

American Data Cable, Inc. has announced an expanded line of "Wire-Wrap jumper cables" designed to make temporary connections between 0.025" square terminal posts, such as those often found in IC sockets and printed-circuit connectors. The jumpers can also be used to connect small components such as diodes, resistors, and capacitors. "Multipoint jumpers," newly added to the line, are Wire-Wrap jumpers strung in electrically continuous chains at regular spacings of 1" to 6". All jumpers are fully insulated and said to be capable of installation in a few seconds. Address: American Data Cable, Inc., 903 San Antonio Rd., Los Altos, CA 94022.



New Literature

RCA COSMAC COMPUTER SYSTEMS

A 12-page booklet "COSMAC Microboard Computer Systems," CMB-250, describes RCA's hardware for microprocessor-based equipment including three computer systems, four memories, five I/O modules, and two multi-board prototyping systems. Microboard units are on 4.5-by-7.5-inch pc boards. Each computer system contains a CDP1802 COSMAC microprocessor, a clock, read-write memory, etc. Using low-power CMOS, the units operate from a 5-volt supply. Address: RCA Solid State Div., Box 3200, Somerville, NJ 08876.

SLIDE RULE MICROPHONE SELECTORS

Audio-Technica has made available three slide-rule microphone selectors to help recordists, sound installers and musicians choose and position microphones for sound reinforcement and recording. The devices provide such information as what microphones are most suitable for particular sources, where they should be placed, the number of mikes needed, as well as the sound frequency range of 26 instruments, voices, and complete bands. Order slide rules ($2.00 each) by type: recording, sound reinforcement, or artists series. Address: Audio-Technica U. S., Inc., 33 Shiawassee Ave., Fairlawn, OH 44313.

WORD-PROCESSING SUPPLIES

An 84-page "Guide to Word Processing Accessories and Supplies, 1979 Edition" describes almost 1600 items available from American Word Processing Co. Included are diskette and mini-diskette storage systems, anti-static mats, CRT work stations, etc. Address: American Word Processing Co., 18730 Oxnard St., Tarzana, CA 91356.

SPEAKER KIT CATALOG

Speakerlab's new catalog features its Subwoofer Drive System 1000 (with a 130-watt amplifier that incorporates equalization and adjustable crossover from 40 to 180 Hz); midrange and tweeter horns using its recently developed Wave Aperture ™ principle; and the Nestorovic Woofer System. Many other speaker kits are included in the 48-page catalog. Address: Speakerlab, 735 N. Northlake Way, Seattle, WA 98103.

SOLAR HEATING EFFECTIVENESS MAPS.

The National Oceanic and Atmospheric Administration has prepared a series of maps to be used in estimating the economic feasibility of solar heating in different locations in the 48 conterminous United States. They show distribution of relative effective solar heating (average solar energy/heating demand) for the January and November through April heating seasons. Based on data updated to 1976, the maps indicate, for example, that effective solar heating in January is 40 times greater in Miami, FL, than in northern parts of the country. Address: Environmental Science Information Center, D811, Environmental Data and Information Service, NOAA, Rockville, MD 20852, Att: W. E. Hardy. Request SEN-79, Figs. 1A & B.

B&K-PRECISION INSTRUMENTS

The BK-80 48-page catalog describes oscilloscopes, frequency counters, digital and analog multimeters, function and r-f signal generators, capacitance meters, probes, semiconductor testers, power supplies, and other instruments. Featured are four new 5" and two new 3" scopes and a 3½-digit DMM with LCD readout and 0.1% accuracy. Address: B&K-Precision, Dynascan Corp., 6460 W. Cortland St., Chicago, IL 60635.

Stereo Scene

By Harold A. Rodgers
Senior Editor

SPECIFICATIONS AND BEYOND

NO ONE, it seems, wants to be accused of specmanship these days. Manufacturers typically profess interest in sound quality, but "just in case someone wants to know what the product does in objective terms. . . ." Or: "We wouldn't bother much with specs, but the competition. . . ." Ironically, actions taken by the Federal Trade Commission to keep specs from being stated in a misleading way have resulted in uniformly forthright disclosures that are still often misleading—but now with a government imprimatur. Worse yet, the inapplicability of certain customary specs to real-world conditions can deceive customers as easily as did misrepresentations of the past.

Knowing the power delivered to a loudspeaker, for example, may tell you what kind of heat stress is applied to the voice coil, but is less than informative about the system's sonic performance. Moreover, a given number of watts does not even correspond to a fixed sound pressure level, for the efficiency of a loudspeaker varies with frequency. In addition, because speaker impedance also varies with frequency, it becomes difficult to tell how much power any wideband (or complex) music signal will cause the amp to deliver.

Though it may seem that this situation is problematic for amplifier and loudspeaker designers, in reality it is not. Amplifier engineers design their products to exhibit very low output impedances—making them, in effect, idealized, voltage-controlled *voltage* sources. Loudspeaker engineers, for their part, design products for flat output (sonic) power with respect to input voltage as none of them really cares how much power the amplifier produces or how much the speaker draws.

The fact that power varies as the square of voltage and that amplifiers of higher power must also be capable of sourcing greater output voltages may lead some people to believe that this argument is without practical consequences. However, as soon as we consider the effects of load impedance it becomes plain that this is not the case. The very requirement that a power rating be qualified by a load impedance, for example "75 watts into 8 ohms," is a dead giveaway that the amplifier is primarily a voltage source. A voltage source whose power output is defined by V^2/Z, where V is voltage and Z impedance, delivers whatever current is necessary to develop the required voltage drop across the load. A current source will apply whatever voltage is necessary to pass rated current through the load; its power output is I^2Z, where I is current. From a power source, the product of the current and voltage fed to a load would remain constant, regardless of impedance.

Pitfalls of Power. One reasonable requirement that should be demanded of whatever number is used to represent the ability of an amp to energize a loudspeaker is *consistency*. That is, with any given speaker, the amplifier with the larger rating should be capable of delivering the highest SPLs. An example will demonstrate that with present specification methods this is not always true.

Let's consider two amplifiers, one rated to deliver 100 watts into an 8-ohm load at some suitably low level of distortion, and the other able to deliver 120 watts under the same conditions. The first delivers a maximum of 28.3 volts rms, the second 31 volts rms. Let's assume further that the "120-watt" amp goes into current limiting at 3.9 amperes, while the "100-watt" component can source a maximum current of, say, 4.5 amperes.

Now let's connect a nominal 4-ohm speaker with a dip 3.1 ohms right in the midrange to each amplifier in turn. (Speakers exhibiting such impedance dips are not rare.) Clearly, applying the 31-volt output of the second amp to this speaker would result in a current of 10 amperes, well beyond its limiting threshold. To stay within the amplifier's current-sourcing abilities, we would have to hold the voltage to no more than 12.1 volts. The first amp, with 4.5 amps on tap, could apply 14 volts across the load without running out of current, despite its lower power rating. Here, then, is an amplifier rated at 0.8 dB more output than another, but capable in fact of 1.3 dB *less* output into a particular loudspeaker.

Most probably, the reason for this anomaly is historical, dating from the time when vacuum tubes fed loudspeakers through tapped output transformers. In those days, rating an amplifier in terms of power was more practical. With the load connected to correct taps one could ensure that the amplifier would run out of current and voltage at more or less the same level of power at all impedances. Consistency was thus maintained; the higher-rated unit could practically always play louder. This, incidentally, may shed some light on why vacuum-tube amplifiers have sometimes been observed to sound better than solid-state units with "identical" ratings; the output transformer may make the tube model effectively the more powerful of the two.

Habit and inertia being as influential as they are, I doubt that the audio industry will take the step of rating amplifiers by voltage output and, say, the lowest impedance across which a level 3 dB below rated voltage can be maintained. What's more, the reaction of the FTC to such a move would be difficult to predict. On the other hand, the ability to drive loads of very low impedance is a significant point of distinction between well- and poorly-designed amplifiers. (Readers of POPULAR ELECTRONICS are made privy to some of this information in audio test reports. Every amplifier is checked with loads of 16, 8, 4, and 2 ohms. The data is expressed in terms of power, but can easily be converted to voltage using $P = V^2/R$.)

Deciphering Distortion Specs. Distortion is another area in which specifications, even though dutifully measured according to all applicable standards, are not as comparable as one would like. Identical distortion numbers can reflect widely divergent behavior from the amps on which they are measured. Once again, I'll try to illustrate the point with an example.

In a paper delivered to the Audio Engineering Society, Prof. Matti Otala and his colleagues concluded that specially trained subjects could detect transient intermodulation distortion (TIM) on the order of 0.003%. Divulging more details about their stunning conclusion, the researchers admitted that what the subjects were hearing was a short, once-per-waveform spike of TIM reaching a peak value on the order of 1% that produced a far smaller reading when averaged over the entire waveform. Obviously, presenting such an average as a specification is misleading in this case, but it can easily be justified on the basis that equipment customarily used to measure distortion performs just this sort of averaging. Looking at matters another way, one might say that all distortion specs may be just this misleading. Again, what are we to make of "identical" distortion specs, unless we are given the chance to examine either the distortion waveform or, perhaps even better, its spectrum? No wonder products that measure the same often sound so different. The "sameness" is probably an artifact of the test procedure.

Once again, I suspect that the anomaly has a historical basis. If one is comparing vacuum-tube amplifiers whose distortion characteristics are spectrally very similar, it may be very practical to relate the magnitude of the distortion to listening quality. Even at the height of the vacuum-tube era, however, audiophiles argued as to whether triodes or pentodes, which distort somewhat differently, sound better.

Today the situation has become almost chaotic. Amplifier designs can have highly divergent distortion characteristics depending on the choice of output devices, circuit geometry, feedback, etc. Compounding the confusion, some designers claim that a change in capacitor type, say, can cause an appreciable difference in sound without affecting measured performance parameters. Considering the ambiguities that are demonstrably inherent in measured parameters, this is not altogether surprising. But are there any other objective standards to supplement or replace performance specifications in making comparisons of equipment prior to purchase?

Listening Tests. One obvious course is to

judge equipment on the way it sounds. This is attractive in a way, but the shortness of human auditory memory seems to require that such evaluations be made on a comparative basis—by means of the traditional A/B test, in which two units performing the same function are alternately switched into the audio chain and thus compared. Testing of this kind is commonly (though not always correctly) performed in audio stores to help prospective customers choose equipment.

Unfortunately, A/B tests are not without problems, although more serious difficulties arise in using them for research than to determine equipment preferences. If we are comparing loudspeakers, for example, all we want to know is which one offers a subjectively preferable sound. We must be reasonably careful about equalizing sound pressure levels for both speakers, of course. On the other hand, if we wanted to know whether 0.00x% percent of harmonic distortion was more audible than 0.00y%, we are faced with the problem of preparing alternative components whose performance is identical except for the difference in distortion. Frequency response and loudness level would have to be minutely equalized.

Another shortcoming of A/B testing is that listeners can be heavily influenced by suggestion in evaluating what they hear. In scientific testing, this problem is addressed by making the test "blind"; that is, concealing from the listener which switch position corresponds to what equipment and, perhaps, interchanging equipment in the course of the test. Sometimes speakers are placed behind an acoustically transparent screen so that a listener's sonic judgement cannot be swayed by a speaker's physical appearance. In its most rigorous form, the test is made "double blind." In a double-blind test, neither the subject nor the tester knows how the switching is arranged. This is considered to prevent unconscious clues and body-language "hints" from being passed to the subject.

Double-blind testing has been attacked on the ground that it is insensitive and may obscure differences. In a letter to *The Audio Amateur*, John Curl, a noted and somewhat controversial circuit designer writes:

> "A double-blind listening test, while removing a subjective bias toward hearing differences that may not truly exist, unfortunately does nothing to remove bias toward NOT hearing any differences that may actually exist in equipment. Indeed a double blind testing situation could intimidate a listener not to take a stance, since one could be embarrassed, if misled momentarily by a change in the quality of timbre of the musical source, to make what would seem to be a random decision. It seems we must invest a certain amount of faith in the objective integrity of the listener in any case."

For several reasons, I cannot agree with Mr. Curl. First, we are not trying to tell whether or not the units under test have differences. Presumably, we already know that the differences are there. What we want to know is if the listener can hear them. Second, we could reasonably expect to overcome the listener's potential for embarassment by making it in his interest to report any differences he can possibly hear. We might offer a reward for each correct determination and exact a penalty for each incorrect one. Third, no amount of integrity will rule out honest errors as well as a double-blind test.

Comparative listening tests have also been attacked on the basis that the hardware used to implement them can produce artifacts. This is true to a point. For example, inadvertent ground loops in a switching network have been shown to materially influence the sound of some (but not all) of the amplifiers used in one highly publicized test, thereby invalidating the comparisons. All this proves, however, is the necessity for approaching testing with great care. More nebulous criticisms such as the notion that relay contacts color the sound and obscure the differences under study could probably be handled by additional objective testing. One might, for example, compare the sonic effect of a single contact with that of several in series to see if and how the effect accumulates. And the knowledge that a difference under investigation changes the sound less than the presence or absence of a relay contact is informative in any case.

It is not my purpose here to lay down standards of electrical and auditory testing for the industry. To do so would be indeed presumptuous. What I ask, rather, is that the industry be much more candid in disclosing why this or that design change contributes to improved sound quality. It would also be nice to know who heard the difference and under what conditions. Anyone who asks a consumer to replace a serviceable piece of equipment with a snazzy new model has a responsibility to inform him what benefits will be conferred by the change and how to be sure the benefits are in fact forthcoming. Surely, measured data and listening tests would both be involved in such an effort. ◇

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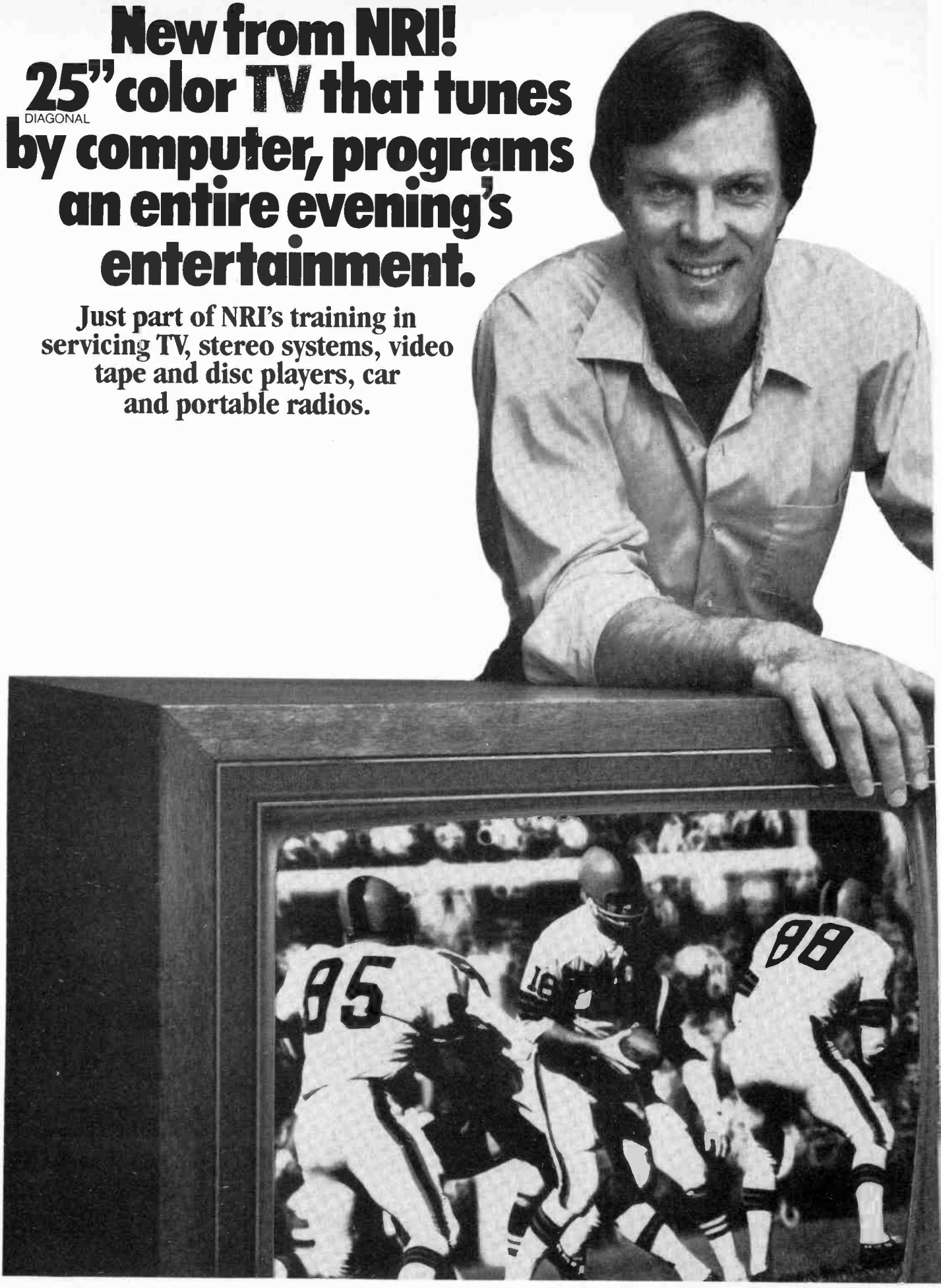

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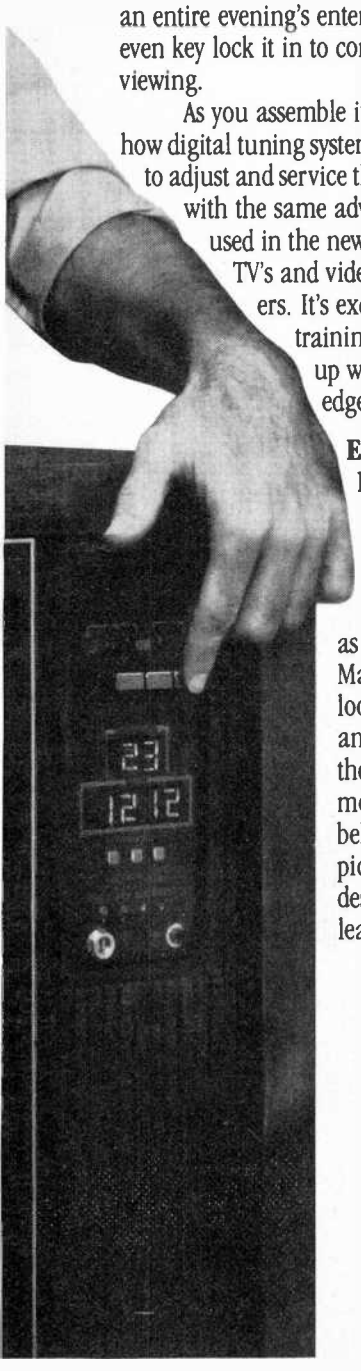

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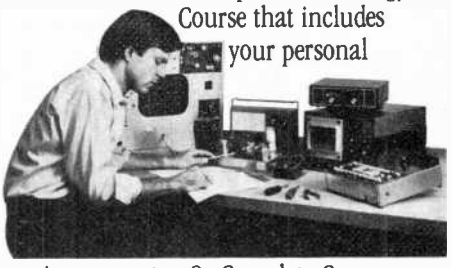

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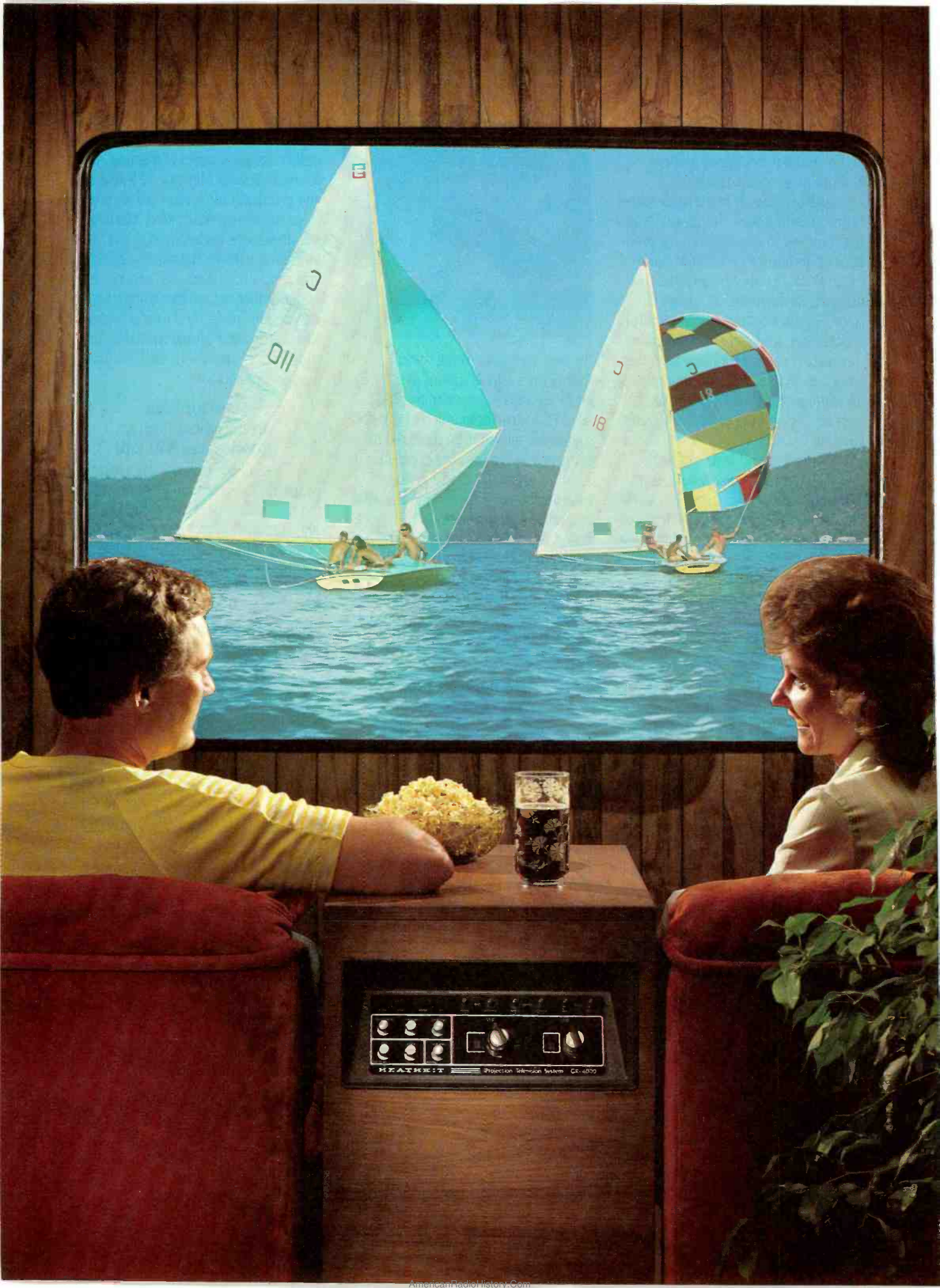

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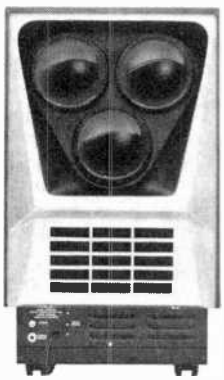

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GX-364

CIRCLE NO. 5 ON FREE INFORMATION CARD

Julian Hirsch Audio Reports

Mitsubishi Model DT-30 three-head, stereo cassette deck.

HIRSCH-HOUCK LABS REPORT

Mitsubishi's Model DT-30 deluxe three-head front-loading cassette deck features a closed-loop, dual-capstan drive and a logic-controlled solenoid-operated tape transport. Built-in test oscillators are used for recording-head azimuth alignment and for bias vernier adjustment for specific tapes. Styled to match other Mitsubishi audio components, the DT-30 has sturdy black handles that contrast with its silver-colored front panel. The deck measures 16¾"W × 14⅞"H × 6¾"D (425 × 378 × 171 mm) and weighs 23 lb (10.5 kg). Suggested retail price is $650.

General Description. The loading system exposes the entire cassette to view, so that the tape can be seen at all times. It also simplifies cleaning and aligning the heads, which are accessible when the hinged protective cover is swung down. Like other three-head decks with physically separate recording and playback heads, the DT-30 requires that the azimuth of its record head be matched to that of the playback head (which is factory aligned). A screwdriver access hole in the head cover permits recording-head azimuth adjustment with the aid of the test oscillator and recording-level meters.

The oscillator, used also for optimizing bias, is activated by a pushbutton switch. When the oscillator is activated, any external signal is replaced with the standard-level signal at either 440 or 8000 Hz, as selected by a separate button. With the deck set for RECORD and the MONITOR switch set to TAPE, the meters indicate playback signal level from the recorded test tone. The frequency button is alternately pressed and released, and any change in playback-level readings between the 440- and 8000-Hz signals is evidence of incorrect bias adjustment. (It is assumed that the front panel bias and equalization switches are set appropriately for the tape used.) Should there be a difference between the tones, one monitors the 8000-Hz signal and adjusts the azimuth for a maximum reading on both meters. Then, the two BIAS ADJUST controls are separately adjusted for each channel until there is no change in either meter reading when the oscillator frequency is switched. Releasing the TEST SIGNAL button disables the oscillator and restores the normal input signal.

The two large meters on the panel indicate from −40 to +7 dB and have fast responses to peak signals and slower decay times. The 200-nW/m Dolby level corresponds to a 0-dB meter reading. A PEAK HOLD button activates a unique circuit that has no effect on the meters until the peak level exceeds 0 dB. Any such peak is "held" for 3 seconds after the level has dropped below 0 dB, so that it can be easily seen.

"Automatic Spacing Pause System inserts 3-second silence between recorded segments"

Four lever switches permit selection of tape bias and equalization, the Dolby system (including a switchable filter that blocks the stereo pilot signal when recording from FM), and the program carried on the LINE outputs. In addition to the usual settings for SOURCE and TAPE, the MONITOR switch has a PLAY MIX position in which the playback from a recorded tape can be mixed at the line outputs with the input program present at the LINE or MIC jacks or both. The PLAY MIX feature is inoperative when recording.

Separate small concentric controls for the two channels permit adjustment of the LINE and MIC recording and the playback OUTPUT level. After the desired mix of LINE and MIC has been achieved, overall recording level can be set with a large REC MASTER control.

Small light-touch pushbuttons below the head assembly control the transport. A logic system enables the transport to be switched from any mode to any other without going through STOP. A "flying-start" recording can be made during playback by holding down the PLAY when pressing the REC button. A unique feature is an ASPS (Automatic Spacing Pause System), that can insert a 3-second period of silence between recorded segments of a tape. When the ASPS button is touched during a recording, the input signal is immediately removed, but the tape continues to run for 3 seconds before stopping in the PAUSE mode. A touch of the PAUSE button restores normal recording. The identifying symbol in each of the buttons lights when the switch is actuated.

A row of slide switches makes up the rest of the controls, except for POWER on/off, which is handled by a pushbutton switch. The deck can be set up for unattended operation in either playback or recording mode with its TIMER switch. When power is applied by an external timer switch, the recorder comes on in the selected mode. A similar switch controls the MEMORY system, which stops the tape in REWIND when the index counter reaches 000. It can also be set to automatically go into PLAY at that time. An AUTO switch causes the tape to rewind when its end has been reached or to repeat itself indefinitely. Finally, there is a switch that interfaces the DT-30 with Mitsubishi's Model DP-EC20 record player so that the transport is controlled by the tonearm for dubbing from discs. It causes the PAUSE function to be released when the arm descends to the record. At end of play, the tape deck can be set to shut off or to go into PAUSE.

Laboratory Measurements. Mitsubishi specifies TDK SA tape for "special," Sony HF for "normal," and Sony Duad tape for the ferrichrome bias settings. We tested the deck with these tapes and several similar tapes, including Memorex High Bias and Scotch Master II (special), Memorex MRX3 and Scotch Master I

Excuse Me!

The watch shown here is the newest concept in today's electronic marvels. Can you figure out why?

We salute Natron. Their innovative technology has brought us a breakthrough in digital watches.

Natron, one of the world's most admired watchmakers, has developed the most advanced timepiece of its kind in the world. By combining every known computer function that you could possibly desire in this spaceage era. Their quality features and advanced electronic knowledge is truly outstanding.

In the early 60's we began hearing about electronic wristwatches, whose basic beat came from a tiny tuning fork which provided accuracy guaranteed to within 2 seconds a day. Soon they became the best sellers in the country.

By the mid-70's an absolute explosion in digitals was set off, with prices reaching as high as $1,800. Manufacturers were working long hours day and night to keep up with the demand.

Now approaching the 80's we find that there are hundreds of manufacturers around the world making digital watches. There are models that tell you the time in two zones. Some offer a daily alarm, others a chronograph feature, ranging in price from $125 to $2,500.

Our company was faced with a dilema. Which digital do we offer our valued customers in our national advertising campaign?

The president of our company was intent on finding a watch that had more microelectronic features at an affordable price than anything else on the market.

We made a study of all the watch manufacturing companies in the world, Omega's Marine Chromgraph $2,500, Seiko's New LC Alarm $300 to Mercury's Global Executive at $125. The results of our experiment were unanimously in favor of the Natron Alarm Chronograph, because this superior watch offers more features than the best-selling superwatches rolled into one, at a price the American public can live with.

The following are the reasons behind our decision: Natron's daily alarm sounds everyday at the hour and minute selected. Its computer brain never forgets. The stopwatch feature with lap time operates independently at the flick of a button. Your choice of eight time zones in eight major cities, Los Angeles, Chicago, New York, Rio De Janiero, London, Paris, Cairo, Tokyo all programed by you in Natron's computer brain. You will have seconds, minutes, hours, day of the week, month and date. The Natron Chronograph also remembers the days in a month and instantly recycles to the correct first day of the month. Nine spaceage features in all, complete with a computer counter that will count your golf strokes (up to 1,300).

Service played a big part in our decision. The watch is guaranteed by a one-year parts and labor limited warranty — backed by two substantial companies. Since the Natron digital watch requires very little service other than a new battery every few years, which can be replaced by any jeweler, service has become less concerning. Should a malfunction ever occur there's a prompt Natron service-by-mail center as close as your postman — further reassurance that service was an important consideration in our experiment.

One of the major reasons for our decision was price. We went to the manufacturer and purchased thousands of watches directly from the factory without the normal mark-ups by importers, wholesalers and distributors.

We now can offer you the most advanced digital watch in the world for only $69.95.

We would like you to be the judge. Order the Natron Digital Chronograph Alarm from Chandler's on a 30-day trial basis. Make your own comparison, compare Natron's quality features with the Omega, Seiko or any other brand. Examine and compare its accuracy, its alarm, and its nine chronograph computer functions.

If after a factual side-by-side trial, you aren't convinced that its quality, accuracy and features make it a truly remarkable watch, return it within 30 days for a full courteous and prompt refund. Chandler's promises to accept the return of your watch with positively no questions asked and even refund the $3.50 postage and handling. There's no Risk.

CIRCLE NO. 11 ON FREE INFORMATION CARD

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To order your Natron Digital Chronograph Alarm, send your check for **$69.95** for the silver-tone model or **$79.95** for the gold-tone along with $3.50 per order for postage and handling (Virginia residents, please add 4% sales tax) to our address shown below or credit card buyers may call our 24-hour Toll-free number below.

We will promptly ship your watch, complete instructions and one-year parts and labor limited warranty. Try your own experiment and prove for yourself how outstanding the Natron Digital Chronograph Alarm really is.

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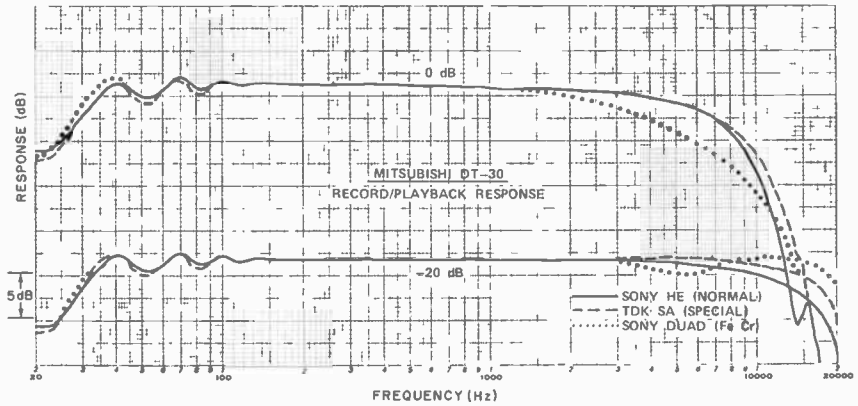
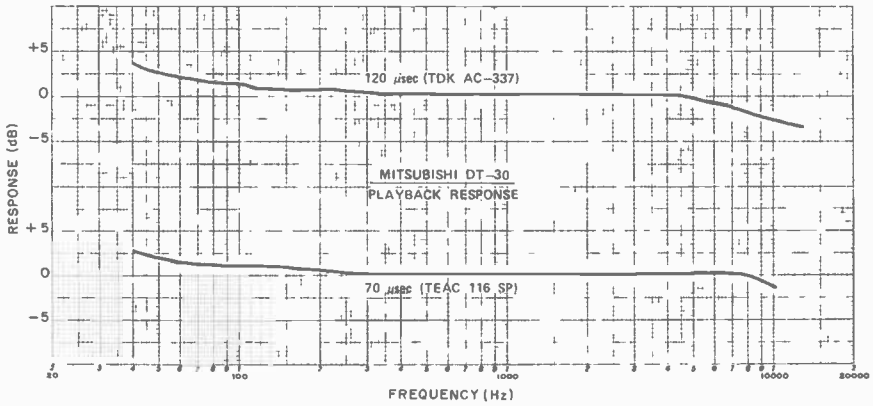


Frequency responses at 0 and −20 db for three different tape types.



Normal playback response at 70 and 120 microseconds.

(normal), and Scotch Master III (ferrichrome). After adjustment of bias according to instructions, all tapes in a given category produced very similar responses.

The frequency response curve was very smooth. It had minor head-contour ripples below 100 Hz, and most tapes revealed a gentle rolloff above 10,000 Hz. The Duad tape had a slight dip at 5000 Hz, after which the response was nearly flat out to 20,000 Hz, varying only ±1 dB from 35 to 20,000 Hz at a −20-dB recording level. TDK SA tape was within +0.5/−2.5 dB from 32 to 15,500 Hz, while Sony HF was within +0.5/−2.5 dB from 31 to 12,000 Hz.

Playback equalization, measured with TDK AC-337 and Teac 116SP test tapes for the 120- and 70-μs characteristics, indicated that at least part of the observed high-frequency rolloff was due to the playback response. The bass response rose slightly, and highs rolled off above 5000 Hz for an overall ±3.5-dB variation from 40 to 12,500 Hz (120 μs) or +2.5/−1.5 dB from 40 to 10,000 Hz (70 μs). Dolby tracking was good; there was no more than 1.5 dB of change at any frequency when the system was switched in and out, at recording levels of −20 to −40 dB. The MPX filter rolled off the highs by 1 dB or so above 4000 Hz and chopped steeply above 16,000 Hz.

A LINE or a MIC input of 92 or 0.43 mV, respectively, was required for a 0-dB recording-meter indication. The MIC preamp overloaded at 105 mV input. Playback output from 0 dB was about 0.5 volt, depending slightly on the tape used. The meter indication was within 0.5 dB of standard Dolby level, from a test tape.

The recording level that gave 3% third-harmonic playback distortion fell between ±1 dB with the tapes we used. Unweighted S/N, referred to the 3% distortion playback level, was 46.5 dB with TDK SA and Sony HF, and 41 dB with Sony Duad tapes. With A weighting, these measurements improved to 53, 56, and 51 dB, respectively. Finally, when we used the Dolby system and CCIR/ARM weighting, S/N was 58.5 dB with Sony HF, 62 dB with TDK SA, and 59.5 dB with Sony Duad tapes. The noise level increased by 8 dB through the MIC inputs at maximum gain, but the increase was negligible at lower gain settings.

"...manages to sound considerably better than its specs suggest"

Tape speed was 1% slow. Flutter measured 0.055% in a weighted rms (JIS) measurement, or ±0.08% weighted peak (CCIR). Crosstalk at 1000 Hz was −57 dB with a TDK AC-352 test tape. The meters had a fast peak response, with no overshoot, and indicated 100% of steady state on 0.3-second tone bursts. Meter decay was visibly slower than the rise time, so that the pointers tended to follow the maximum level contour of the program. PEAK HOLD made it easy to detect and measure any momentary peak overload.

A C-60 cassette was handled in 87 seconds in fast forward and 83 seconds in reverse. Headphone volume with 200-ohm phones was acceptable for casual listening but not for monitoring during recording. (The headphone output is designed to drive 8-ohm phones.)

User Comment. When we recorded interstation FM-tuner hiss and compared the playback to the incoming signal, the difference was very slight with any of the basic tape formulations we used. With TDK SA, there was *no* audible difference at most recording levels. With the other tapes, only a trace of dulling or accentuation of the extreme highs could be heard. It was surprising at first to find that the full recording/

Performance Specifications

Specification	Rating	Measured
Bias/erase frequency	85 kHz	Not checked
Input level/impedance		
LINE:	100 mV/82,000 ohms	92 mV
MIC:	0.3 mV/1200 ohms	0.43 mV
Output level/impedance		
LINE:	0.44 V/22,000 ohms	Approx. 0.5 V
HEADPHONES:	90 mV/8 ohms	Not checked
Motor: Capstan:	PLL dc servo	
Hubs:	Dc governor	
Wow & flutter	0.045% wrms	0.055% wrms
	±0.09% W p-p, DIN	0.08% CCIR (DIN)
Signal/noise ratio	Wtd, Dolby out 58 dB	51-56 dB, depending on tape
	Wtd, Dolby in 66 dB	58.5-62 dB depending on tape
Frequency response		
Normal:	40-15,000 ±3 dB	31-12,000 +0.5/−2.5 dB
Special:	40-17,000 ±3 dB	32-15,500 +0.5/−2.5 dB
FeCr:	40-18,000 ±3 dB	35-20,000 ±1 dB
Crosstalk	−35 dB at 1000 Hz	−57 dB

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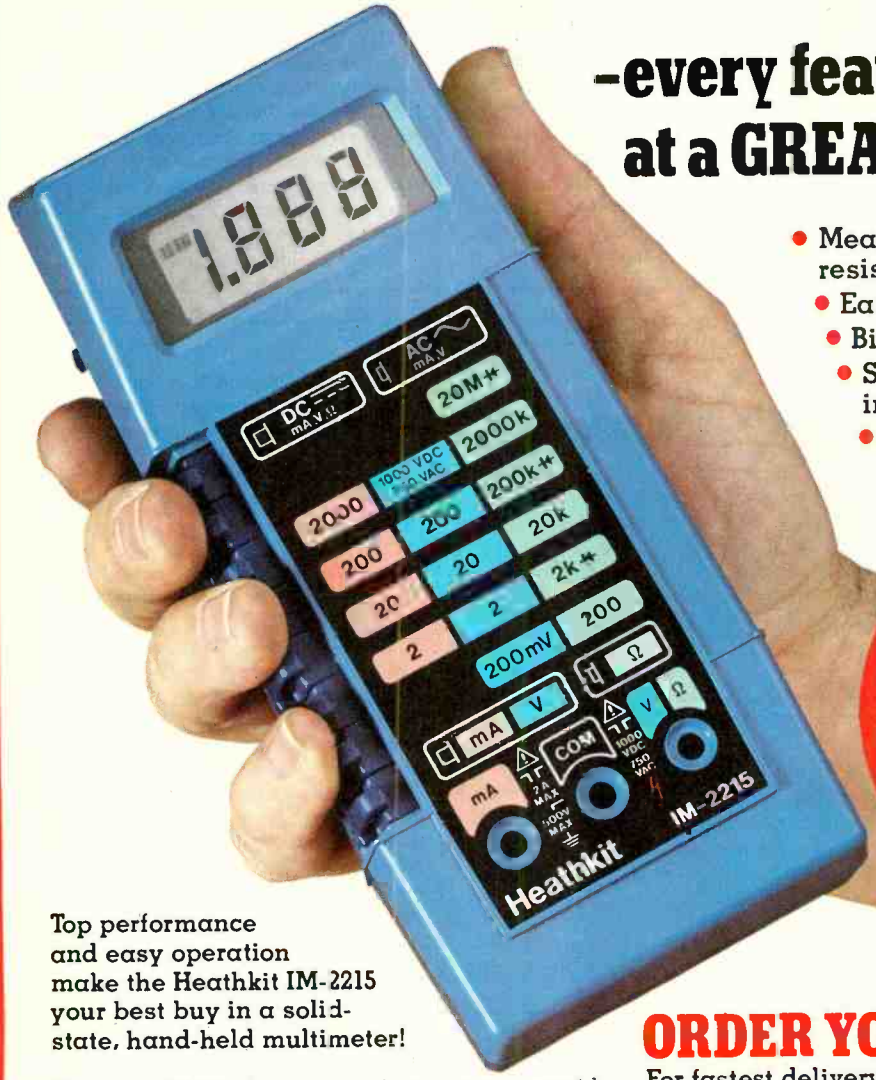

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reproducing accuracy could be obtained with relatively high indicated recording levels (as high as −5 dB, compared to the −20 dB required for most cassette decks if reasonable accuracy is to be obtained). This is partially a result of excellent high-frequency headroom, a typical advantage of a good three-head design. But it is also because of the fast peak-responding meters. On high-quality recorded music, peak-reading meters such as these may give readings 10 dB or more above those of averaging meters, and on live music the difference can approach 17 dB. Allowance must be made for this in setting recording levels. Although no peak should be allowed to exceed 0 dB, the meter readings should be kept as close as possible to 0 dB. The PEAK HOLD system is a considerable help in setting and maintaining proper recording levels.

Adjustment of record-head azimuth should probably be done for each cassette to be recorded. This is not difficult to do, but it can be a minor annoyance. We found that for any but the most critical recordings, it was possible to omit this adjustment (except possibly for a change of tape brand or type). The bias vernier had a surprisingly limited range, and we found ourselves at its limits of adjustment with some of the tapes we used. Here, too, acceptable results can usually be obtained if the adjustments are left at their lightly detented center-position settings.

The DT-30 is a cassette deck that manages to sound considerably better than its numerical specifications suggest. Although its rated performance is good, in most respects it is not at all superior to that of other fine decks. On the other hand, the sound *is* superior, and we doubt one could improve on it without spending considerably more money.

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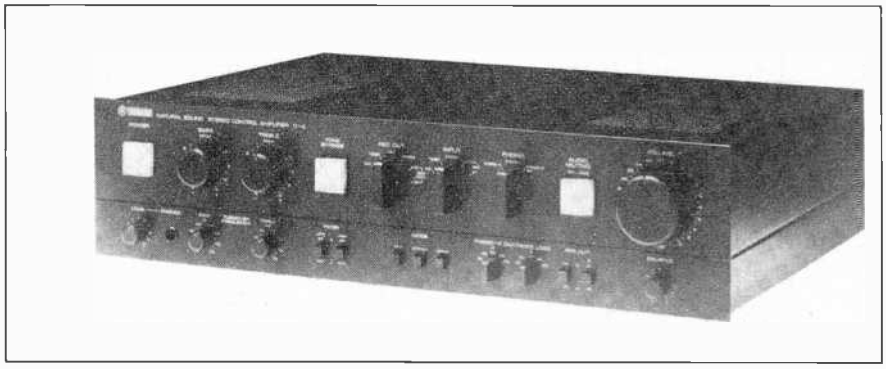

Yamaha Model C-4 preamplifier with variable tone control

HIRSCH-HOUCK LABS REPORT

The Model C-4 preamplifier is part of Yamaha's new line of deluxe separate components and is designed to be a companion to the Model M-4 power amplifier. Great emphasis has been placed on keeping noise and distortion to a minimum in the C-4 by the use of a special "Current Noise Reduction Circuit." The preamp features an unusually flexible tone-control system that supplements the conventional bass and treble adjustments to provide continuously variable turnover frequencies.

There is a separate recording output selector (featured in other Yamaha receivers and amplifiers) and a separate headphone amplifier (with volume control) capable of driving stereo phones of any impedance to high listening levels. The C-4 has selectable phono-cartridge resistance and capacitance termination and a head amplifier for use with low-output moving-coil cartridges.

The finish is flat black with black control knobs and pushbutton switches and white panel labelling. Size is 17⅛"W × 14¾"D × 4½"H (435 × 376 × 116 mm) and weight is about 19 lb (8.6 kg). Suggested retail price is $550.

General Description. The principal operating controls are grouped along the upper portion of the front panel, with the smaller, less-used controls along the bottom. Large square pushbuttons that light up internally when engaged control POWER, TONE BYPASS, and AUDIO MUTING. The BASS and TREBLE tone controls are continuously adjustable, detented only at their center DEFEAT positions.

Input source selections include AUX, TUNER, PHONO, TAPE 1, and TAPE 2. When the INPUT selector is set to PHONO, a separate PHONO selector offers a choice of PHONO 1 and PHONO 2 (for fixed-coil pickups) and PHONO 3 (for moving-coil pickups). Independent of the INPUT selector, a REC OUT switch can channel any of the program sources to the tape-recording outputs. Its TAPE settings are for dubbing from either of two tape decks to the other. This control has an OFF position that completely disconnects the tape-recording outputs from the preamp's circuitry. Turnover frequency control range is from 100 to 500 Hz for the BASS and 1000 to 5000 Hz for the TREBLE, with approximate calibration provided for each control.

"nearly unmeasurable noise and distortion"

The phono-input capacitance selector has settings for 100, 150, 220, 330, and 470 pF, and the resistance selector has settings for 100, 33,000, 37,000, 68,000, and 100,000 ohms. Both affect PHONO 1 and 2 simultaneously; PHONO 3 has a fixed 100-ohm termination.

The LOW and HIGH filters operate at nominally 15 and 10,000 Hz, both with 12-dB/octave slopes. The MODE switch has positions for STEREO, REversed stereo, and MONO. Either or both of two sets of preamplifier outputs can be selected. Finally, two of the three convenience ac receptacles on the rear of the preamp are switched.

Laboratory Measurements. We tested the C-4 under IHF standard conditions wherever possible. Where our test results do not agree with the published ratings, the differences were due to different test conditions and reference levels.

A 40-mV AUX or 0.65-mV PHONO 1 or PHONO 2 input was needed to generate a 0.5-volt output. Sensitivity of PHONO 3 was not measured, but it is rated at 100 μV for the 2-volt rated output. Phono preamplifier overload occurred at about 286 mV at 20 and 20,000 Hz, referred to the 1000-Hz gain level, and at 310 mV at 1000 Hz. Phono input resistances were as shown on the panel, and the measured input capacitance at the 100-pF setting was 140 pF.

Maximum output at clipping was about 11.5 volts from 20 to 20,000 Hz. IHF slew factor was greater than our measurement limit of 25. The A-weighted S/N ratio was better than 74 dB referred to a 0.5-volt output, or 86 dB referred to the rated 2-volt output. The measurement limit was set by our minimum meter reading of 100 μV.

Distortion in the output (which was entirely second harmonic), measured at 1000 Hz as a function of output, was 0.0018% at 6 volts output.

RIAA equalization was accurate within +0.6/−0 dB from 20 to 20,000 Hz. When measured through the inductance of a phono cartridge, the high-frequency phono response rose slightly above 5000 Hz, to a maximum of about 1 dB in the range from

(Continued on page 30)

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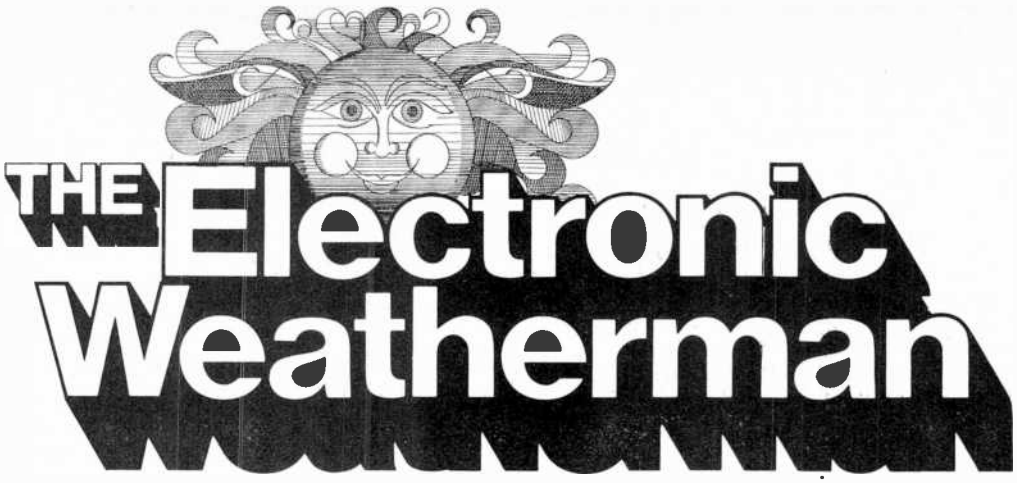

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(Continued from page 26)

7000 to 20,000 Hz. The HIGH filter, which had the rated 12-dB/octave slope, dropped the response by 3 dB at 8600 Hz. The LOW filter had most of its effect below 20 Hz, where it reduced the output level by about 1 dB.

User Comment. The controls operated with a smooth, positive, and precise "feel." The generally excellent human engineering of the Model C-4 was marred by only one minor error: unlike the buttons for POWER and TONE BYPASS, which I ight, respectively, when the preamp is on and when the tone controls are bypassed, the button for AUDIO MUTING lights when the muting is *disabled*. It was obvious from the measurements we made at various settings that the tone-control response could be given almost any desired shape. The tone-control effects were always subtle but, on the other hand, considerable patience or skill is required to obtain full potential of the system.

Operation of the PHONO 3 input was evaluated by using the preamp with several moving-coil cartridges. It proved to be as quiet as the moving-magnet inputs, with no noise audible even at maximum gain. The two sets of preamp outputs were very convenient for our listening setup, where we drove an accessory time-delay system from the second output. The headphone output was roughly equivalent to what we would expect from an amplifier or receiver. Even with 200-ohm phones, it was able to produce very high listening levels. In fact, anyone who normally listens through headphones could use the C-4 as a complete system amplifier, omitting a power amplifier altogether. Normal ventilation should be provided for this unit, which, unlike some preamplifiers, generates appreciable heat during operation.

The Yamaha Model C-4 is a highly refined preamplifier, with inaudible and nearly unmeasurable distortion and noise and greater than average control and operating versatility. Anyone who uses a moving-coil cartridge will find in this preamp a first-rate head amplifier. This feature alone might justify the price of the C-4 to many people. Those who hope to equalize audible frequencies in their room acoustics or speaker response, or just to tweak program material with precision and elegance, are almost certain to like the variable turnover frequencies of the tone control system.

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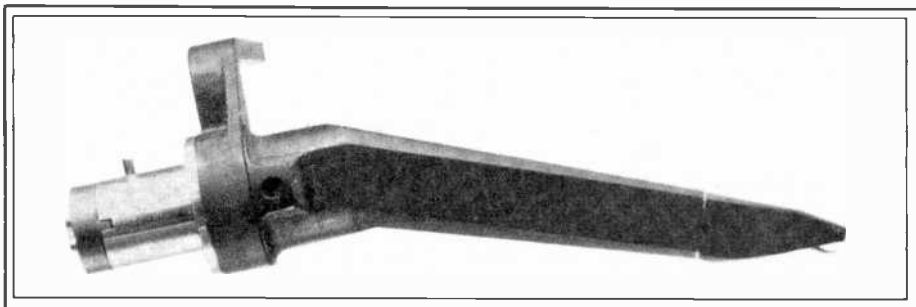
Performance Specifications

Specification	Rating	Measured
Input sensitivity		
PHONO 1, 2	2.5 mV/2 V out	0.65 mV/0.5 V out
PHONO 3	100 μV/2 V out	Not measured
AUX	150 mV/2 V out	40 mV/0.5 V out
Maximum input level		
PHONO 1, 2	285 mV at 0.01% THD	286 mV
PHONO 3	10 mV at 0.02% THD	Not measured
AUX	8.2 V at 0.01% THD	More than 10 V
Output level/impedance		
REC OUT	150 mV/180 ohms	Not measured
PRE OUT	2 V/600 ohms	—
PHONES	18 V (open load) 330 ohms	Not measured
Maximum output level (20–20,000 Hz)		
REC OUT	15 V	Not measured
PRE OUT	10 V	More than 11 V
PHONES	18 V open ckt	Not measured
THD (20–20,000 Hz)		
PHONO 1, 2	0.0035%/2 V out	Not measured
PHONO 3	0.1%/2 V out	Not measured
AUX	0.0035%/10 V out	Less than 0.002%
PHONES	0.02%/12 mW/8 omms	Not measured
S/N ratio (A weighted)		
PHONO 1, 2	73 dB (input open)	Better than 86 dB/2 V (IHF)
PHONO 3	77 dB (input shorted)	Not measured
AUX	106 dB (TONE BYPASS ON) 100 dB (TONE BYPASS OFF)	Better than 86 dB/2 V
Residual noise	0.2 μV	Can only be read to 100 μV (none measured)
Frequency response		
PHONO RIAA	±0.2 dB 20–20,000 Hz	+0.6/−0 dB
AUX	±0.5 dB 5–100,000 Hz	±0.25 dB 20–20,000 Hz
Tone controls		
Bass turnover	100 Hz–500 Hz	Confirmed
Bass boost/cut	±10 dB/20 Hz	Confirmed
Treble turnover	1 kHz-5 kHz	1.5 kHz-5 kHz
Treble boost/cut	±10 dB/20 kHz	Confirmed
Filters: LOW	15 Hz (12 dB/octave)	Not measured
HIGH	10 kHz (12 dB/octave)	8.6 kHz (12 dB/octave)
Audio muting	20 dB	Confirmed



Ortofon Concorde 30 low-mass stereo phono cartridge

HIRSCH-HOUCK LABS REPORT

The Concorde 30 is the premium model in a new line of LM series phono cartridges from Ortofon. This series has been designed, according to Ortofon, to have the lowest possible mass; hence the appellation "LM." This is actual cartridge mass, as distinguished from the effective mass of the stylus system, the latter also being very low in LM cartridges.

There are four LM series models, two designed for conventional tonearm headshells with ½" (12.7-mm) mounting centers and two that plug directly into the end of a universal four-pin plug-in type headshell tonearm. The Concorde 30 is in the latter category. It has a total mass of only 6.5 grams (less than half the mass of the typical cartridge/headshell assembly it replaces) and plugs directly into the end of the tonearm. The name "Concorde" derives from the cartridge's shape, which

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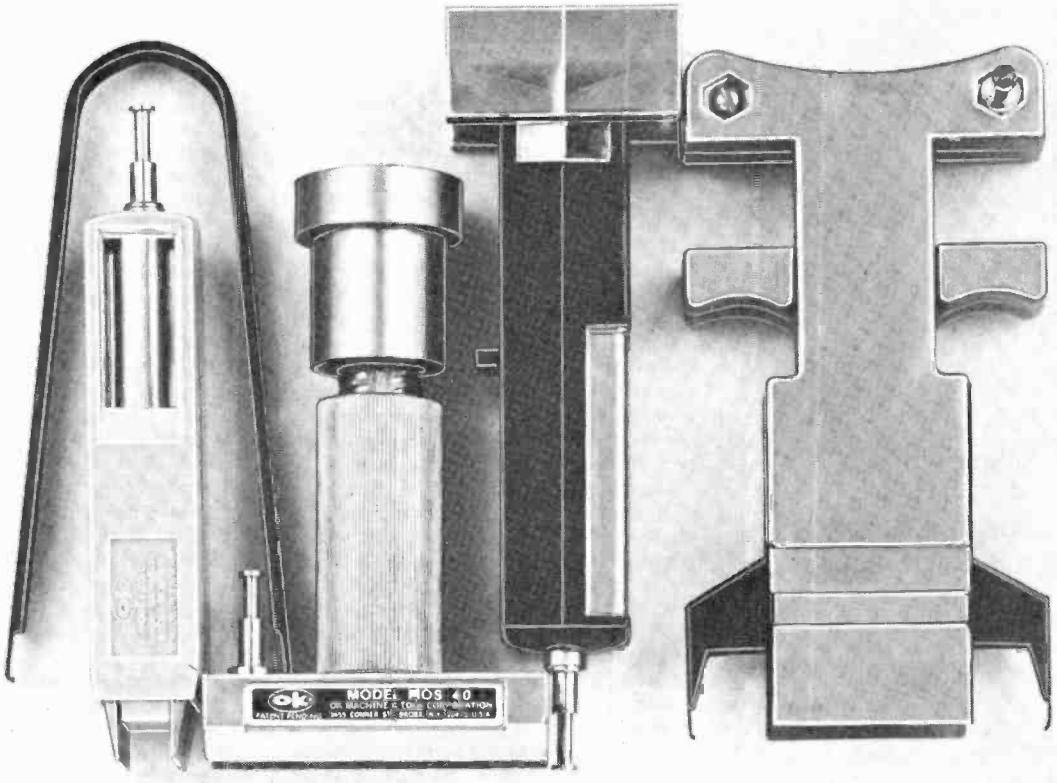

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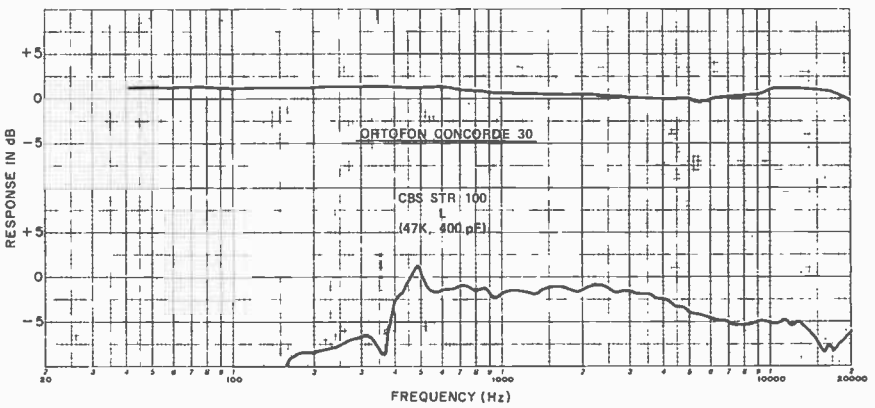

Frequency response and crosstalk for left channel.

closely resembles the hinged nose section of the Concorde aircraft. The actual cartridge occupies only the tip of the tapered body, and its stylus assembly pulls off for easy replacement. Suggested retail price is $165.00.

General Description. When installed in a typical tonearm, a low-mass cartridge such as the Concorde 30 usually has a low-frequency resonance greater than 8 Hz, where it will not be unduly sensitive to excitation by record warps. This reduced sensitivity produces a more stable tracking system that is able to handle warped records that would normally be unplayable.

Most tonearms designed for universal plug-in headshells were meant to accommodate fairly massive cartridges. In many cases, their counterweights cannot be adjusted to balance a very-low-mass cartridge like the Concorde 30. Therefore, Ortofon supplies with each LM cartridge a low-mass counterweight, which has a mass of 70 grams (the usual is 120 to 150 grams) and is designed to fit almost any tonearm to properly balance the Concorde 30. Since this weight is fastened in place with a plastic setscrew, the tracking-force scale of the usual threaded counterweight cannot be used with this cartridge.

Included with each Concorde 30 are a small stylus-force gauge, a plastic jig for aligning cartridge azimuth so the stylus cantilever is perpendicular with the record surface in a front view, a small screwdriver, and a stylus cleaning brush. There is also a small Allen wrench for loosening the cartridge body to permit its overhang to be varied over a range of about 4 mm.

In operation, the stylus cantilever moves a small armature in the field of a powerful but lightweight magnet. This varies the distribution of magnetic flux between a pair of fixed pole pieces for each channel. This induces a corresponding voltage into coils that surround the pole pieces. Ortofon claims that this Variable Magnetic Shunt (VMS) design gives exceptionally low distortion. The diamond stylus at the free end of the cantilever has a "fine-line" shape that gives an extended contact area along the groove wall and an ability to trace the shortest wavelengths, or highest frequencies, with minimum distortion.

Like other Ortofon moving-iron cartridges, also of VMS design, the Concorde 30 should be loaded by a relatively high capacitance of 400 pF in parallel with the usual 47,000 ohms. It is designed to track at 1.2 to 1.8 grams (1.5 grams nominal) and is rated to track a 70-micron amplitude of a 300-Hz laterally modulated groove.

Laboratory Measurements. We tested the Concorde 30 in the tonearm of a typical record player designed for the universal plug-in headshell. The effective mass of the tonearm and a conventional cartridge of about 6 grams mass measured 26.5 grams. As expected, the regular counterweight was unable to balance the Concorde 30. Therefore, we replaced it with the weight supplied with the cartridge. When balanced for a tracking force of 1.5 grams, the tonearm with the Concorde 30 had an effective mass of 18 grams.

Then we terminated the cartridge outputs with the recommended resistance and capacitance values. As rated, the

Performance Specifications

Specification	Rating	Measured
Frequency response	20-25,000 Hz (no tol.)	40-20,000 Hz ±1.5 dB
Output voltage at 3.54 cm/s	2.25 mV	3.75 mV
Channel separation (1 kHz)	More than 25 dB	32 dB
Channel balance (1 kHz)	1.5 dB	0.5 dB
Tracking ability at 300 Hz lateral	70 microns	Confirmed
Tracking ability at 10 kHz	30 cm/s	Not checked
Vertical tracking angle	20°	24°
Total weight	6.5 g	Not checked
Recommended load	47k/400 pF	Confirmed

Concorde 30 tracked the 300-Hz tones on the German Hi Fi Institute record up to the 70-micron level with low distortion. The cartridge was also able to track our high-level midrange and low-frequency test records with no difficulty. Its output was 3.75 mV/channel at a 3.54-cm/s velocity. Channel balance was within 0.5 dB. Vertical stylus angle was 24°.

Using the CBS STR100 test record, the frequency response was within ±1.5 dB from 40 to 20,000 Hz. Similar results were obtained with a B&K 2009 test record. Channel separation at 1000 Hz was about 20 dB with these records. Evidently, the cartridge geometry was closer to that of the cutters used to make JVC and Audio-Technica test records, since they elicited a separation of about 32 dB. With all records, high-frequency separation was very good, measuring 25 to 27 dB at 10,000 Hz and 22 to 27 dB at 20,000 Hz.

Flattest frequency response was obtained with the recommended 400-pF load. However, even with 150-pF termination, the output reduced by only about 1 dB between 5000 and 11,000 Hz and to a maximum of +3 dB at 20,000 Hz, relative to the 1000-Hz level. This would probably not be detectable by many listeners. The low-frequency resonance in the test tonearm was well-placed at 9 Hz with a somewhat high amplitude of about 7 dB.

Ortofon's claims for low distortion in the Concorde design were amply confirmed by our tests. High-frequency tracking distortion, playing the 10,800-Hz tone bursts of the Shure TTR-103 test record, varied from 0.74% at 15 cm/s to 1.2% at 30 cm/s, which is on a par with some of the best results we have found. Even more impressive was the IM distortion we measured with the Shure TTR-102 record (400- and 4000-Hz tones). It was 0.6% to 0.8% at velocities up to 13.5 cm/s and climbed smoothly to a mere 2.7% at 27 cm/s. These are about the lowest distortion figures (at the velocity levels normally encountered on commercial records) we have measured from the TTR-102 record—and they may be the residual of the record. More important, the cartridge showed no tendency to mistrack at the 1.5-gram force we used. The square-wave response to the CBS STR112 record was also very good, with a flat top and only a single small overshoot.

User Comment. Subjective tracking tests with Shure's "Audio Obstacle Course" records were consistent with our measurements. The earlier ERA III record was playable in its entirety with no audible mistracking. With the newer ERA IV record, we heard the beginning of slight mistracking on the highest level of the bells, combined harp/flute, and flute/bell sections. The flute and harp solo sections were playable at their maximum levels without distortion. This represents excellent tracking ability, matched by only a few cartridges in our experience.

These tracking tests are unusually severe, designed as they are to exceed the capabilities of almost any cartridge (otherwise they would have little value as test signal sources). When we played music records of various kinds, we found that the Concorde 30 was as inconspicuous sonically as it was visually. Some listeners felt that the cartridge has particularly well-defined bass.

Over the years, we have accumulated a number of badly warped records whose present function is to challenge record-playing equipment. Most of today's fairly massive tonearms, including the one in which we installed the Concorde 30, when coupled with a highly compliant cartridge, will bounce into the air every time one of these warps is encountered. This both creates a "thump" and, under the influence of the antiskating torque, outward shift of a few grooves every time the tonearm loses contact with the record.

The Concorde 30 played many of these records successfully. We still heard the "thump" in some cases, but the pickup usually stayed with the record, making it once again playable and listenable. Other tonearms would doubtlessly respond differently, but it is safe to say that the Concorde 30 will make almost any tonearm track better than would be possible with more massive conventional cartridges. Sonically, the Concorde 30 is one of the smoothest, cleanest, and least distorted cartridges we have heard in some time. Its reduced mass represents a much needed step in the right direction.

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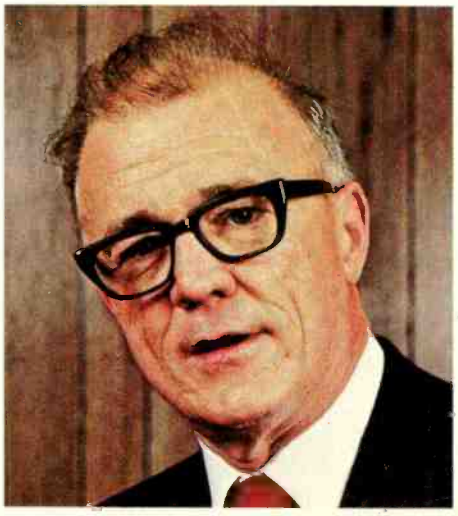

John E Cunningham

Special Projects Director
Cleveland Institute of Electronics

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Popular Electronics
NOVEMBER 1979

Radioteletype Reader for Shortwave Receivers

BY GEORGE STEBER
WB9LVI

Part 1: Theory and Circuit Operation

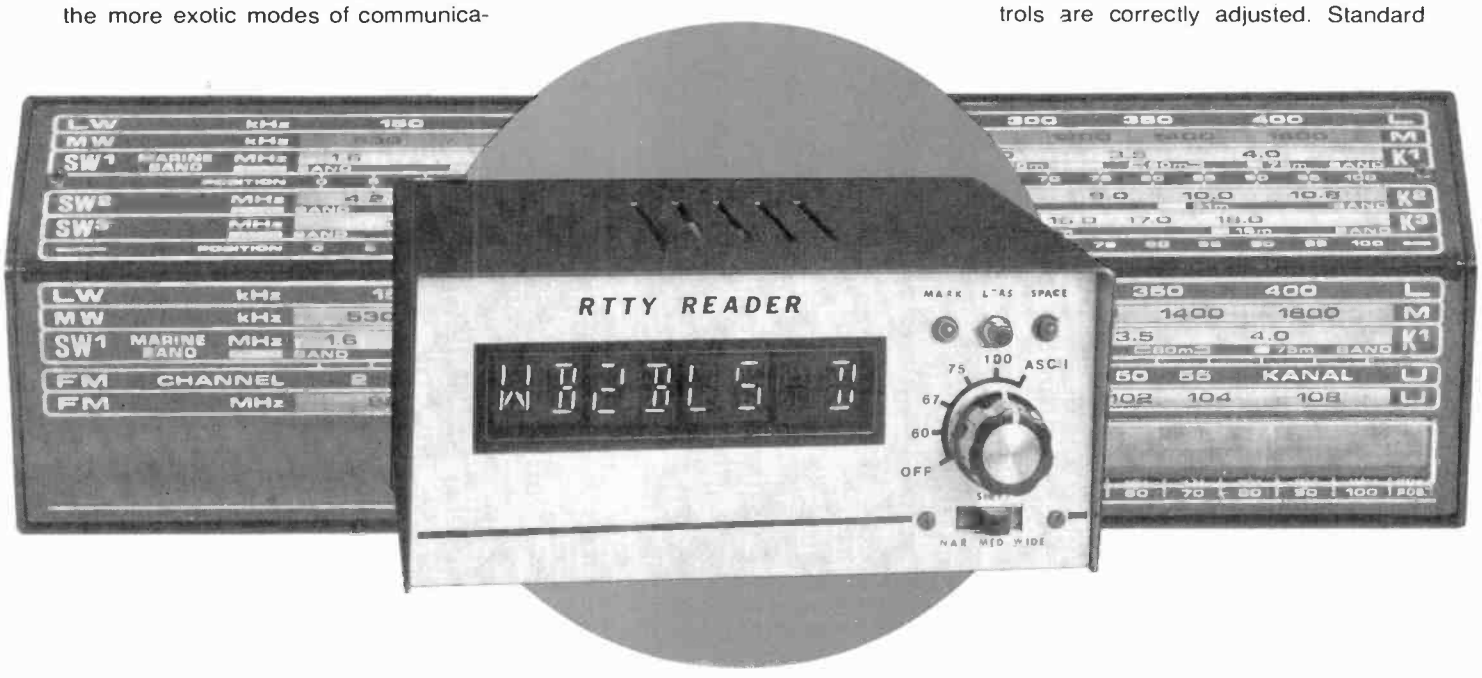
Words and numbers are spelled out as moving characters when the garbled ASCII or Baudot code signal is received.

HAVE YOU ever wondered about those strange-sounding "deedle-deedle" signals on the shortwave utility and amateur bands? Chances are they are radioteletype (RTTY) signals, one of the more exotic modes of communication employed today. News dispatches, commercial messages, weather bulletins, and amateur radio traffic are just some of the fascinating transmissions sent via RTTY.

The project presented here, the RTTY Reader, makes it possible for you to tune in and literally read these RTTY messages. It accepts audio signals from a communications receiver and automatically converts them into alphanumeric symbols which are displayed on an eight-character LED readout. The display operates in "Times Square" moving-character fashion, making it easy to read the decoded messages.

What's more, the RTTY Reader boasts an advanced circuit design that ensures accurate, reliable performance—even when receiving conditions are marginal.

The project's versatile signal-processing system is capable of handling Baudot code at speeds of 60, 67, 75 and 100 wpm as well as ASCII at 110 baud. Its demodulator includes separate active filters for narrow, medium, and wide frequency shifts. "Space" and "mark" LEDs glow when the RTTY signal is properly tuned in and the project's controls are correctly adjusted. Standard



TTL and linear IC's are employed, as are a UART a PROM, and discrete components. Total project cost is approximately $190.

RTTY Basics. Radioteletype transmits data in serial form by means of frequency-shift keying (FSK). Two frequencies are employed in an FSK system, one called the "mark" frequency and the other the "space" frequency. Only one of them is transmitted at any given moment. At the receiver, a demodulator or terminal unit (TU) converts these frequencies into appropriate logic levels. If a teleprinter is connected to the TU, the "mark" or "on" state causes current to flow in the RTTY loop, while the "space" or "off" state causes no current to flow. In the RTTY Reader, the "mark" frequency is decoded as a logic one and the "space" frequency as a logic zero.

There is some variation in the choice of frequencies corresponding to marks and spaces. So-called "narrow-shift" (170-Hz) FSK systems employ 2125 Hz for marks and 2295 Hz for spaces. Narrow shift is the choice of most radio amateurs active in RTTY communications. Commercial press and weather stations, however, favor medium- or wide-shift FSK. Medium (400-Hz) shift employs 2125 Hz for marks and 2525 Hz for spaces. In wide-shift (850-Hz) FSK, marks are transmitted on 2125 Hz, as in the other two systems, but spaces are transmitted on 2975 Hz. For maximum versatility, the RTTY Reader has been designed to handle all three frequency shifts.

There are several methods of generating FSK signals. Audio frequency-shift keying (AFSK) is accomplished by modulating an AM, SSB or FM transmitter with audio tones corresponding to the appropriate mark and space frequencies. Pure FSK is generated by switching a small reactance in and out of the RTTY transmitter's frequency-determining network. Inserting and removing the reactance causes the oscillator to shift frequency slightly. The magnitude of the keyed reactance is chosen to generate the appropriate frequency shift.

Diode switching of a discrete capacitor is a time-honored method of generating pure FSK, but Varactor diodes offer an attractive alternative. The capacitance of a Varactor diode changes with the amount of reverse bias applied across the pn junction. Therefore, if a Varactor is inserted in the frequency-determining network and its bias is changed to reflect the presence of a mark or a space, the frequency of the oscillator will shift. An appropriate choice of Varactor type and bias levels will result in the generation of the desired frequency shift.

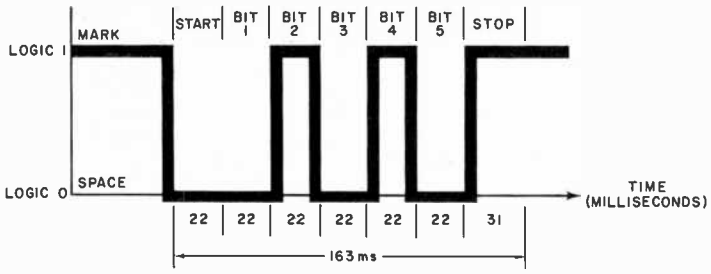


Fig. 1. Graphical representation of the letter R or the numeral 4 encoded in 60-wpm Baudot code.

On the hf bands, pure FSK and AFSK modulation of an SSB transmitter are the rule. If AFSK/SSB modulation is done correctly, it will be indistinguishable from pure FSK at the receiver. Either mode requires the use of a communications receiver with a BFO. At vhf, AFSK modulation of an AM or FM transmitter is more common than pure FSK. This calls for the use of a vhf receiver capable of detecting the type of modulation impressed upon the carrier at the transmitter.

Various *codes* are used to transmit alphanumeric characters via RTTY. The most popular is a five-level code, popularly known as *Baudot*. Another code employed in many commercial-communications and computer-interface teleprinter applications is eight-level ASCII. At the time this article is being written, the FCC has not yet approved the use of ASCII RTTY by radio amateurs. There is, however, great expectation that the FCC will do so. Until then, amateur RTTY enthusiasts will continue to employ Baudot. The fact that many

TABLE I—BAUDOT CHARACTER SET AND BIT SEQUENCES

Lower case	Upper case	Start bit	Bit 1	Bit 2	Bit 3	Bit 4	Bit 5	Stop bit
A	–	0	1	1	0	0	0	1
B	?	0	1	0	0	1	1	1
C	:	0	0	1	1	1	0	1
D	$	0	1	0	0	1	0	1
E	3	0	1	0	0	0	0	1
F	1	0	1	0	1	1	0	1
G	&	0	0	1	0	1	1	1
H	#	0	0	0	1	0	1	1
I	8	0	0	1	1	0	0	1
J	1	0	1	1	0	1	0	1
K	(	0	1	1	1	1	0	1
L	)	0	0	1	0	0	1	1
M	.	0	0	0	1	1	1	1
N	,	0	0	0	1	1	0	1
O	9	0	0	0	0	1	1	1
P	0	0	0	1	1	0	1	1
Q	1	0	1	1	1	0	1	1
R	4	0	0	1	0	1	0	1
S	Bell	0	1	0	1	0	0	1
T	5	0	0	0	0	0	1	1
U	7	0	1	1	1	0	0	1
V	;	0	0	1	1	1	1	1
W	2	0	1	1	0	0	1	1
X	/	0	1	0	1	1	1	1
Y	6	0	1	0	1	0	1	1
Z	"	0	1	0	0	0	1	1
Blank	Non-printing	0	0	0	0	0	0	1
Car. return	Non-printing	0	0	0	0	1	0	1
Line feed	Non-printing	0	0	1	0	0	0	1
Space	Non-printing	0	0	0	1	0	0	1
Letters	Non-printing	0	1	1	1	1	1	1
Figures	Non-printing	0	1	1	0	1	1	1

Note: 1 = mark, 0 = space.

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commercial as well as amateur RTTY users have made large investments in Baudot-code equipment makes it most probable that this code will continue to be used for many years. The RTTY Reader has been designed to be compatible with both codes, ensuring that FCC approval of ASCII will not render it obsolete.

Because Baudot is widely used, let's take a moment to see how it works. Each character transmitted in Baudot code is composed of a sequence of seven bits—a start bit, five data bits, and a stop bit. The start and stop bits are introduced to provide synchronization between the transmitting and receiving equipment. The data bits define the exact character transmitted. When Baudot is sent at a rate of 60 wpm, all elements (bits) of the code have a duration of 22 milliseconds, except the stop bit, which is 31 milliseconds long. Other common speeds, such as 67, 75, and 100 wpm, utilize correspondingly shorter bits.

A graphical representation of the letter R or the numeral 4 encoded in 60-wpm Baudot is shown in Fig. 1. This seven-bit word can be written as 0010101, where 0 is a space and 1 a mark. The duration of the seven-bit sequence is 163 milliseconds. Note that there is no way to tell whether an R or a 4 is being transmitted because the seven-bit sequence is identical for each. To distinguish between the two, the previous sequence of bits must be examined. If it was 0110111, which is defined in Baudot code as a nonprinting "figures shift" character, the next bit sequence received (0010101) will be interpreted as a 4. The teleprinter will remain in its "figures" mode until the bit sequence 0111111, defined as "letters shift", is received. Thereupon the teleprinter will return to its "letters" mode.

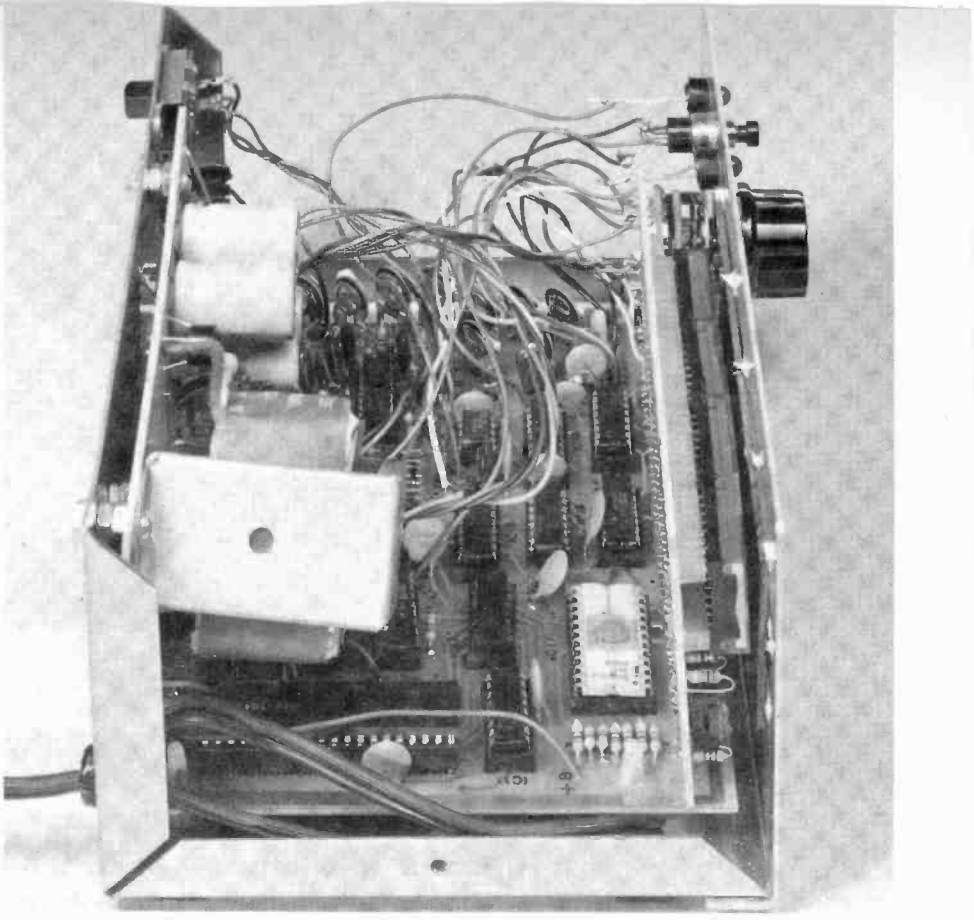

Photo of internal arrangement of author's prototype shows vertical mounting of power-supply and display boards.

A standard Baudot keyboard has 31 keys and a space bar, but can generate a set of 52 characters and five "housekeeping" functions. This is done by doubling the functions of certain keys using the "letters shift" and "figures shift" commands. Listed in Table I are the standard Baudot character set and corresponding bit sequences. The RTTY Reader can decode all of these characters except "Bell," a nonprinting command which activates an operator's signal inside a standard teleprinter.

System Analysis. A block diagram of the RTTY Reader is shown in Fig. 2. Audio signals from the communications receiver are applied to the input jack of the project. A limiter removes amplitude var-

(Continued on page 46)

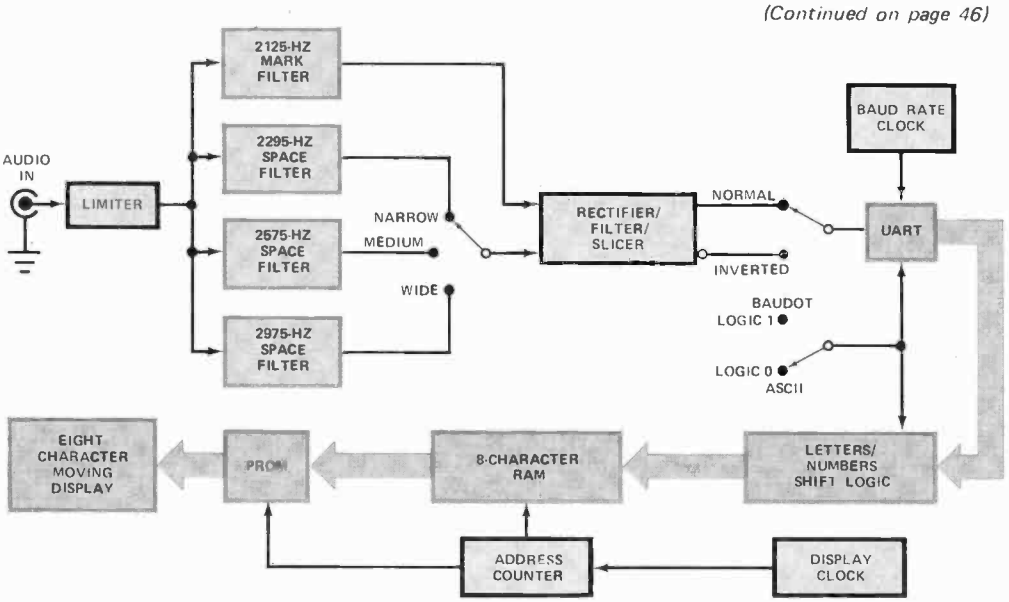

Fig. 2. Functional block diagram of the RTTY reader illustrates how received teletype signals are converted into legible text.

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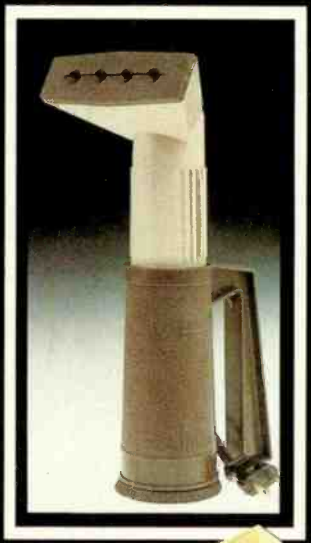

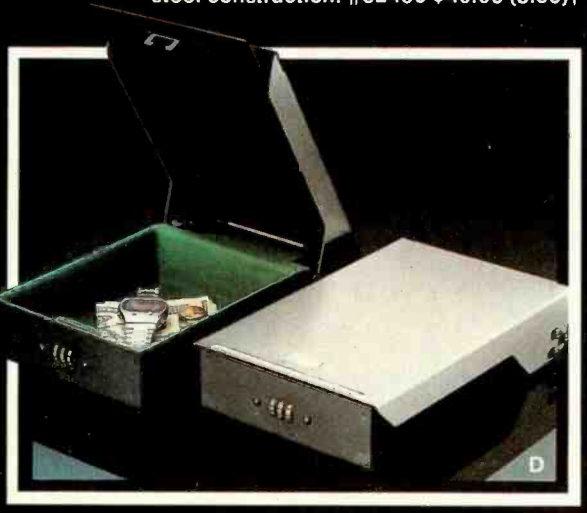

E. THE KWIK-STAMP...really great for marking a return address or identification. Just press down and a clear three-line imprint appears. And the ink is self-contained so the need for an ink pad is eliminated. Over 50,000 impressions without re-inking. #24306 $7.95 (.95)*

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G. NO MISTAKING YOUR WEIGHT! This computerized scale is all electronic...and shows an accurate weight in the form of a large red LED readout. All solid state, operates for about one year on 5 penlight batteries. Digital readout in pounds or kilos. #66242 $59.95 (3.15)†

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J. PHONE INDEX. Battery operated...so you just press the letter. The index spins and stops on that letter to reveal your collection of numbers. #19054 $29.95 (2.80)†

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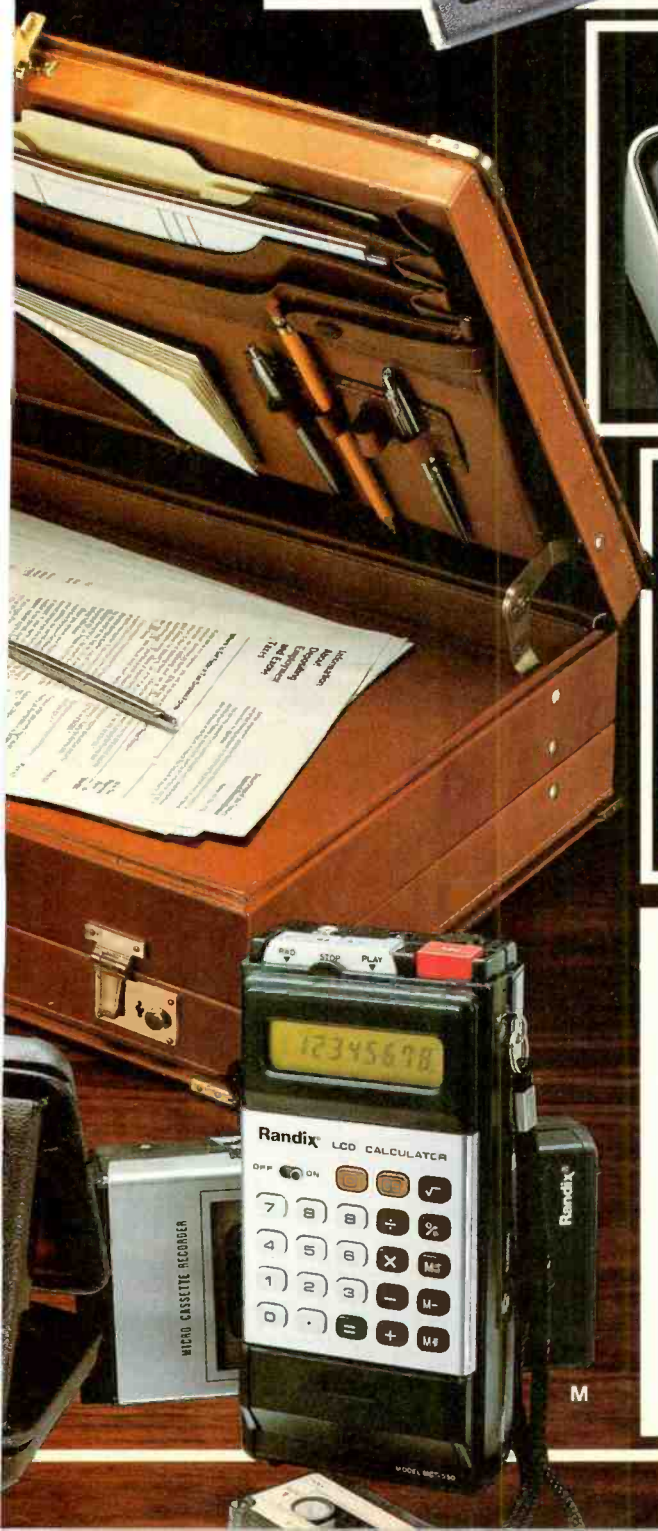

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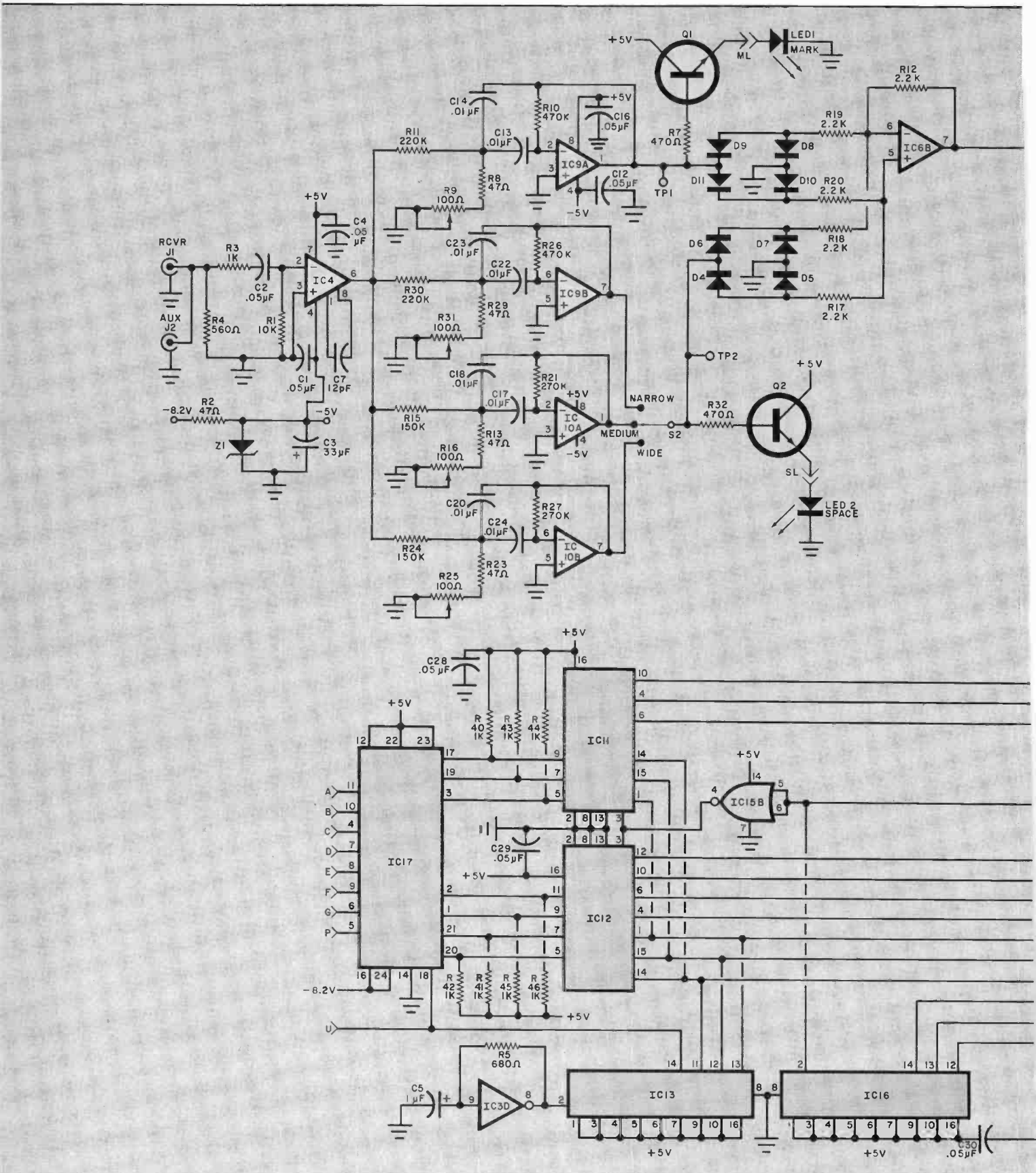
(Continued from page 42)

iations from the audio signal to enhance the reliability of demodulation. Next, a bank of active bandpass filters separates the mark and space frequencies from any other unwanted audio signals present at the output of the receiver. Narrow, medium or wide shift is selected by means of a switch that taps the output of the active bandpass filter whose center frequency corresponds to the appropriate space frequency. The mark frequency remains the same no matter



which shift is selected by the switch.

In the next functional block, the selected space and mark signals are rectified and filtered into dc levels. This block also contains a "slicer" which decides whether the RTTY signal is in the mark or space mode at any given instant. If it decides that a space is being received, it generates a TTL-compatible logic 0. If the slicer decides that a mark is being received, a TTL-compatible logic 1 appears at the output of this stage.

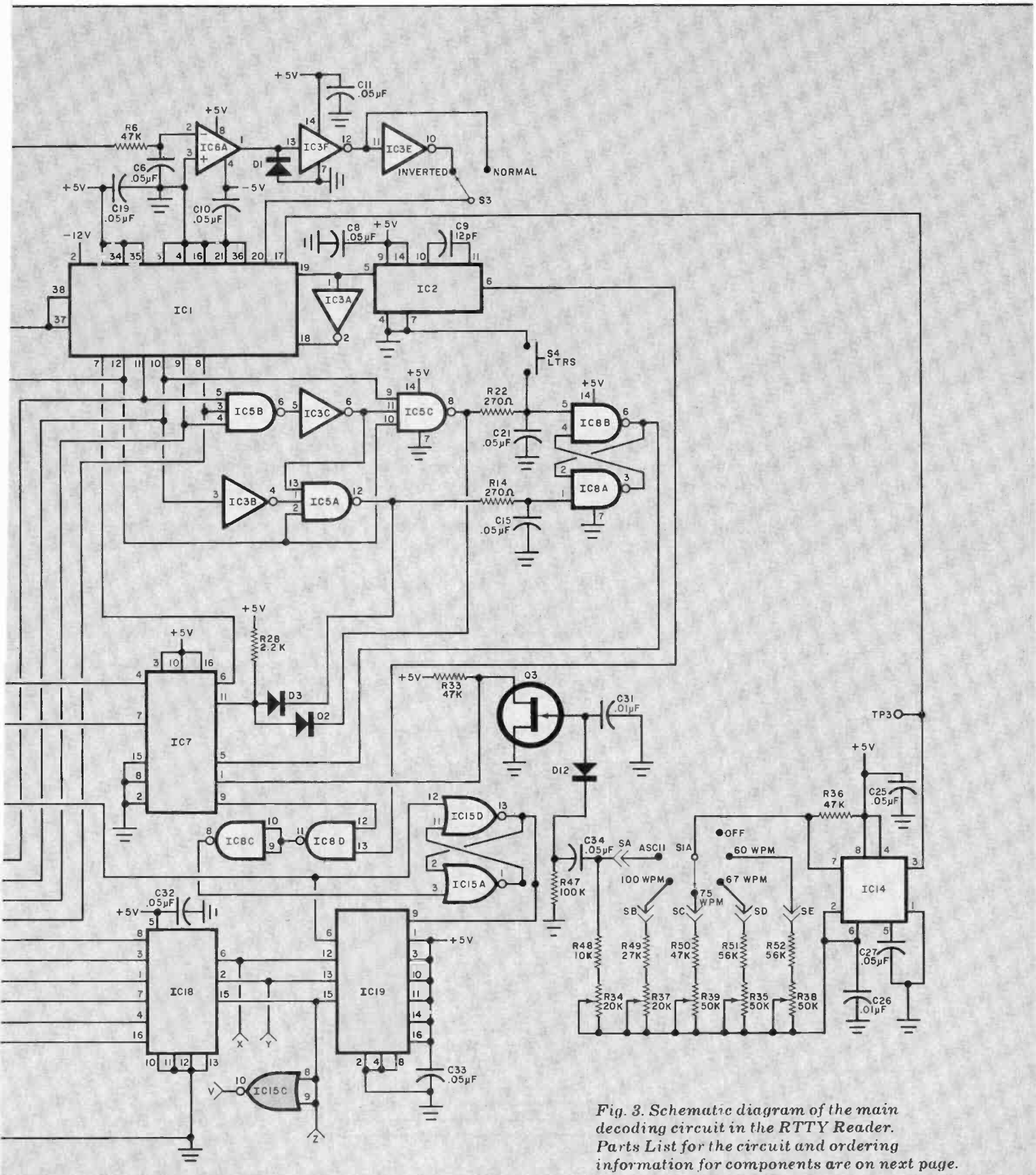


Fig. 3. Schematic diagram of the main decoding circuit in the RTTY Reader. Parts List for the circuit and ordering information for components are on next page.

PARTS LIST (Fig. 3)

C1,C2,C4,C6,C8,C10,C11,C12,C15,C16, C19,C21,C25,C27 through C30, C32 through C34—0.05-μF disc ceramic
C3—33-μF, 6-volt tantalum capacitor
C5—1-μF, 6-volt tantalum capacitor
C7,C9—12-pF, disc ceramic capacitor
C13,C14,C17,C18,C20,C22,C23,C24,C26, C31—0.01-μF Mylar capacitor
D1 through D12—1N914 or 1N4148 diode
IC1—TMS6011 or TR1602B UART
IC2—74121 monostable multivibrator
IC3—7414 hex inverting Schmitt trigger
IC4—LM301 op amp
IC5—7410 triple 3-input NAND gate
IC6,IC9,IC10—MC1458 dual op amp
IC7—74157 multiplexer
IC8—7400 quad 2-input NAND gate
IC11,IC12—7489 64-bit RAM
IC13,IC16—74161 or 9316 4-bit counter
IC14—555 timer
IC15—7402 quad 2-input NOR gate
IC17—1702A PROM
IC18—7483 4-bit binary adder
IC19—7485 4-bit magnitude comparator
J1, J2—Phono jack
LED1, LED2—Light-emitting diode

Following are ¼-watt, 10% resistors unless otherwise specified:
R1,R48—10,000 ohms
R2,R8,R13,R23,R29—47 ohms
R3,R40 through R46—1000 ohms
R4—560 ohms
R5—680 ohms
R6,R36,R50—47,000 ohms
R7,R32—470 ohms
R9,R16,R25,R31—100-ohm, pc-mount trimmer potentiometer
R10,R26—470,000 ohms
R11,R30—220,000 ohms
R12,R17 through R20,R28—2200 ohms
R14,R22—270 ohms
R15,R24—150,000 ohms
R21,R27—270,000 ohms
R33—47,000 ohms
R34,R37—20,000-ohm, pc-mount trimmer potentiometer
R35,R38,R39—50,000-ohm, pc-mount trimmer potentiometer
R47—100,000 ohms
R49—27,000 ohms
R51,R52—56,000 ohms
Q1,Q2—2N2222 or 2N3904 npn transistor
Q3—2N4304 n-channel JFET
Z1—1N5232 5.6-volt zener
Misc.—Printed circuit board; IC sockets; pushbutton switch; 6-position, 2-pole switch; 3-position, 2-pole slide switch; spdt slide switch; suitable enclosure; LED holders; pc standoff insulators; control knob; machine hardware; hookup wire; etc.
Note—The following are available from Microcraft Corp., P.O. Box 513, Thiensville, WI 53092: complete kit of parts (No. RRK-1) including ICs, sockets, pc boards, all displays and prepunched and lettered enclosure at $189.95 plus $3.50 handling and shipping within continental U.S. Also available separately are: set of three pc boards (main, display, and power supply) (No. RB-1) at $24.00; programmed 1702A ROM (No. RPROM-1) at $10.00; one dual character IEE 3785R LED display (No. DSP-1) at $9.00; alignment cassette tape (No. RRT-1) at $7.00. On last four items, add $1.50 shipping and handling within continental U.S. Wisconsin residents, add 4% sales tax.

In pure FSK or AFSK/SSB communications on the shortwave bands, whether the mark frequency is higher or lower than the space frequency is determined by the communications receiver, which can be operated in either the USB or LSB mode. Obviously, in an AFSK/SSB system, this choice also depends on which sideband the transmitter is emitting. Most hams have settled on a standardized sideband for the particular amateur band being used. However, commercial stations and some hams have not. It is important to realize that inversion of the signal can be accomplished by switching the receiver to the alternate sideband mode and retuning. For convenience, the RTTY Reader contains a

PARTS LIST (Fig. 4)

C1,C2—0.05-μF disc ceramic capacitor
DIS1 through DIS4—IEE 3785R dual alphanumeric LED display
IC1,IC4—75491 or ITT491 MOS-to-LED display driver
IC2,IC3—7445 or 74145 BCD-to-decimal decoder/driver
R1,R4,R5,R8,R9,R12,R13,R16—1000-ohm, ¼-watt, 10% resistor
R2,R3,R6,R7,R10,R11,R14,R15—27-ohm, ¼-watt, 10% resistor
Misc.—Printed circuit board, Molex Soldercons for displays, IC sockets, red bezel for displays, etc.
Note: See Parts List for Fig. 3 for kit information.

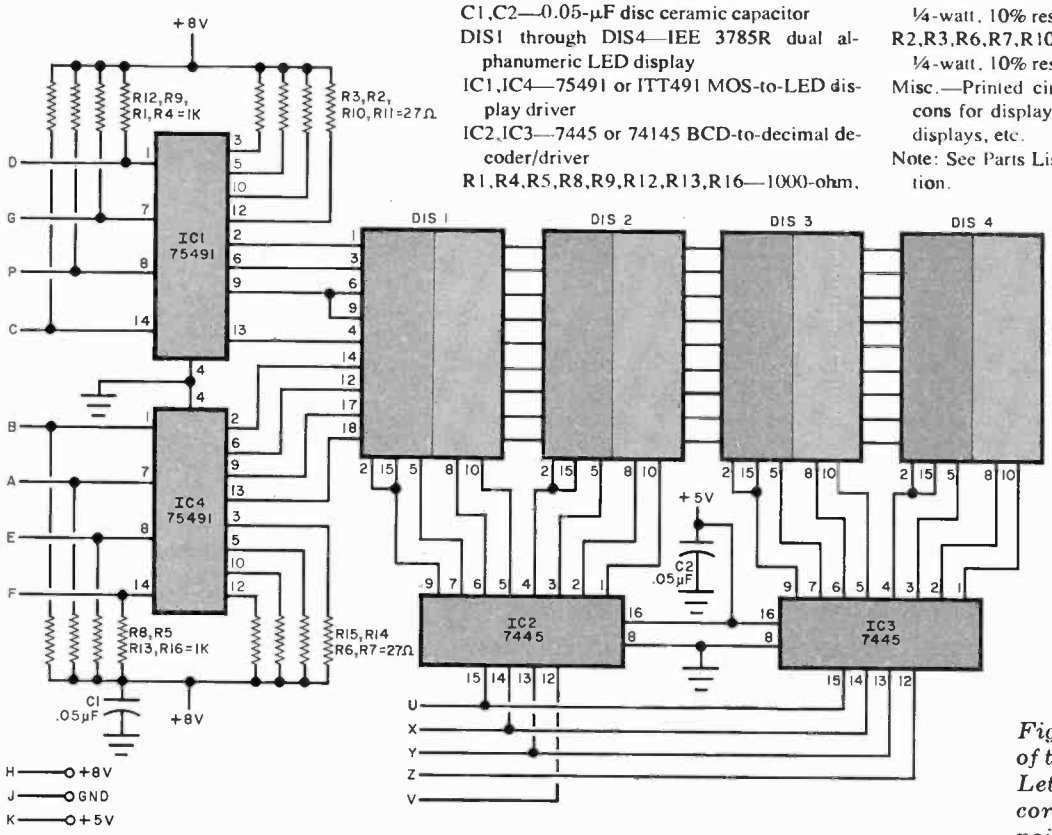


Fig. 4. Schematic diagram of the display circuit. Letters on incoming lines correspond to similar points in Fig. 3.

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Scientific or engineering training is a legal as well as practical requirement for patent practitioners in obtaining effective patent protection. Although not widely known, engineers and physical scientists need not go to law school to be licensed and to practice as Patent Agents. The U.S. Supreme Court has held that, in representing client-inventors before the U.S. Patent Office, Patent Agents may practice patent law in any state of the United States. Virtually all the work done in obtaining a patent is in writing and by mail.

To become a Patent Agent, you must pass the one-day, six-hour examination in patent law given by the U. S. Patent Office. Currently the examination is given by the Civil Service once a year, in October, in federal buildings in all major cities of the United States. Even technically trained *lawyers* are required to pass this examination in order to practice before the U. S. Patent Office. In such practice, Patent Agents and patent lawyers are the legal equivalents of each other and do *exactly the same work.*

Any U.S. resident with a degree in any field of engineering, chemistry, physics or applied science may apply to take the Patent Agent's Examination. Write to Clerk of the Committee on Enrollment, U.S. Patent and Trademark Office, Washington, D.C. 20231, for Examination application forms or for the Patent Office document "General Requirements for Admission to the Examination for Registration".

Demand for competent patent practitioners is at an historic high and the relative supply at an all time low (mainly because engineers and physical scientists are simply not aware of their eligibility). The director of the General Motors Patent Department observed recently:

> Are we doomed to a chronic shortage of capable persons to prepare patent applications? Do we face a time when the patent system will be made ineffective . . . by the sheer impossibility of getting sufficient manpower to do the basic task of preparing applications? I shall not attempt to make predictions — but the questions are not idle and they do warrant thought.

Corporations and patent law firms employ and are constantly seeking Patent Agents. New York has ruled that Patent Agents may be listed as such in the letterheads of law firms. Moreover, establishing a patent practice on your own has a higher probability of success than ever before. The Supreme Court of the United States held recently that lawyers may advertise the nature of their services and fees. Patent Agents are subject to the same rules as lawyers. Since that Supreme Court decision, a place in the sun is possible for the capable but less well known professional. But, how can you become trained in patent law?

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PATENT PREPARATION & PROSECUTION PRACTICE (at the price of $450) is the ultimate for learning to be a patent practitioner. It distills 26 years of practice and 15 years of teaching by Dr. Irving Kayton, Professor of Law and Director of the Patent Law Program at The George Washington University in Washington, D.C. Professor Kayton spent eight years designing the Treatise and two years editing and co-authoring it with six coauthors. His coauthors are partners in leading patent law firms throughout the United States. Professor Kayton and his coauthors prepare annual or biennial replacement-sheet supplements to the Treatise, as new developments occur in patent law and practice. The supplements will be available for purchase at a reasonable price by Treatise owners. With such supplements, the Treatise may be maintained as a daily working guide and reference for a lifetime of use.

Professor Kayton is the only full-time professor of patent law in the United States. He has trained or taught more than 2,000 of the approximately 8,000 active patent practitioners in the United States. The Treatise is what he uses to teach both lawyers and engineers to become patent practitioners. Neither it nor anything like it is available anywhere else. Assiduous, step-by-step study of the Treatise can give mastery of its contents to anyone intelligent enough to have earned a degree in engineering or one of the physical sciences. **Mastery of its contents guarantees passing the Patent Agent's examination.** Many hundreds of people have done so.

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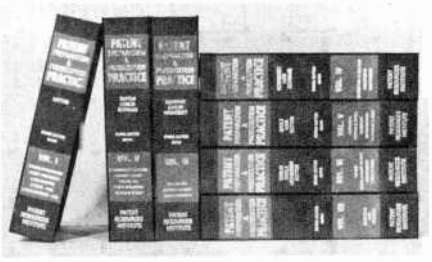

the subject. Use of the text and questions and answers will enable you to judge the effectiveness (and readability) of the Treatise as a teaching device and also your aptitude for this profession.

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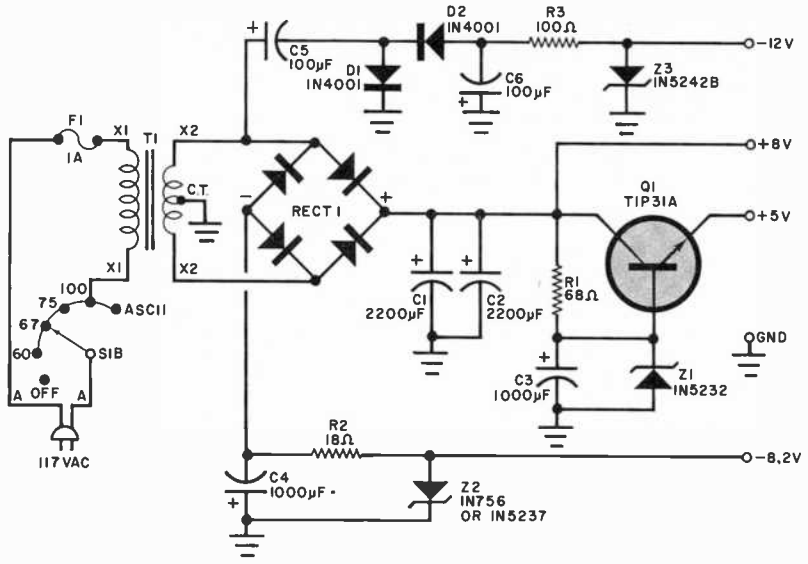

Fig. 5. Schematic diagram of a power supply that can furnish all voltages required by the RTTY Reader.

PARTS LIST (Fig. 5)

C1,C2—2200-μF, 16-volt upright electrolytic
C3—1000-μF, 10-volt upright electrolytic
C4—1000-μF, 16-volt upright electrolytic
C5,C6—100-μF, 25-volt upright electrolytic
D1,D2—1N4001 diode
F1—1-ampere, fast-blow fuse
Q1—TIP31A npn transistor
R1—68-ohm, ½-watt, 10% resistor
R2—18-ohm, ½-watt, 10% resistor
R3—100-ohm, ½-watt, 10% resistor
RECT1—1-ampere, 50-PIV modular bridge rectifier
T1—12.6-volt, 2-ampere, center-tapped transformer (Stancor P8130 or similar)
Misc.—Printed circuit board, pc-mount heat sink for Q1, fuse-holder clips, line cord and strain relief, hookup wire, machine hardware, etc.
Note: See Parts List for Fig. 3 for kit information.

NORMAL/INVERT switch located at the output of the slicer which accomplishes this inversion independently of the communications receiver.

The output of the slicer is applied to a UART (Universal Asynchronous Receiver/Transmitter). This chip accepts serial data from the slicer and converts it to parallel form. The speed at which the UART operates is governed by a baud-rate clock, whose frequency of oscillation is governed by a rotary switch. This switch has positions for 60-, 67-, 75- and 100-wpm Baudot and 110-baud ASCII. The UART device can handle five- or eight-bit serial data with equal facility, so switching between Baudot code and ASCII is a simple matter.

Parallel data generated by the UART is converted into a special 8-bit code for display purposes. This code is continuously sampled and deposited in an eight-character random-access memory. (The code comprises 64 characters for the Baudot code and 64 characters for ASCII.) As more data is received and converted into this special code, the code characters deposited in the RAM are read out and applied to a programmable read-only memory. The PROM converts the coded characters into a form compatible with the eight-character moving display.

About the Circuit. The main RTTY Reader circuit is shown schematically in Fig. 3. Audio signals are applied to jack *J1* or *J2* and routed to an active limiter composed of op amp *IC4* and its associated components. Amplitude-limited signals from *IC4* are applied to the inputs of four active bandpass filters. These filters are designed around op amps *IC9* and *IC10*. Active filter *IC9A* is tuned to the mark frequency, 2125 Hz. Filters *IC9B*, *IC10A*, and *IC10B* are tuned to the space frequencies of 2295, 2575, and 2975 Hz, respectively. Tuning indicators *LED1* and *LED2* are controlled by transistors *Q1* and *Q2*, respectively. These transistors receive base drive from the outputs of the mark filter and the selected space filter. They cause the LEDs to glow when the active filters are passing mark and space signals, providing a visual indication of proper RTTY reception.

The filter output signals are also applied to diode bridges *D4* through *D7* and *D8* through *D11*, which rectify them. Rectified signals are applied to low-pass filter *R6C6* via *IC6B*. Open-loop op amp *IC6A* converts the filtered dc levels into TTL-compatible signals for processing by the rest of the RTTY Reader circuit. A logic 0 at the output of *IC6A* corresponds to the reception of a mark frequency, a logic 1 to the reception of the appropriate space frequency.

Logic levels generated by *IC6A* are inverted by *IC3F*. If switch *S3* is in its NORMAL position, the output of *IC3F* is routed directly to UART *IC1*. If the switch is placed in its INVERTED position, the output of *IC3F* is inverted by *IC3E*, which in turn supplies serial data to the UART.

The UART converts the serial data presented to its input into five- or eight-level parallel form. Its operation is governed by baud clock *IC14*, a 555 timer functioning as an astable multivibrator. The frequency of oscillation of the 555 is determined by the setting of *S1*.

ASCII code is loaded directly into the RAM composed of *IC11* and *IC12*. Baudot code is processed by the logic network *IC5IC8* to detect letters/figures shifts. Pushbutton switch *S4* allows the user to manually reset the network back into its letters mode. An additional bit (at pin 10 of RAM *IC11*) is added to the data loaded into the RAM to create the special code that PROM *IC17* recognizes. The PROM, its associated address counters *IC13* and *IC16*, and display oscillator *IC3D* provide the necessary signals for the multiplexed LED display.

The display circuit is shown schematically in Fig. 4. Four dual-character, 14-segment IEE 3785R LED readouts are employed to display eight alphanumeric characters at a time. The displays are driven by *IC1* through *IC4*. This circuit has been designed to provide a moving-character type of display which introduces new characters at the rightmost position and moves each of the existing characters to the left, one position at a time, as additional characters are received.

Power requirements for the RTTY Reader are 750 mA at +5 volts, 100 mA at +8 volts, 20 mA at −8.2 volts, and 10 mA at −12 volts. The supply shown schematically in Fig. 5 satisfies these requirements. Only the +8-volt output, which feeds the displays, is not regulated. ◇

Part Two of this article, which will appear next month, describes how to assemble, align, and use the project. Programming instructions for IC17 will be included.

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5600A-W	$179.95									
3550	99.95	50Hz-550MHz	TCXO 1 PPM 17°-40°C	25MV	25MV	75MV	8	.5 Inch	*115 VAC or 8.2-14.5 VDC	2⅛" x 8" x 5"
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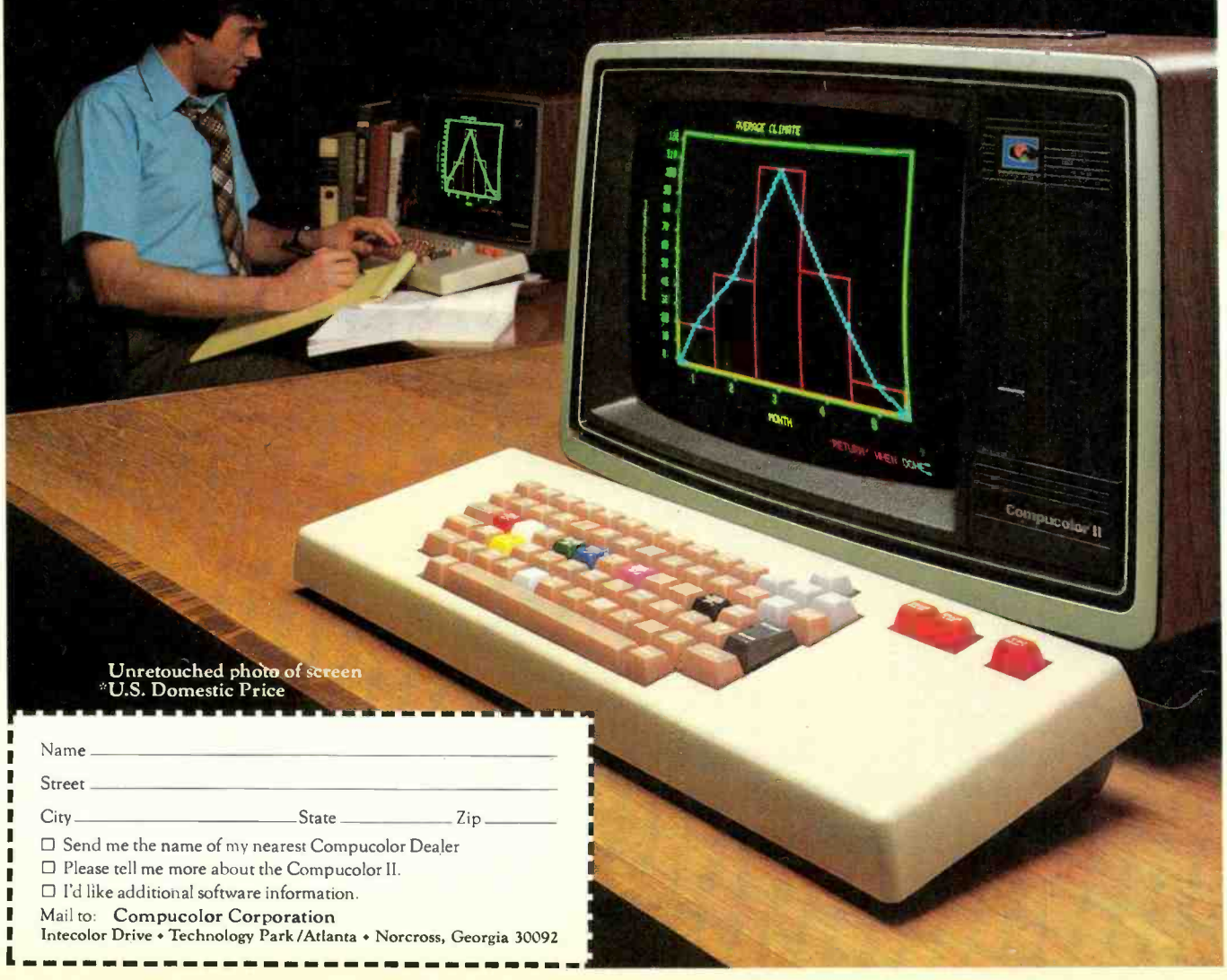

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FOCUS ON MICROCOMPUTERS

Computers for use in very small businesses, and many of the so-called "personal" computers are often one and the same. Interestingly enough, this was the case from "Day One" when POPULAR ELECTRONICS *introduced the Altair 8800 computer in January 1975. At that time, data from the Altair kit supplier made it clear that some 60% of the kits purchased were for business use.*

This wasn't surprising since PE readers include many people associated with business in managerial capacities, and numerous small business owners (physicians, lawyers, etc.). Indeed the 1979 version of the PE Market Study reveals that some 33% of its almost half a million subscribers still use microcomputers for business only. An additional 31% use them in a combination of business and personal applications, and about 35% for personal applications only.

Choosing a Computer for a Very Small Business

BY JOHN ZITZ *

THE US GOVERNMENT identifies a *small* business as one that employs up to 250 people and has an annual gross income of up to $5-million. However, small businesses that can use computers to advantage may be much smaller than that, ranging down to a single user in a part-time business operation. These types of operations are often called "very small businesses."

System cost, naturally, plays an important role. An enterprise grossing $50,000 yearly cannot afford a $20,000 computer or its equivalent in time-sharing systems. Like any capital investment, a data-processing system should be justified by the return it can be expected to produce. Experience has shown that a single computer and its operator can do the work of several people, either saving the cost of some salaries and benefits or freeing personnel for other tasks. In some cases, the computer will have enough extra data-handling capacity to allow the business to expand with little or nothing in the way of increased computing costs.

Perhaps more important, the computer is very fast and can keep the businessperson informed about the status of affairs today, not the way they were last week. Further, since the computer eliminates many hours of manual clerical work and can deliver its output in a compact precise form that obviates a good deal of "paper shuffling," it can create more time for the research, decision making, and creativity that are the real essence of an entrepreneur's function.

Besides its obvious functions in accounting, inventory and production control, and the like, a computer can also—with the right software—handle secretarial functions such as appointment planning. Mailing lists, telephone files, library catalogs, and similar collections of data can be created, alphabetized, updated, and printed as desired. With the addition of a text-editing program a computer can process correspondence. Form letters, for example, can be written, recalled, and personalized with great facility.

Requiring no rest or sleep and only occasional maintenance, a computer can be used 24 hours a day; even when the business is closed. Both hardware and software are available to let the computer "watch over" sensitive systems such as refrigerators, air conditioners, water pumps, etc. It can also sense intrusion, fire, smoke and other emergency conditions and perform some predetermined function when an alarm is activated. Communication with the computer at any time is a possibility, even from remote points across the country using a telephone attachment called a modem. This means that salesmen can communicate orders, or get product information over the phone line when they desire. Businessmen who generate new

*PCE Microcomputer Systems, Sacramento, CA.

ideas at night can, via a terminal and modem at home, put these into effect or at least record them while they are fresh. It is even possible to run an enterprise by "remote control."

The System. Just as vehicles, regardless of their make or model, are pretty much the same under their metal skins, computers are too. The former have engines, suspensions, transmissions, etc., as main working parts while the latter have memory, central processor units, input/output modules, interfaces, etc.

Vehicles can be optimized for business or pleasure depending on the options selected, and the same is true of computers. For business use, you need a machine that has enough computing power and enough options to handle both your present and anticipated future requirements. This is why it always pays to take a look at *all* the options for a particular computer, since as your business grows, you may require functions not needed at the present.

A few years ago, computer enthusiasts who wanted to use a "hobby-type" computer for business would explore what microprocessor was being used, what type of bus was offered, and so on. The growth of the moderately priced computer market has changed all that. Consequently, software is *the single overriding consideration* in buying a business-oriented computer today.

For most applications, the "computer" will be a keyboard, video display and printer, all attached to a small enclosure in which the actual data manipulations are performed. There may also be another enclosure containing the disk storage system. Sometimes a keyboard and printer or video display are combined in a single unit called a terminal. This can be located near or remote from the computer.

To enable the computer to be used by personnel trained in normal secretarial skills, the keyboard should have a conventional typewriter format, with comfortably spaced and easy-to-the-touch keys. If a lot of numeric entries are to be made, a separate keypad is a definite convenience.

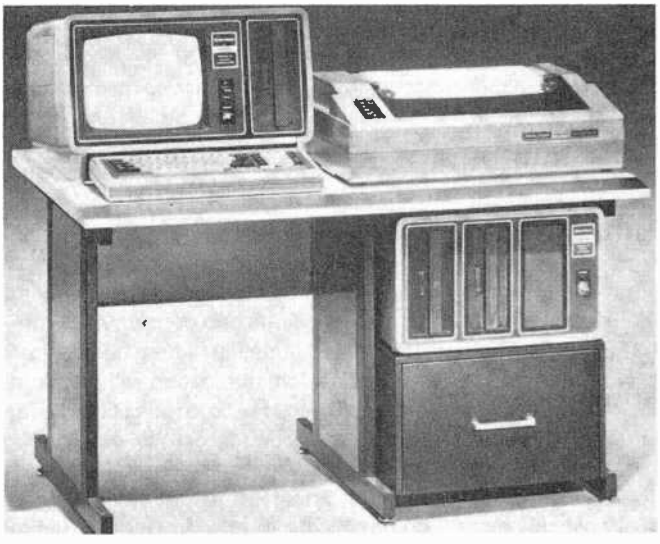
Quality of the video display is also important as it will determine the extent of eyestrain (which may result in possible entry or reading errors) if the display is used for extended periods. The usable screen should measure at least 12" diagonally and have a contrast that is comfortable to the eyes. The characters should be sharp, and free from glare. They should be crisp from edge to edge across and from the top to the bottom of the screen, and should exhibit very little nonlinearity. Dual-brightness or inverted (black-on-white instead of white-on-black) characters are useful for special attention-getting displays, as is the capability of rendering color. The system should display at least 80 characters on 24 lines for business applications. Many small computers project only 16 lines of 64 characters per line—somewhat limiting for ledger and similar entries.

The printer, or hard-copy device, should be selected for its type face, speed, and noise level (some are quieter than others). It should be of sturdy construction and have adjustable columns for different width paper. The paper should be tractor or pin fed from the carriage to keep the paper secure in its place and free from misalignment—a necessity for automatic printing of checks and for keeping columns in proper vertical order.

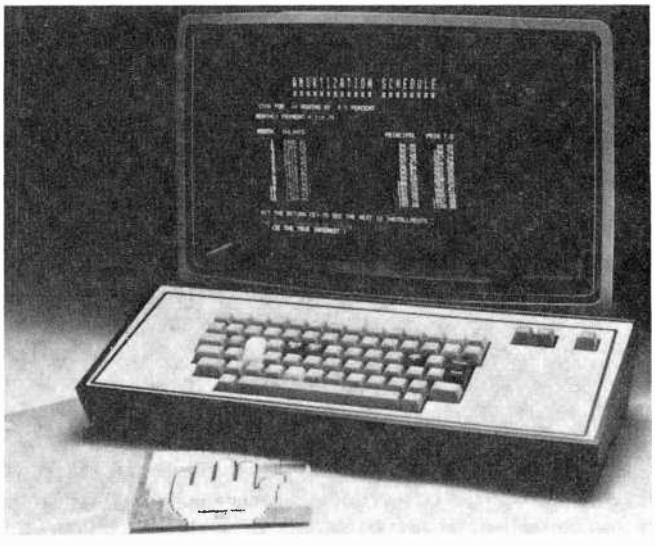
Printer prices increase directly with the speed and quality of the print, and it is up to the purchaser to determine just what he wants. The need for upper- and lower-case characters and for multiple copies is a consideration, too.

The disk system is also determined by the amount of data you expect to store. Obviously, the larger the disk system, the more data can be stored. Keep Parkinson's Law in mind—data expands to fill the available disks. Small (so-called 5" disks) can hold up to 90K bytes of data (enough for several hundred inventory entries), while the so-called 8" disk can support up to 240K bytes of data. There are dual disk systems that increase data storage in one package, and there are dual- and quad-density and double-sided disk systems that maintain package size but greatly increase storage capacity. If your business is large enough, it may even pay you to take a look at the more expensive hard disk systems that can hold many millions of bytes of data. If at all possible, a business person should have at least a dual-disk system since it pays to make a backup copy of a completed disk for emergency use.

Since the most important consideration is software, it pays to make certain that the computer system you choose has a good selection available for it.



Radio Shack TRS-80 Model II Microcomputer with Line Printer III, External Disk System.



Compucolor II Model 3 Computer with color video display.

While, in some cases, special "emulator" programs that allow one machine to mimic another for which a desired item of software is available, this approach lowers the effective operating speed of the processor to a mere fraction of normal. Clearly, a modest (less costly) installation humming along with efficient software is preferable to a fancy one that limps because its software pinches. If it would be beneficial for your purposes to use COBOL or FORTRAN instead of BASIC, be sure your system is compatible with these languages.

Cost And Operation. The cost of a computer system is not just what the store charges you to take the package home. Maintenance and later expansion, for example, are obvious sources of additional cost. The great nemesis of all system planning is changing needs. A system that can be altered to suit all contingencies will cost more than one that is specialized, but it may be worth the difference in the long run. The choice between the two depends on the nature of your business. We will try to develop here rational guidelines that, taking the special nature of computers into account, will help to minimize costs.

"Off the Shelf" or "Custom". One attractive and low-cost approach is to buy standard hardware and software packages. If your application is commonplace, you may be able to purchase application programs that have already been written and field-tested. Packages exist for inventory applications, payroll, general ledger, accounts/payable and receivable, etc. With good knowledge of your business requirements, you could purchase a system that is optimized for the packages you need, while allowing for system integration, and expansion.

To have custom software written specifically to your needs by a reputable analyst and then have a hardware system implemented around that software, is another possible alternative. The pitfall is that the exclusivity of your system may inhibit changes in the future should they become necessary.

A middle path between these two extremes is to purchase a system that is mostly "off the shelf" and make minor adjustments as necessary. Many private vendors will have the resources to make these modifications if they are not too extensive and may even include them in the overall price of the system. In any case, all software and hardware modification should be in the hands of reliable consultants. A largely "off the shelf" system with canned software included in its price would range from about $4,000 to $8,000, depending on the peripherals put into the final system.

One difference between a "business computer system" and a "computer system that means business" is in the planning done in anticipation of breakdown and further expansion. The usual vendor warranties are enough to absorb the cost of initial problems until the system is finally "up and running." The reliability of the electronic technology that goes into computers is such that a business computer under normal use should not encounter a debilitating breakdown in well over a year of use. Even then, the most common breakdowns in a microsystem are not electrical but mechanical. Switches, motors, drivers actuator arms, and wheels fail far more often than electronic components.

Superficially attractive as all-in-one computers are, they are not for business. When a single functional part of an all-in-one computer fails, the whole machine goes down and, in many cases, must be sent to the factory for repair. The independent modular approach allows the offending module to be removed and repaired, often while a temporary replacement is substituted. This keeps the system reliability high despite the failure of individual modules. In the case of duplicate systems in one installation, modules can be temporarily "swapped" until replacements arrive.

External Problems. One of the hidden causes of computer component failure is noise transients and voltage spikes from electrical equipment such as motors, tools, etc., that are passed to the computer via the power lines. Not only can such "hash" and power-line surges damage components, they can also interfere with computer operation. It is essential that a well-engineered computer system have hash and power surge suppression built into its power supply. This can eliminate considerable hidden cost in operation.

Options. Another interesting power-supply option protects your computer against momentary power-line "blackouts". The capacitors in a good heavy-duty power supply can maintain their

Commodore PET 2001 Series Professional Computer.

Exidy Inc. Sorcerer Computer with dual-disk drive and video display.

charge for about a fifth of a second after the mains go down. This is time to kick in a back-up power supply without losing data or causing the system to "crash". An uninterruptable power supply can be added to a system fairly inexpensively and may, once in a while, save the day.

What About Protecting the Data? Computer failure can wipe out valuable data. However, if one takes the normal precautions of keeping backup disks and tapes, the likelihood of a serious setback is reduced. Cassette tapes and recorders are relatively cheap compared to disks and disk drives and are a cost-effective means of data protection. The high access speed of the disk is not a factor when all you are looking for is long-term archival storage. A small routine for transferring the data stored on a disk to a cassette is not difficult to implement and might even be part of the DOS (Disk Operating System) provided with the computer.

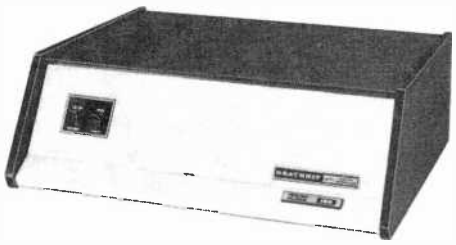
Security. Principally, this involves protecting the data physically from theft, destruction or tampering. Such protection is not difficult to implement if the entire system is in your premises, where access to it can be controlled. But what if data must be transmitted by telephone, other hard-wire lines, or mail?

Hardware and software for encrypting data have just begun to appear on the market and will probably be included in total systems in the near future. For example, special chips which can encode data at high speeds, could be incorporated as part of the input-output interfacing of a data-transmission module. Here is another instance in which the modular approach to the computer design facilitates expansion of an existing system.

When To Buy. Is there a "right time" to buy a computer? Should the small business lease a computer, timeshare on a larger computer, or buy one outright? In the past, the high cost of computers and their relative inaccessibility made timesharing at a cost of several hundred dollars per month seem attractive. The low cost of microcomputers today has made this a more dubious proposition. The cost of the timeshare terminal alone is approximately 25% the cost of a microcomputer-based business system. Add to this the monthly cost of computer services and telephone line hookups and the total over a year rapidly approaches the cost of an entire small computer system. And of course, there is no equity.

Timesharing should only be considered when access to a large, computationally powerful computer is needed, as might be the case in engineering or scientific applications or those that generate volumes of statistical analyses. For the standard small-business-scale applications, even where sizable inventory accounting is involved, eight-bit microprocessing is the most cost-effective way to go. In short, for most very small businesses, don't borrow, don't lease—buy! And if you feel that your business is ready for the system, now is the moment of decision. ◇

Vector Business System—MZ Computer with dual floppy drive, MT Terminal, and Centronics 702 Printer.



Heathkit H11A 16-bit Computer has provisions for business peripherals.

Apple II Color-graphics Computer.

Ohio Scientific C8P DF System—Challenger 8P Computer, dual-disk drive, terminal, monitor, peripheral control devices.

Personal Computers

BY IVAN BERGER

IF YOU WANT a personal computer for nonbusiness purposes, there is a host of different types available to you. Which one you choose will largely depend on your intended applications and the money you wish to spend.

Is your main interest in learning about computer circuits as well as programming? If so, you might consider building a computer kit. Here one's choice could be between an expandable building-block type or a full-blown computer or even a complete system contained in one package.

Do you essentially want to make a few plug-in connections, apply ac power, and start right off making things happen? Then you can choose from assembled versions of some of the foregoing or an "appliance" computer. You might also be guided by which computers are popular in local computer clubs or which give you the most flexibility in choosing peripherals, buying or exchanging software, etc. Computer choices range from low-cost single-board systems, to all-in-one intelligent terminals, to micro mainframes plus many peripherals.

Microcomputers are used for a wide variety of purposes; for program development and teaching oneself to program; for small mass mailings; for education in noncomputer subjects; to handle home data such as recipes, Christmas-card lists and the checkbook; to control appliances; to play games; for computer-generated music or speech; for mathematical computation; for word processing to develop cleanly-typed reports, papers, letters, etc.; and for some business applications.

The more such applications you have, the more sense computers (basically all-purpose devices) make. For some single applications, in fact, alternatives to the computer make more sense. If all you want is to play games, for instance, get a programmable video game, and have done with it. The game will probably cost less, and put more interesting, cartoon-like graphics on your TV screen.

Similarly, if all you need to do is complex calculation, consider a programmable calculator. Again, the cost will be less—and you'll be able to carry the calculator with you at all times.

But calculators can play only limited games, and TV games have only limited calculating ability, if any (not counting the small but growing number of games that can be converted into full-fledged computers). If you're interested in both these applications at once—or in any of the others so far mentioned—you'll need a full-fledged computer.

But which one? All computers have some similarities: They all have some sort of *input* device to enter programs and data, some sort of *output* device to verify the input data and show what results the computer comes up with when the program runs. They all have *processors*, the chips that do the actual computing; and *memory* to hold programs and data while they're being used. But the types of input, output and processor differ, as do the amount of memory and the number of accessories or *peripherals* which can be used with the system.

Input and Output. The most visible differences between computer systems are usually in their input and output (I/O, for short) facilities. These are the channels of communications between the computer and you. The computer and you speak very different languages, and one measure of I/O sophistication is how cleverly the system can disguise that fact.

In its most primitive (and, today, rarest) form, the system will communicate in *binary*, a numbering system based on twos. A completely binary I/O system would have a row of eight switches to input each 8-bit computer command or data "word" and eight lights per "word" for output.

More commonly, the system will translate such binary numbers as "11000000" into either an octal (base-8) number such as "300" or a hexidecimal (base-16) number such as "CO." (Since hex numbering requires more digits than our base-10 decimal system, it follows the digits 0-9 with the letters A-F.) Many low-priced, single-board computers have calculator-like keypads and displays for use with either octal or hex input and output.

But octal and hex are only more sophisticated ways of talking *machine language*, the instructions that computers understand directly. Machine-language programs run very quickly, and don't use much memory. But they're cumbersome to write since you must not only learn at least a hundred or so instructions and how to use them, but must learn them as abstract numbers like "CD" or "305".

Consequently, keypad-and-display computers are only useful, as is, for writing very short programs, especially programs designed to interact with other devices rather than with people. Control applications are often a perfect match for these computers. Here, the limitations of keypad programming aren't serious, and the computers are small and cheap enough to be assigned to specific devices, or sometimes the computers are even built into the devices.

But most such computers also have *ports* for communicating with other I/O devices. Connect one to a *terminal*, which combines a full typewriter-like keyboard with a video display screen or a printer, and you can work with other programming languages which use the entire alphabet and other symbols.

With the keyboard's full set of characters at your command, you can program in assembly or high-level languages. *Assembly* language is just a word-for-word translation of machine language from abstract numbers into more easily-memorized abbreviations. In 8080 assembler, for example, the instruction "return if not zero" is "RNZ". In machine language, it would be either "CO" (hex), "300" (octal) or "11000000" (binary). A program called an *assembler* translates the mnemonic abbreviations into machine code, as well as performing such useful tricks as letting you call subroutines (frequently-invoked subprograms) by name, instead of remembering their memory addresses.

But that's still doing things the computer's way, not yours. *High-level languages*, such as BASIC or PASCAL, use standard English words (though sometimes in abbreviated form) to represent whole sequences of computer operations. In BASIC, for example, "PRINT SQR(SIN(Y))" will make the computer tell you what the square root of the sine of Y is. An assembly-language program for that would probably fill up this column.

Just as with assembly language, a special program is needed to translate your BASIC or other high-level language program into the computer's commands. That program can be read into the computer from a tape, or can be permanently built into the computer's memory. If you use BASIC a lot, it is a great convenience to have it instantly on tap whenever you turn the computer on. If you don't, this feature won't make much difference to you.

The typewriter keyboard and video screen are the most common microcomputer I/O devices, but there are variations and alternatives available. Many of these systems let you not only display letters and numbers (*alphanumerics*) on the screen, but "draw" pictures (*graphics*) on the screen as well. The pictures are often rather crude, being composed of clearly-noticeable blocks, but they're useful for such applications as games, graphing mathematical functions, and in business for bar-graph and other displays that are easier to understand than tables of numbers. Color makes the games more exciting and the bar-graphs more readable. This raises the cost of the computer, naturally, but may well be worth it for your uses.

Graphics programs written in BASIC run very slowly; for speed, you'll have to use assembly-language programs. Bear that in mind if you plan to write your own graphics. If you want fast graphics at low cost, you'll find a few graphics-capable machines with hex keypad input for machine-language programming.

Even alphanumeric video displays differ. Some computers have built-in video monitor screens. Others are usually sold with a video screen in a separate cabinet. Still others include video output circuits to feed signals to a video monitor screen. To feed it to a regular TV receiver, though, you'll have to convert that signal to a modulated radio-frequency one by passing it either through an *r-f modulator* or through a video-cassette recorder, if you have one. Not all computer/recorder combinations work well, though; nor do all r-f modulators (the latter cannot be legally sold separately unless it's in kit form.) Try to check out your combination in the store or on a money-back guarantee. Computers with built-in r-f modulators are beginning to appear, too. This feature makes more sense in home systems, where there's likely to be a TV receiver available, than in a business or industrial system.

There are also differences in how much information you can put on the video screen. Alphanumeric displays are available with 16 lines of 64 characters each, or less, and with 25 lines of 80

Start Computing For Just $129.95 With An 8085-Based Professional Computer Kit—

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Level "A" Specifications

Explorer/85's Level "A" system features the advanced Intel 8085 cpu, an 8355 ROM with 2k deluxe monitor/operating system, and an 8155 ROM-I/O—all on a single motherboard with room for RAM/ROM/PROM/EPROM and S-100 expansion, *plus* generous prototyping space.

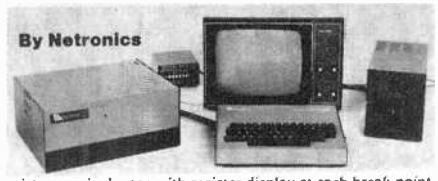
(Level "A" makes a perfect OEM controller for industrial applications and is available in a special Hex Version which can be programmed using the Netronics Hex Keypad/Display.)

Level "A" at $129.95 is a complete operating system, perfect for beginners, hobbiests, or industrial controller use.

PC Board: glass epoxy, plated through holes with solder mask • **I/O:** provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader ...provision for 24-pin DIP socket for hex keyboard/display...cassette tape recorder input...cassette tape recorder output...cassette tape control output...speaker output... LED output indicator on SOD (serial output) line...printer interface (less drivers)...total of four 8-bit plus one 6-bit I/O ports • **Crystal Frequency:** 6.144 MHz • **Control Switches:** reset and user (RST 7.5) interrupt...additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard • **Counter/Timer:** programmable, 14-bit binary • **System RAM:** 256 bytes located at F8ØØ, ideal for smaller systems and for use as an isolated stack area in expanded systems...RAM expandable to 64k via S-100 bus or 4K on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F*ØØØ* leaving *ØØØØ* free for user RAM/ROM. Features include tape load with labeling ...tape dump with labeling...examine/change contents of memory ...insert data...warm start...examine and change all registers...single step with register display at each break point, a debugging/training feature...go to execution address... move blocks of memory from one location to another...fill blocks of memory with a constant...display blocks of memory ...automatic baud rate selection...variable display line length control (1-255 characters/line)...channelized I/O monitor routine with 8-bit parallel output for high speed printer... serial console in and console out channel so that monitor can communicate with I/O ports.

System Monitor (Hex Version): Tape load with labeling... tape dump with labeling...examine/change contents of memory...insert data...warm start...examine and change all registers...single step with register display at each break point ...go to execution address. Level "A" in the *Hex Version* makes a perfect controller for industrial applications and can be programmed using the Netronics Hex Keypad/Display.



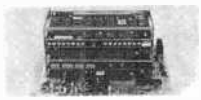
Hex Keypad/Display.

Hex Keypad/Display Specifications

Calculator type keypad with 24 system defined and 16 user defined keys. 6 digit calculator type display which displays full address plus data as well as register and status information.

Level "B" Specifications

Level "B" provides the S-100 signals plus buffers/drivers to support up to six S-100 bus boards and includes: address decoding for onboard 4k RAM expansion select-able in 4k blocks...address decoding for onboard 8k EPROM expansion selectable in 8k blocks...address and data bus drivers for onboard expansion...wait state generator (jumper selectable), to allow the use of slower memories...two separate 5 volt regulators.



Explorer/85 with Level "C" card cage.

Level "C" Specifications

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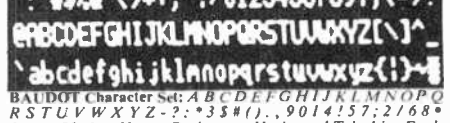

BAUDOT Character Set: *A B C D E F G H I J K L M N O P Q R S T U V W X Y Z - ? : • 3 $ # ( ) . , 9 0 1 4 ! 5 7 ; 2 / 6 8* • **Cursor Modes:** *Home, Backspace, Horizontal Tab, Line Feed, Vertical Tab, Carriage Return. Two special cursor sequences are provided for absolute and relative X-Y cursor addressing* • **Cursor Control:** *Erase, End of Line, Erase of Screen, Form Feed, Delete* • **Monitor Operation:** *50 or 60Hz (jumper selectable.*

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characters, or more. Similarly, graphics displays differ in the number of vertical and horizontal elements they can show—the amount of picture detail, in other words. The more information you can pack on one screen, the more you can take in at one glance. But more detailed displays cost more, and require higher-resolution monitors. As a result, high-density displays often cannot be used with r-f modulators and regular television receivers.

Keyboards are more standardized. The basic differences are in keyboard "feel" (more likely to matter to an operator who already knows touch typing than to a hunt-and-peck operator) and in the presence or absence of separate numeric keypads. These keypads are very worthwhile in applications involving large amounts of numerical entries, such as in business accounting or in scientific computation. It's far quicker to punch numbers into a calculator-like nest of keys in a compact bunch than to use a row of number keys spread out across the top of the keyboard.

That's fine for most applications, but not for word processing.

Word processing systems are mostly used for business, where it costs lots of money to turn roughly-typed or written drafts into smoothly-typed letters and reports. On a typical word-processing system, the operator can enter text, make corrections of all kinds, then command the computer to print out a perfectly-typed, finished copy. If it's a form letter, the computer can turn out a separate copy for each name and address on its list. Such systems are being adopted by offices, by free-lance writers and others.

Most small computers communicate with you through video screens. For most applications, this makes perfect sense: video systems are fast, silent, reliable, and don't use up paper.

But there are times when it definitely pays to have a permanent record of the computer's output. Word processing is an obvious example, but so are accounting (including your personal checkbook), alphabetizing of lists, or even for making written records of your programs that you can send to friends or carry with you while you look for problems and improvements. Properly programmed, a computer could print out your shopping list in the order in which the items appear on your supermarket's shelves.

In the early days of small computers, Teletype® printing terminals were the most common I/O devices. Today, video screens—on terminals or connected directly to the computer—are. But most systems do allow separate printers to be added to the system. If this is important to you, check how easily the printer can be added to any system you're considering, and how much the printer and its connections will cost.

Inside the Computer. It's no accident that we've been talking only about externals so far. For the input-output communication channels between you and the computer have far more to do with its utility than the circuits inside.

The most important of these circuits is probably *memory*. You'll find computers here with as few as 256 "bytes" of memory, each *byte* being an 8-bit computer "word" that can represent a single alphanumeric symbol or a single computer command. You'll also find that several are expandable to as many as 65,536 bytes, variously abbreviated as either "64K" or "65K".

Most systems, though, fall into the 2K to 32K range. Memory costs money, so the more you have, the more the system costs. But the more memory you have, the longer the programs you can store, and the more data you can have available for them to work on.

There are two types of memory: RAM and ROM. *RAM* (Random-Access Memory) is used for temporary storage of programs and data and for the results of program runs. The contents of RAM can be changed at will, and many of them change constantly during the running of a program. But those contents also fade out within seconds when the power is turned off.

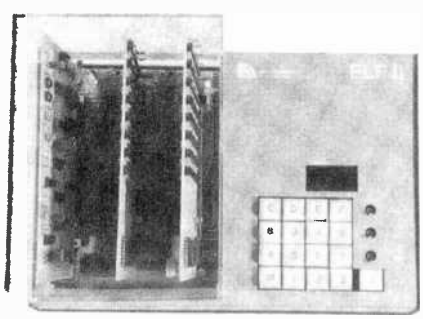
That's where *ROM* comes in. ROM (Read-Only Memory) doesn't forget—but you can't readily change it, either. Hence, ROM is used to hold vital programs which you'll use all the time, such as those which instruct the computer how to accept input from the keyboard. Some computers have BASIC in ROM, too—on others, you have to load in the BASIC language program from a tape each time you use it.

Most computers have more RAM than ROM. Typically, a system will wind up having about 2K of ROM (about 8K or 10K with BASIC in ROM) and 16K or more of RAM (less, if BASIC is in ROM, since that frees the RAM space that BASIC would otherwise occupy). They may start with less, but sooner or later, more memory is added.

Some inexpensive systems, usually the single-board, keypad-and-display type, have very limited RAM space on board (perhaps 1K or 2K). Most of these allow other boards to be connected with more RAM. But unless your application is a simple one using machine-language or assembly-language programs (device control, for example), be sure any system you buy can be expanded to include enough memory for all your needs. There's no hard-and-fast rule about how much is enough, except that many systems seem never to have enough memory—you can always use more.

Mass Storage. Programs, other than those in ROM, must be fed into the computer every time you turn the system on or switch from one program to another. Entering them each time from the keyboard or keypad is ridiculously time-consuming, and almost inevitably leads to

COMPUTER KIT EXAMPLES



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errors. So it's vital to have some easy, fool-proof way to save programs and re-enter them.

The use of punched paper tape has virtually died out, since it's a slow and noisy procedure. Most small computer systems standardize instead on cassette tape, either built in or as an accessory program storage device. Most such systems convert programs and data into tones which can be recorded on ordinary audio cassette recorders, but a few record digital pulses, not audio tones, which requires a special recorder. Cassettes, especially audio cassette systems, are fairly slow (they require several minutes to load BASIC, for example). But they're faster than paper tape, use tape you can buy almost anywhere, and usually make extra use of a cassette recorder you already own. Cassette programs are not always interchangeable between different computer makes, though a few cassette formats (chiefly Tarbell and Kansas City) available as accessories for many computers, have achieved fairly wide use.

A very few personal computers also have "canned" programs in ROM memory cartridges that look like 8-track audio cartridges. They cannot be used interchangeably with different brands of computers, though.

If you need reliable loading (cassettes sometimes have to be loaded several times before you get them right) quicker loading, and faster access to a wide variety of programs and data, then it's time to consider *floppy disks*. Floppies are basically magnetic recording tape cut into disks instead of ribbons. They use digital recording, and are very fast—BASIC or other long programs typically load in seconds. They also speed up access to programs and data. Getting from the first program on the disk to the last is a matter of moving the head a few inches from the outside to the inside track. In contrast, getting from the first to the last program on a C-60 cassette means moving about 250 *feet* of tape past the head.

Unlike cassettes, disks allow greater interchangeability between computer systems. This is especially true for systems based on the 8080, 8085 or Z80 processors. Many companies sell 5¼-inch disk programs written for use with these systems. Furthermore, Digital Research's CP/M operating system (and CP/M software available from such companies as Lifeboat Associates) simplifies interchange of programs. from different computers using the foregoing processors.

The processor is, for the most part, less important than the system you use it in. If you're programming in BASIC or some other language, you'll find as much difference between versions of BASIC running on a common processor as between versions running on altogether different ones. If you program in assembly or machine language, you'll find unlike processors very different to work with, but you'll also find that every processor has its firm adherents, with each processor's advantages being balanced by disadvantages relative to other processors. The best way to choose is to settle for whatever processor is in the system which best suits you, and for which the programs you need are already available.

Structure and Expandability. Any computer system worth its salt is designed to allow expansion. Your needs may grow or change; your budget will certainly grow, allowing you to make additions piecemeal.

Computer systems can be expanded in a variety of ways, and a given computer may use several of them. The simplest way to expand a system is to plug more integrated circuits into sockets already provided for them. This is usually done to expand RAM and ROM memory, and only for moderate expansions. Many single-board computers use this method, but so do some larger ones.

A more popular and more versatile route to system expansion is to plug in additional circuit boards. This implies that the computer will have some sort of *bus structure*, which is a group of signal, data, address and power lines into which boards can be plugged in any order. Several bus systems are in use, some are used in just one model of computer, others are used in many.

Boards are available for a very wide variety of purposes: to expand memory; to add more I/O circuits for additional terminals, printers and the like; to generate speech or sounds; to accept voice input; to tell the computer what time it is; to allow the user to build circuits of his own; to control other devices; to communicate by phone with other computers and terminals; to test integrated circuits; to add graphics capabilities; to send and receive Morse code; to interface with computers using other buses; to speed math processing; and many more possibilities.

Some computers, chiefly very compact ones, require a separate "box" to hold more than a minimum of extra memory, I/O and other circuits. Others combine approaches, with an expansion box that's built around an S-100 bus.

Peripherals. Much system expansion occurs outside the computer, of course. With the right programs and I/O circuits, a computer (even the kind whose built-in keyboard and video screen make it a terminal unto itself) can support several terminals around an office or house. For a very few machines, there are even programs available which allow several terminals to operate at once.

Even a one-terminal system can frequently use an add-on printer, for all the reasons already cited. But the application has a lot to do with which printer should be selected. The main choices are between dot-matrix and character printers: between impact, electrosensitive and thermal printing systems; and between printers offering upper-case (capitals) only and those offering both upper and lower case. (See "Printer" article that follows.)

Modems are another useful accessory, allowing your computer to communicate with others by telephone. Originate-only modems, the least expensive type, let your computer call up others. Originate/answer types also let others call you up. Some of the latter type also have "auto answer" facilities, so they can answer calls even in your absence.

The Systems Approach. When you buy a computer, you're not just buying a computer. You're starting a *system*. So your choice should be governed by the entire system it belongs to, and how well that system suits your application. Can the system be expanded to keep pace with your future needs? Can you get the peripherals you need—disk drives, modems, printers, device control boards, or whatever? How easily can you add any extra memory you may need, and at what cost? How many companies supply equipment to use with this system? Do you have near-future use for a business purpose? And, most important of all, is software available to make this system do what you want and need it to do? If the answer to all these questions is yes and cost is in your ballpark, then you've found the right system. ◇

(Focus continues on page 63)

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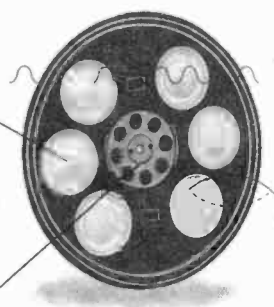

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How to Buy a Computer Printer

BY ALEXANDER W. BURAWA, Features Editor

Sooner or later, if you own a personal-computer system, you'll want to add a hard-copy printer. For example, a home user might want to keep printouts of programs in case he "blows" them on his tapes or disks, or have recipes that can be taken into the kitchen instead of a video monitor or terminal. A small businessman, on the other hand, would need a printer even more—for generating letters, billing information, stock-inventory lists, etc. Thanks to the introduction of lower-priced models, anyone can now seriously consider adding a hard-copy facility.

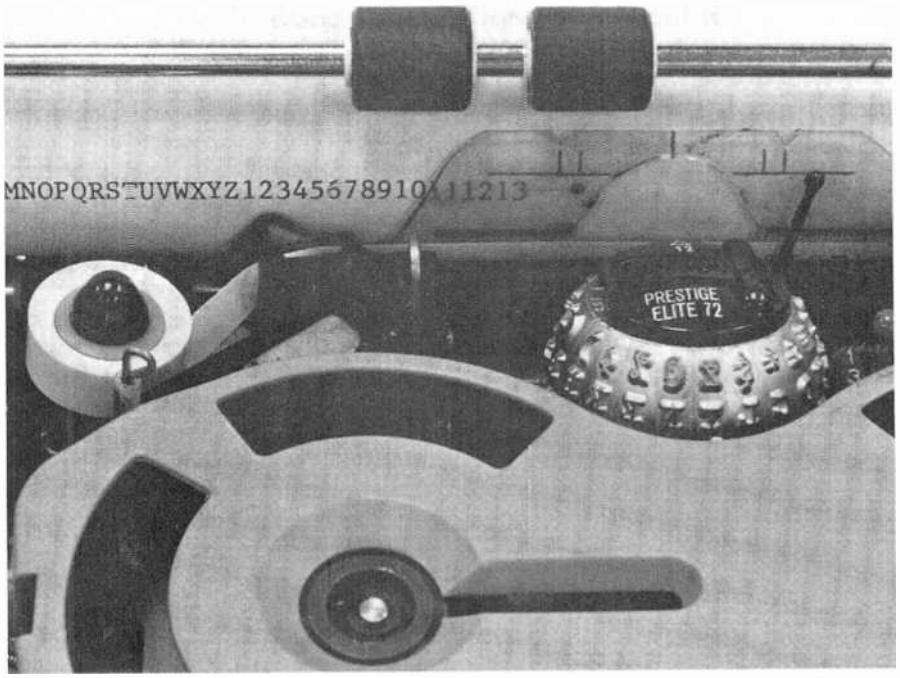
In this article, we will discuss the various types of printers available and explain how each operates. Our objective is to provide guidance on selecting the printer that is just right for the purpose, based on such features, as performance and cost.

Some Generalizations. Hard-copy printers are considered to be one-way machines that provide a permanent copy of whatever appears at the appropriate output port of a computer. This computer peripheral generally has no facility for "talking to" the computer (although there are terminals, such as a teletypewriter, that permit two-way communications, including hard copy).

A number of factors contribute to the price of a printer, the most important being the printing mechanism used, number of characters per line, and printing speed. As a general rule, the greater the number of characters per line and/or the faster the operating speed, the more expensive the printer. For example, a 40-column (40-character/line) thermal printer of the type used with many calculators is much less expensive than a line printer that prints at a rate of 500 lines/minute and has a capacity of 80 characters/line or more.

All computer-controlled hard-copy printers can be classified as either "impact" or "nonimpact" in design. Characters and symbols can be printed either fully formed or in a dot-matrix format. Finally, printers can be classified as either "serial" or "line." Individual printers vary immensely in terms of operating features, capacity, reliability, print quality, cost, etc.

At one time, all hard-copy printers were referred to as "line" printers. Today, a line printer generally means a device that prints an entire line of characters simultaneously. To differentiate between this type of printer and those that print each character individually across the page, the term "serial" has come into common usage. Unfortunately, a few manufacturers continue to refer to their serial printers as "line" printers. In most cases, however, you can determine which is which by referring to manufacturer specification sheets. Serial-printer speeds are generally given in characters/second (cps) with no mention of lines/minute (LPM), while line-printer speeds are almost invariably given in lines/minute and may or may not include characters/second. If in doubt, ask your dealer.



IBM Selectric uses interchangeable "golf ball" printhead for selectable-font, preformed solid characters.

Dot-matrix characters (bottom) may be more difficult to read than solid characters (top).

Character Format. Impact printers with solid, fully formed characters abound for high-quality typefaces used for business letters, business forms, magazine and book printing, etc. These can be found on Teletype[R] cylinders, IBM Selectric[R] "golf" balls, "daisy" wheels, drums, chain-print mechanisms, and embossed "bands." In general, fully formed type carriers provide both upper- and lower-case alphabetic characters, numbers, punctuation marks, and special symbols (if any are required). Additionally, many offer a choice of different type fonts, such as Roman, italic, bold, etc. The exception here is the cylinder printhead, which is limited to upper-case alphabetic characters, the numerals 0 through 9, and a few punctuation marks and symbols.

Dot-matrix printing is the other technique for forming printed characters on paper. Here, a number of dot "elements" make up each character in the set. The dots are usually arranged in a matrix consisting of 4 to 7 dots horizontally and 7 to 9 dots vertically. When the elements are limited to 7 or fewer dots vertically, the character set may not contain lower-case letters because of problems with legible descenders.

Dot-matrix-formed characters are not continuous and may, as a result, lead to problems in legibility, especially if the matrix is made up of very few elements. (Some very expensive dot-matrix printers generate so many elements per character that individual characters appear to be continuous.)

Printheads that use the dot-matrix format of generating characters can be used in impact printers and are used exclusively in nonimpact printers.

Impact vs. Nonimpact. Like an ordinary typewriter, all impact printers require force to print a character on paper. In the great majority of impact printers, the printhead is forced with hammer-like action against the paper through an inked ribbon. In rare cases, the selected character in the printhead is held stationary while a hammer drives the paper and inked ribbon against the character slug or matrix from the *rear* to accomplish the printing task.

Almost without exception, impact printers are considerably slower than their nonimpact counterparts, averaging less than 60 characters/second for serial printers. While some serial printers that use the dot-matrix printhead may be capable of operating at speeds of up to 330 characters/second, few in the lower-price ranges can achieve better than 100 characters/second. At the lowest end of the price range, printing speed may be restricted to 60 characters/second or less.

One characteristic of all impact printers is a high level of noise during operation. Noisiest of all is the cylinder printer, which clatters away at distracting noise levels. Perhaps the quietest is the band printer, which is, relatively speaking, unobtrusive. Even with its high noise level, the impact printer is often the one most preferred for high-quality printing and/or multiple-copy capability.

By comparison, nonimpact printers are almost silent in operation, the only sound coming from the mechanisms that move the head across the paper and feed the paper upward for the next line. Unfortunately, two disadvantages are common to all nonimpact printers—inability to make multiple copies and sometimes very low legibility of the dot-matrix-formed characters.

Nonimpact printers form their characters by any of the following techniques: thermally, electrosensitively, electrostatically, Xerographically, and ink jet. For limited budgets, all but the first two can be eliminated from consideration.

Impact Printers. Here is a rundown on moderately priced impact printers:

Cylinder. The printhead used in this type of printer was one of the earliest to gain popularity (the old Teletype used it). The cylinder printhead gets its name from the shape of the character carrier. In operation, the cylinder rotates and moves up and down to carry the appropriate character into striking position. Then a hammer strikes the cylinder, forcing the selected character against the paper through an inked ribbon.

One can buy a used cylinder printer from a surplus dealer at low cost. Its multiple-copy capability, using carbon-paper-interleaved rolls, is a major advantage. Disadvantages include a 10-character/second printing speed, just passable print quality, no lower-case alphabet, limited symbol availability and very noisy operation.

Golf-Ball. The spherical "golf" ball printhead was developed by IBM for its Selectric typewriter. Similar in concept to the cylindrical printhead, the golf ball is a sphere on which the printing character set is embossed. Operation is also basically similar to the cylinder printer, except that the ball itself strikes the paper through an inked ribbon without help from a hammer. Also, it features both upper- and lower-case characters.

(continued on page 66)

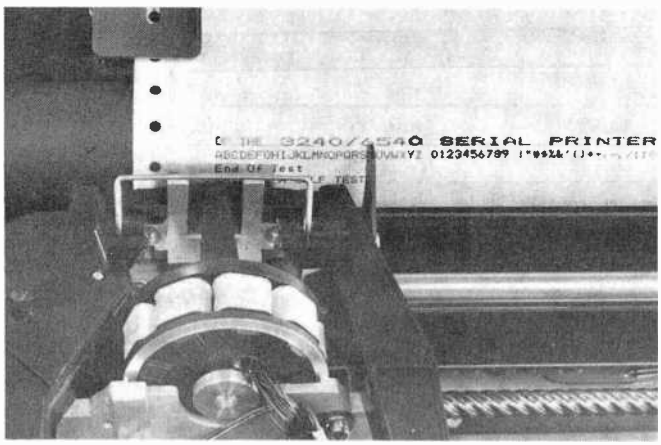
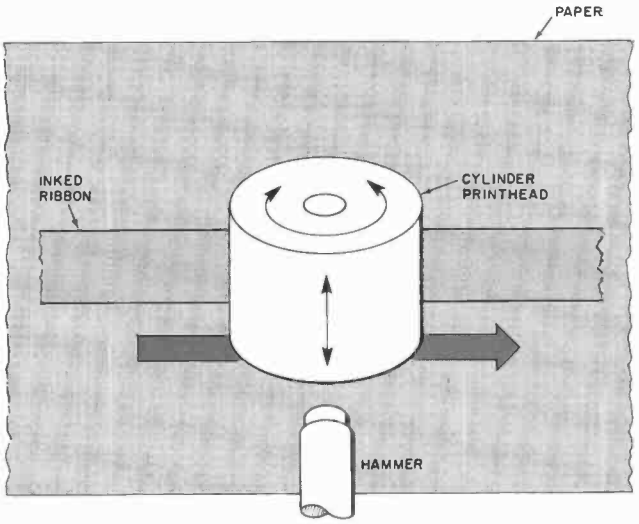
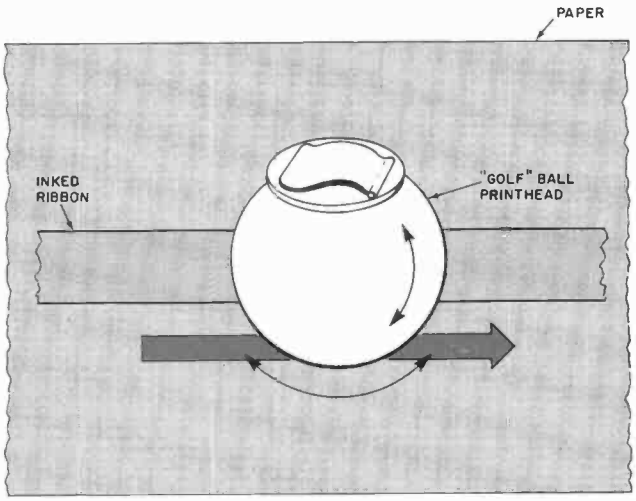


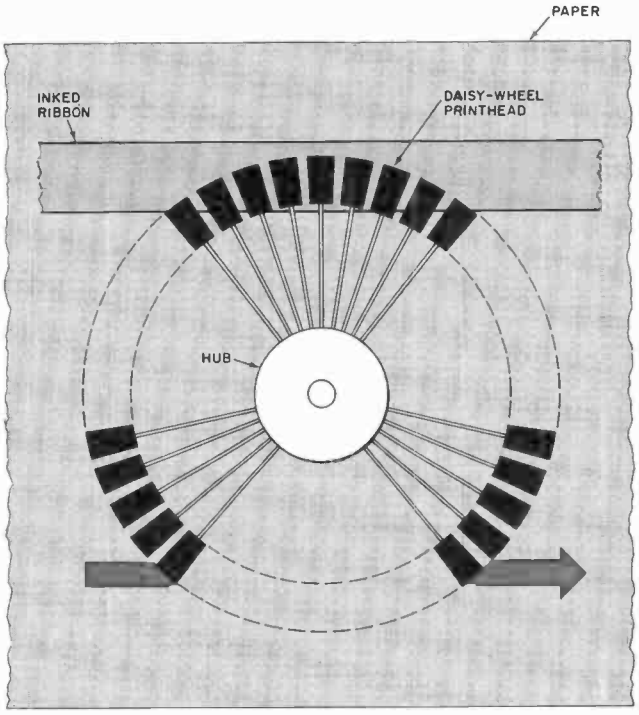
Photo courtesy Precision Data

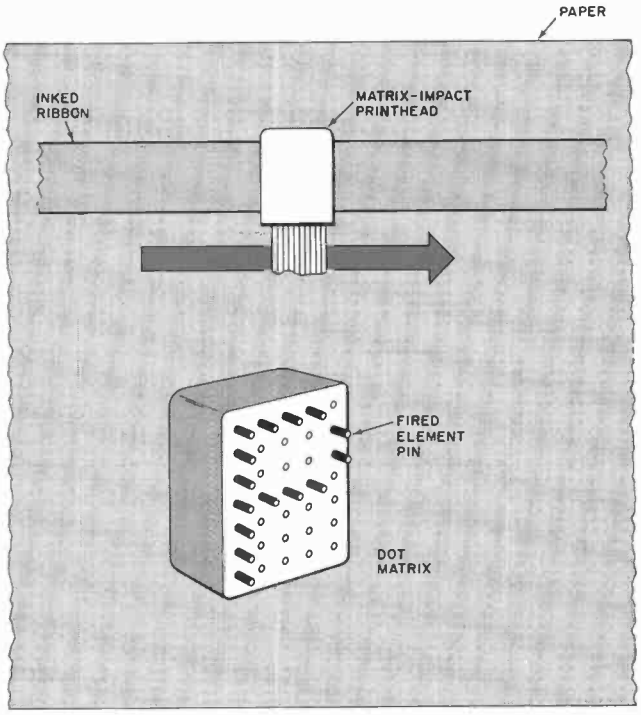
Matrix printhead is used exclusively in nonimpact and in some impact printers.

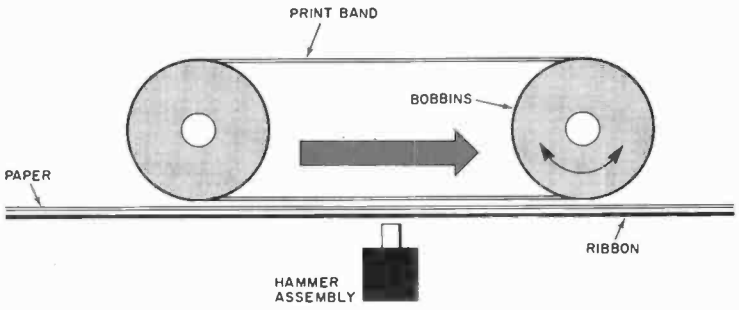
Printing band produces preformed characters but legibility is only fair to poor.

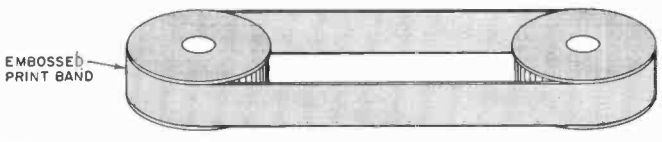












Illustrated (clockwise from upper left) are cylinder, IBM golf ball, dot matrix, impact, band, and daisy wheel printheads.

Excellent print quality, plus quick interchange of printheads (balls) with different character fonts are the leading advantages of the golf-ball printer. Prices of new machines start at about $2000, while reconditioned ones such as from Anderson Jacobson sell in the area of $1200.

Two disadvantages are prominent in the golf-ball printer: printing speed averages only about 15 characters/second, and operation is noisy, though certainly not as noisy as with the cylinder printer.

Daisy-Wheel. The name "daisy wheel" is derived from the printhead's resemblance to the flower. Character slugs are located at the ends of "spokes" that radiate from a hub. Under computer control, the hub is rapidly rotated to bring the selected character into striking position, where a hammer drives the slug against ribbon and paper.

Daisy-wheel printers are more reliable and faster than cylinder and golf-ball printers, averaging 45 to 55 characters/second. Like the golf-ball printer, the daisy-wheel printer has interchangeable type-font printheads. Its print quality is especially good. The major disadvantage of the daisy-wheel printer is its relatively high price of $3000 to $5000.

Matrix-Impact. This is perhaps the fastest growing type of printer in common use. Each character is formed from a pattern of dots arranged in a matrix. Each dot is struck onto the paper through an inked ribbon by an independent "pin" in the printhead. As the head passes over the paper, the computer "tells" it which pins are to be "fired."

Since the chracter set of a matrix-impact printer is determined by patterns stored in ROM or PROM, not by the configuration of the printhead, character fonts can be changed easily, allowing unique symbols to be created almost at will. This matrix approach also makes it possible to have limited graphics mixed with printed characters. Speed is generally higher than with other types of impact printers—up to 330 characters/second in the most expensive serial printers and as low as 30 characters/second at the low-price end. Reliability, relatively quiet operation, and low cost (about $900 to start) round out the advantages of the matrix-impact printer.

The major disadvantage of this type of printer is that legibility may be poor because the characters are not continuous. The problem becomes progressively worse as the number of dots in the matrix for a letter become smaller.

Band. Unlike other impact printers, the band printer can be designed to strike the paper through an inked ribbon or to force paper and ribbon against the selected character with a hammer *behind* the paper. It gets its name from the fact that the character set is embossed on a continuous metal or reinforced polyurethane "band" that fits over a pair of bobbins. The bobbins rotate to set the selected character slug into position.

Advantages of the band printer include: easily interchangeable type bands for replacement or changing type font, good print quality, high reliability, and relatively high operating speeds that range from 30 characters/second on up.

Disadvantages are charactersitic of various models. Some are subject to excessive belt and drive wear, others print low-quality characters, and still others wear out individual characters on the band relatively rapidly. And one worn character means replacing the entire band. Finally, these are fairly expensive printers, starting at about $3000.

Nonimpact Printers. In the nonimpact-printer category, there are basically two types from which to choose in the affordable range of most personal- and very-small-business computer users—thermal and electrosensitive. Both share a disadvantage common to all nonimpact printers, namely, an inability to produce simultaneous multiple copies of the printed matter. An advantage they share is whisper-quiet operation.

Thermal. The matrix format for this type of printhead is the same as for the impact matrix printhead discussed above. As the printhead moves across the specially treated paper, it pauses at each position where a character is to be printed. At each pause, selected elements inside the printhead are rapidly heated, activating the coating in the selected areas. When the coating is activated, it changes color to form dots that contrast with the overall color of the paper itself.

Very low cost and silent operation are the major advantages of the matrix thermal printer. Disadvantages include: relatively low speed (30 to 100 characters/second), need for special paper, lack of preprinted forms, and short line width.

Electrosensitive. The printhead used in this type of printer is similar to that used in the thermal printer, except that it vaporizes selected points of a special coating on the paper with a *voltage* rather than with heat. Operation is also basically the same.

Electrosensitive printers are low in cost, ranging from about $400 to $3000. A couple of peripherals manufacturers have hinted that at some future time, electrosensitive printers minus case and power supply might be available for as little as $250. These printers are also relatively fast, operating at speeds of 160 to 2200 characters/second.

The single important disadvantage that has prevented the electrosensitive printer from taking over the single-copy market is the special paper it requires. This paper, bearing a thin black layer and an even thinner coating of aluminum, is very fragile and must be handled with utmost care to prevent wrinkling and soiling. A further problem is the reflectivity of the aluminum surface, which virtually "washes out" under some lighting conditions and makes it almost impossible to photocopy printed text.

Other Considerations. Not all hard-copy printers have full-page-width (8½") printing capability. There are a number of "column" printers that use adding-machine-size paper rolls and give an average of 40 columns (40 characters) per line of upper-case alphabet, numerals, and punctuation and some special characters. In general, these printers employ either impact or nonimpact dot-matrix printheads. These printers are extremely low in cost, as little as $150 if you shop around, but their graphics capability may be limited.

Another consideration often overlooked by prospective buyers is the manner in which the paper is fed from the supply roll or folded stack. There are two alternatives here, the most common of which is friction-roller feed, such as used in typewriters. The other is sprocket feed. Here, gear-like sprockets located at opposite ends of the "carriage" engage perforations along the sides of the paper to move the paper upward as each line of printing is completed. Sprocket-feed is superior to friction-feed because it very precisely locates each line of print, but the perforated paper costs more.

The costs of a hard-copy printing system do not stop with the purchase of the printer itself; in fact, that may be just the beginning. You must take into account the cost of the paper. Here, the advantage is on the side of the impact printer

that uses inexpensive paper rolls. Prices are considerably higher for the special papers required for thermal and electrosensitive papers. And, where available, accordion-folded, sprocket-feed forms can be very expensive. Last but not least, you must allow for maintenance. A formed-character impact printer will generate much steeper maintenance and repair costs than a nonimpact matrix printer, if only because the former has more mechanical elements.

While most machines print in one direction only (left to right), others print bidirectionally. In a bidirectional printer, when the printhead sweeps from left to right and comes to the end of a line, the paper feeds up one line and printing continues from right to left. This process is repeated for every pair of lines in the text, eliminating "carriage return." To accomplish bidirectional operation, these printers have built into them a one-line data-storage buffer.

Finally, not all printers have the same "typing" density. Full-width printers can have as few as 5 and as many as 16.5 characters/inch across the page and as few as 5 and as many as 12 lines/inch down the page. High-density printing can save considerably on the cost of paper but may be difficult to read.

Buying Hints. Most of the prices quoted in this article are manufacturer suggested list. Dealers in the microcomputer marketplace, however, often sell below list and, on occasion, considerably below. So, it pays to shop around.

Though it might be preferable to buy new equipment, don't overlook the used-printer market. Occasionally, very expensive printers that have been taken out of a large system will be refurbished and sold in satisfactory operating order at a fraction of their original price. Be sure you get a warranty, though.

If you own or plan to buy a video terminal—that is, a keyboard-video monitor system—it would be wise to purchase only a one-way printer. Having a two-way one would make the typing facility redundant unless you also wish to own an electric typewriter.

Finally, try to get some "hands-on" experience with the printers you have in mind. Visit your local computer store and, if possible, other computer users who already have hard-copy printers to see which fills your needs. ◇

CP/M: The Standard Microcomputer Software Interface?

BY DOROTHY SIEGEL*

This semi-universal software interface is already providing tremendous advantages for 8080 and Z80-based computer users. Its extension to other systems may not be far off.

IN THE early days of personal computing, toggling switches and watching LEDS constituted the only means of data-handling available to enthusiasts. As microcomputers and peripherals proliferated, users expected to be able to obtain high-quality software to run on their systems. However, because hardware and software were not standardized, proven software that large computers had been using for years and software written specifically for, say, the 8080 and Z80 (the largest population of chips in use) had to be adapted to accommodate a multitude of incompatible systems. This uneconomical state of affairs inhibited the development of good software. What was needed was a quasi-universal interface that would allow applications of software once written to run on any 8080/Z80 machine. Just as the S-100 bus became the 8080/Z80 standard for hardware, CP/M (a registered trademark of Digital Research) is filling this need in the realm of software.

*Lifeboat Associates, New York, NY.

What Is CP/M? CP/M is an operating system, a layer of software that masks the hardware and makes it "impersonate" a computer defined by CP/M itself. Once CP/M is loaded on a microcomputer system, the details of the hardware actually in use become irrelevant to the user. As far as he is concerned, he is dealing only with CP/M; the operating system does the rest. Similarly, a program need only be designed to run under CP/M, not with any particular hardware configuration. This ability to mate virtually any microcomputer and any software is one of the main reasons for the growing popularity of CP/M.

CP/M consists of a monitor control program plus some utility programs, principally a text editor, an assembler and a debugger. Together, these programs comprise a complete and independent software-development package that enables the user to create, edit, debug, assemble and run programs using one, two, three, or four floppy or minifloppy disk drives. It can be used with any of the family of 8080- or Z80-based micro-processor that have at least 16K of memory.

The heart of the CP/M is the disk operating system (FDOS). It relieves the user of all housekeeping tasks, creating and manipulating files, and coordinating communication between peripherals. The FDOS acts as a supervisor for other programs, whether they are utilities like CP/M's own editor, application pro-

grams like inventory control, or translators for high-level programming languages like BASIC, COBOL, FORTRAN, and PL-1.

The FDOS can be further subdivided into the BIOS or Basic Input/Output System, which provides machine language interfacing to the I/O devices, and the BDOS, or Basic Disk Operating System, which provides disk and file management. Together, the BIOS and BDOS supervise the I/O hardware. BDOS allocates disk space for new files and maintains a record of disk storage in use and available. When a program demands storage, BDOS determines the disk addresses to be employed, and performs disk I/O through the BIOS drivers. For example, when an application program such as an editor or an assembler needs to write data to a file, it calls BDOS function #21 to write a record. BDOS does the necessary calculations and calls the BIOS with four different operations: select disk, set track, set sector, and perform data write.

The Console Command Processor (CCP) is the user interface to the rest of CP/M. It executes its own set of commands, such as DIR to list the file names on a diskette or ERA to erase a file. There are five such built-in commands that the CCP can perform. When the hardware is first activated, or a program run has ended, CCP is loaded "by default." But when a program such as a BASIC interpreter is executed, CCP's 2K of memory is released for use by the program and becomes part of the TPA or transient program area as shown in Fig. 1.

The TPA is the section of memory where a program is loaded for execution. For example, when "BASIC" is typed to the CCP, the FDOS loads the binary command file BASIC.COM at 100H (the H denotes hexadecimal or base-16 notation) and transfers execution to the start of the BASIC program.

CP/M's transient commands (see Table) reside not in memory, but on the CP/M disk, ready to be loaded by the CCP. The user can load one of the transient commands supplied with CP/M, such as the CP/M editor (ED). Or, as in the example with BASIC above, he can create his own transient commands, even using an editor, assembler or debugger obtained from another source. When the user wishes to edit a file, he types "ED." When he wishes to run BASIC, he types "BASIC." And when he wishes to list the files on the disk, he types "DIR." The manner in which the system copes with these different tasks is unimportant to the user seated at the console.

The "standard" CP/M for most machines with an S-100 bus (such as the Altair, IMSAI, North Star, Cromemco, etc.) has programs loading at address 100H (Fig. 1). A second "standard" CP/M, for computers with firmware at low memory addresses (such as the TRS-80, Heath H-8, and Poly 8813), has programs running at 4300H. Major software houses such as Digital Research and Microsoft have produced versions of their products for both standards.

Why CP/M? The decision to make CP/M easily transportable between different computer systems was a recent one. In 1973, when Intel introduced its 8080 microprocessor, Gary Kildall of Digital Research designed a PL/M cross-compiler to generate code for the new device. He separately designed an 8080 operating system, CP/M (for "Control Program for Microprocessors") ver.1.0, that he later configured for the 8080-based systems built by Omron and Digital Microsystems. In 1976, when IMSAI asked him to implement CP/M on their 8080-based computer, Digital Research redesigned CP/M (ver.1.3) to be transportable between different machines with standard 8" IBM diskettes. CP/M started becoming a popular system for microcomputer users who owned 8" disk drives, and it was possible for users with dissimilar hardware to start swapping disks and programs.

In 1977, Larry Alkoff of Lifeboat Associates configured CP/M to work on the North Star minifloppy disk system. Enthusiastic response to word of its existence led Lifeboat to offer CP/M configurations for almost every other minifloppy and floppy disk system—single and double density, single and double sided, hard and soft sectored, 5¼" and 8", and with any disk controller. Today, CP/M is available from Digital Research, from disk system manufacturers, and from distributors like Lifeboat for virtually all 8080/Z80-based computer disk systems sold.

The popularity of CP/M mushroomed. It was inexpensive compared to systems software for large computers, and it provided a machine-independent environment for the wider world of software. For

(Continued on page 73)

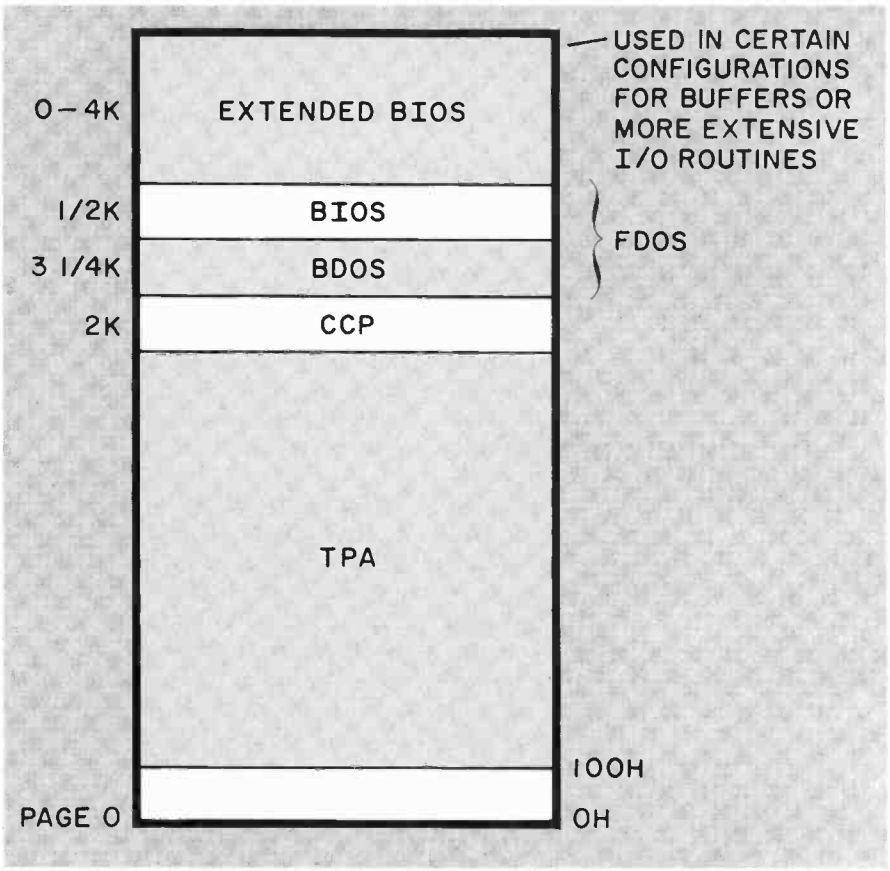


Fig. 1. System memory map for the CP/M microcomputer software interface.

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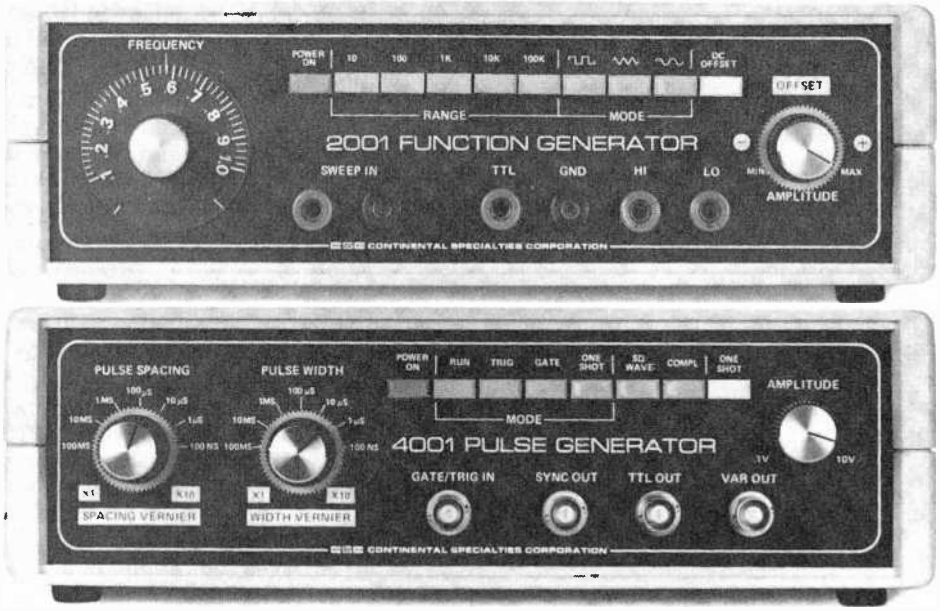

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(Continued from page 68)

example, when CP/M is used, the same version of Microsoft Disk Extended BASIC will execute identical BASIC programs on a North Star Horizon, an Ohio Scientific Challenger, or a Cromemco System 3 Computer. This standardization and broadening of the market has helped to promote the writing of high-quality software.

A spartan operating system, CP/M is designed for the most efficient use of the limited memory most users had back in 1976. It is also economical with disk space, not requiring contiguous blocks of space on the disk in order to create continuous files. The system is forgiving, which makes it difficult for a user to inadvertently destroy his program. Furthermore, CP/M is well-conceived, reliable, and thoroughly debugged.

A wide variety of CP/M software is available from dozens of sources. There are application packages such as word-processing and mail-list programs, payroll, and general ledger; utility packages such as TEX (a text formatter for Digital Research) and Macro-80 (a relocating Macro Assembler from Microsoft); and language programs in which to develop or run application programs. Two recent releases are a BASIC Compiler and two Compilers for the language "C". CP/M offers the luxury of a selection among more than a dozen BASIC's, three FORTRAN's, three COBOL's, an APL, a PL-1 and innumerable assemblers, editors, and business packages.

Computer users who are still dependent on the equipment manufacturers can benefit from CP/M. With a nonstandard DOS supplied by the manufacturer, their machines constitute a captive software market. If the manufacturer, either because of bankruptcy or a change in plans, fails to supply that market, the users are in trouble. For instance, the availability of CP/M software for the Processor Technology Helios disk system should offer more than a little comfort to the recently orphaned owners of these systems.

Communication Using CP/M. Users of CP/M having similar disk systems can exchange disks. Users with dissimilar disk systems can communicate programs and data via telephone lines or they can exchange listings. They have the further alternative of using Lifeboat Associates' media conversion facilities to convert a CP/M disk from one system's format to a CP/M disk in another.

Other communication possibilities have been fostered by CP/M. Ward Christensen and Randy Suess of the Chicago Area Computer Hobbyist Exchange (CACHE) devised a computerized dial-in "corkboard and pushpin" community bulletin board—a modern-day version of a wall full of index cards.

CP/M TRANSIENT COMMANDS

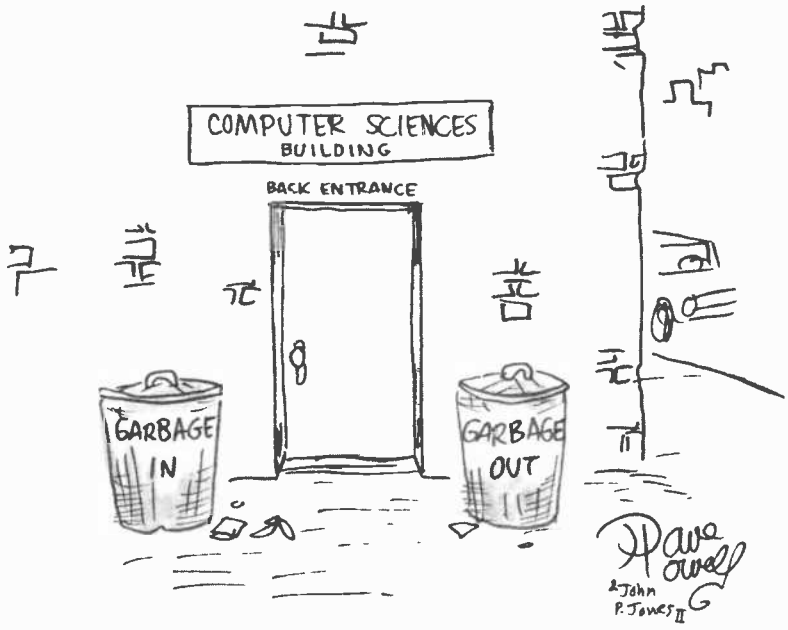
STAT—List the number of bytes of storage remaining on the currently logged disk, provide statistical information about particular files, and display or alter device assignment.
ASM—Load the CP/M Assembler and assemble the specified program from disk.
LOAD—Load the file in Intel "hex" machine code format and produce a file in machine executable form which can be loaded into the TPA. (This loaded program becomes a new command under the CCP.)
DDT—Load the CP/M debugger into TPA and start execution.
PIP—Load the Peripheral Interchange Program for subsequent disk file and peripheral transfer operations.
ED—Load and execute the CP/M text editor program.
SYSGEN—Create a new CP/M system diskette.
SUBMIT—Submit a file of commands for batch processing.
DUMP—Dump the contents of a file in hex.
MOVCPM—Regenerate the CP/M system for a particular memory size.

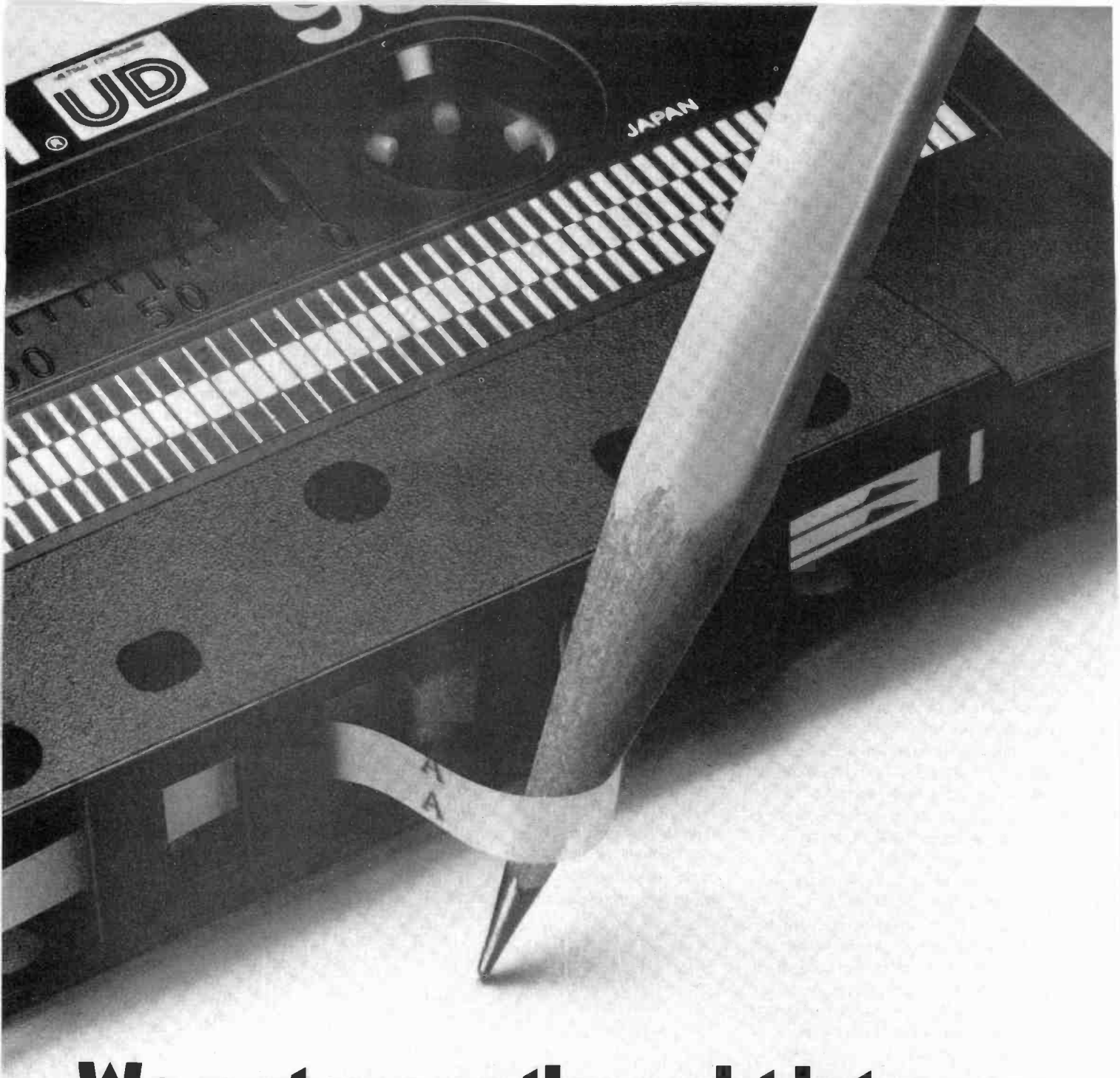
Note: These are commands supplied with CP/M. Any programs acquired by the user are added to his repertoire of Transient Commands.

In its first 16 months of operation, CBBS (Computerized Bulletin Board System) handled 16,000 calls. Ward reports that often the entire operation is automated, with a user's computer calling the CBBS computer. CBBS's have reportedly cropped up in Pasadena, Boston, Maynard (Mass.), Atlanta, Dallas, and Beaverton (Oregon), all employing the CACHE supervisory software and CP/M. Ward feels that CP/M made implementation of CBBS much easier, and he uses standard CP/M utility programs to maintain it. Eventually, CP/M Users Groups may use on-line computers with modems to transfer files.

For the Future. Feedback from CP/M users has led Digital Research to plan for the introduction of a more expensive, more sophisticated, upwardly compatible operating system, MP/M. This Multi-Programming Monitor supports processes arranged by priority for handling events in real time, yet it is designed so that CP/M programs can run with it. The MP/M is about four times the size of CP/M and costs about twice as much.

If the advent of microcomputers is seen as a revolution, surely the development of advanced, universal operating systems must be too. By unifying the software market and making it worthwhile to design sophisticated programs for the micros, CP/M (and MP/M to come) has unleashed these machines and put them to work. ◇





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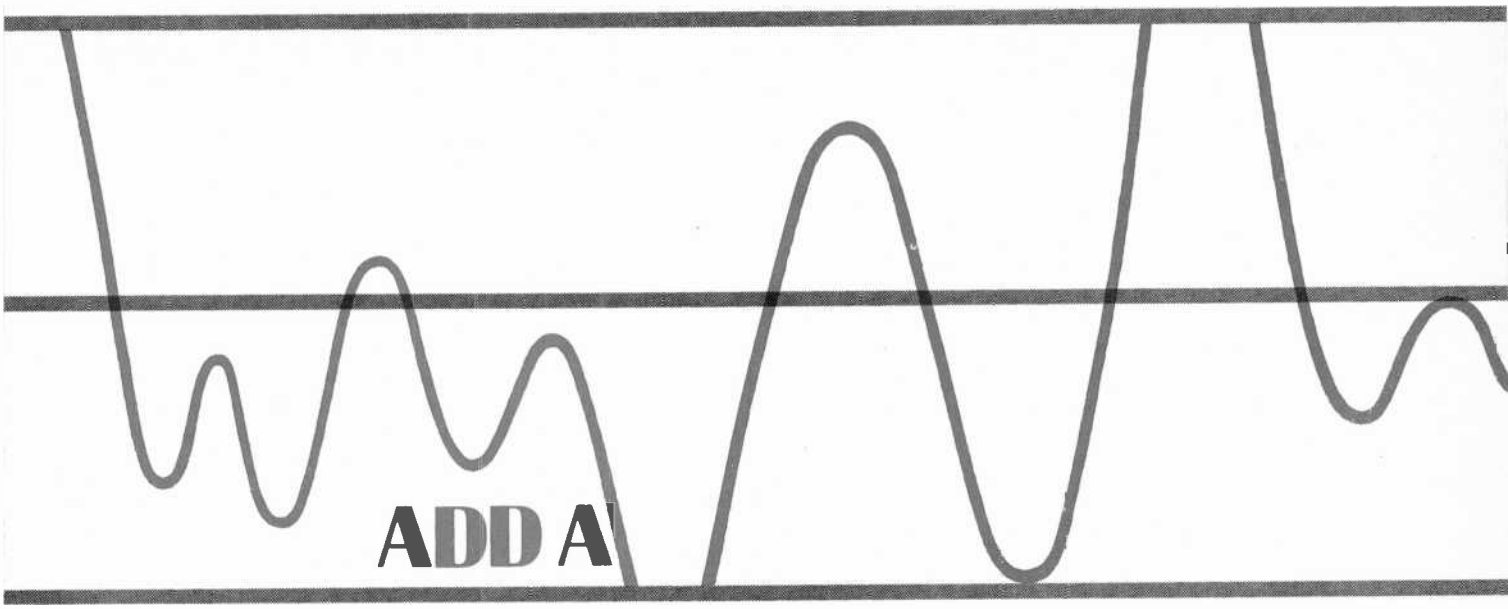


ADD A CLIPPING INDICATOR TO YOUR AUDIO AMPLIFIER

To protect speakers, this simple circuit senses power supply voltages and flashes a warning LED just before the onset of clipping

BY NORMAN PARRON

THE CONSEQUENCES of overdriving an audio power amplifier can range from the unpleasant (ragged, distorted sound) to the catastrophic (burnt, black remains of tweeters and supertweeters). It's obvious, therefore, that the audiophile will want to avoid this condition. The project presented here, an Amplifier Clipping Indicator, will help him do just that. It continually senses both the audio output of the amplifier and the power supply voltages, and flashes a warning LED if the output signal voltage approaches either power supply rail. The user can then reduce the drive level so that the LED stops flashing.

Readily available, inexpensive components comprise the Amplifier Clipping Indicator. Many of them will be found in an experimenter's "junk box." A stereo version can be built in just a few hours, making the Amplifier Clipping Indicator an enjoyable weekend project. The modest amount of power the circuit requires can be tapped from the power amplifier's supply or furnished by a small supply built especially for this purpose.

What Is Clipping? When an audio amplifier is overdriven, it "clips" the input signal. The process is shown graphically in Fig. 1. A power amplifier is driven by a sinusoidal input signal having maximum positive and negative amplitudes of $+V_{IN}$ and $-V_{IN}$, respectively (Fig. 1A). The amplifier generates an output signal that is (ideally) an exact replica of the input except for its increased amplitude.

Because the amplifier must reproduce ac waveforms, it employs a bipolar dc power supply. This means that the most positive voltage it can produce at the output terminals is $+V_{CC}$, and the most negative voltage is $-V_{CC}$. If the amplifier's gain control is adjusted so that the output signal approaches the limits imposed by the power supply, a waveform like that shown in Fig. 1B is generated. It can be seen that the maximum positive and negative swings of the output voltage, $+V_{OUT}$ and $-V_{OUT}$, are somewhat less than the absolute limits of $+V_{CC}$ and $-V_{CC}$.

Adjusting the control for more gain causes the amplifier to attempt to exceed the constraints of the power supply. The result is a clipped waveform like that shown in Fig. 1C. Spectral analysis of such a waveform indicates the presence of high-order harmonic distortion products during the interval that clipping takes place. If the output signal is clipped less than 1% of the time, the effect is usually inaudible. As the duration of clipping approaches 10%, the usual consequence is audible, "raspy" distortion. A severely clipped signal (more than 10% of the time) contains a considerable amount of high-frequency energy. This energy poses a significant threat to midrange and high-frequency drivers because it is directed to them by the crossover network and they are usually capable of dissipating far less power than bass drivers.

Although the example that has been discussed used sinusoidal signals, an audio amplifier usually processes musical signals that are much more complex. It is characteristic of most recorded music that the average signal level is low. However, musical program material does contain a significant number of

short-lived, high-level transients. An amplifier might be called upon to deliver one watt of output power on an average basis, but accurate reproduction of a bass percussion transient can require fifty to one-hundred times that power level for a brief instant.

All is well if the amplifier has enough voltage and current reserves to pass the transient unclipped. However, if the amplifier cannot do so, the dynamic range of the recording will be compressed and audible distortion products introduced. This, coupled with the fact that perceived loudness is a function of average (as opposed to peak) power, explains the trend toward power output capabilities that were unheard of in audio amplifiers a relatively short time ago. So-called "super-power" amplifiers allow the audiophile to listen to program material at realistic levels without clipping high-level transients, even if inefficient speakers are used.

About the Circuit. The Amplifier Clipping Indicator is shown schematically in Fig. 2. Each channel of amplification in a sound system will require a separate indicator circuit. The most common application for the project is in a stereo system, so component numbers for two channels are shown. Those for the right channel are given in parentheses. The discussion that follows pertains to only one channel, designated the left channel of a stereo pair. Everything that will be said, however, applies equally to as many channels as are needed because the indicator circuit is identical for each.

Output signals from the audio amplifier are applied to an 11:1 voltage attenuator (*R1R3*). Similarly, the positive and negative supply voltages, $+V_{CC}$ and $-V_{CC}$, are applied to attenuators *R5R7* and *R9R11*. The voltage dividers associated with the power-supply outputs, however, employ trimmer potentiometers and have variable attenuation factors. Those portions of the input voltages passed by the attenuators are applied to two 741 operational amplifiers (*IC1A* and *IC1B*) employed as voltage comparators.

Assume that the trimmer potentiometers have been adjusted to attenuate the power supply voltages slightly more than the fixed divider attenuates the audio signal. If the amplifier is being driven by an audio signal, but not to the point of clipping, its output voltage will be smaller in magnitude than either the positive or negative supply voltage. This means that the voltage applied to the noninverting input of *IC1A* is never more positive than that applied to the inverting input, and the output of the comparator remains at −12 volts. Similarly, the voltage applied to the inverting input of *IC1B* remains positive with respect to that present at the noninverting input, keeping the output of *IC1B* at −12 volts.

Diodes *D1* and *D3* form an OR gate whose output goes to +12 volts when either of the comparator outputs does. In the absence of clipping, both *D1* and *D3* are reverse-biased, which keeps transistor *Q1* cut off. Monostable multivibrator *IC3* remains untriggered and its output (pin 3) is at ground potential. This keeps *D7*, which together with *D5* forms a second diode OR gate, in a nonconducting state. The output of the *D1D3* OR gate is applied to the *D5* input of the second gate. Both inputs are low, so *Q3* receives no base drive and the clipping indicator LED (*LED1*) remains dark.

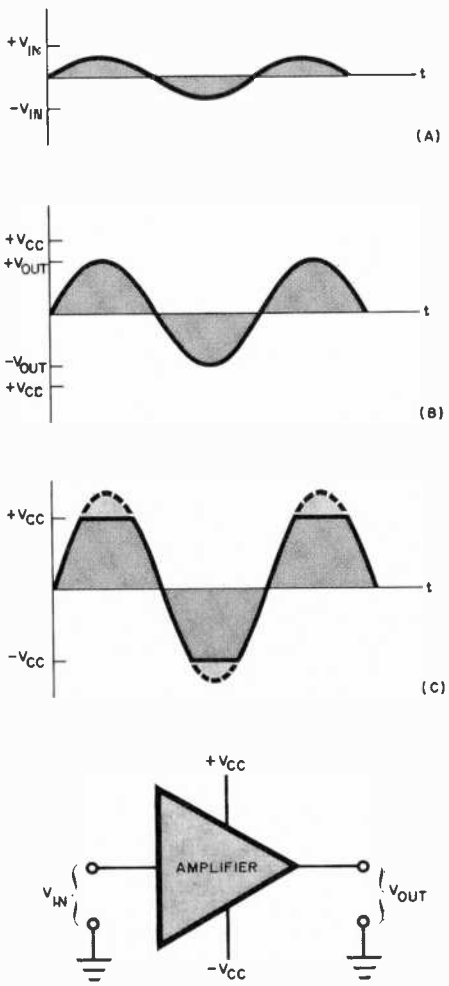


Fig. 1. If input amplitude (A) or gain of amplifier is not excessive, output is not clipped (B). Increasing one or both causes amplifier to clip the output (C).

Now let's assume that the audio amplifier is driven into clipping. The audio output voltage reaches the positive or negative supply voltage (or both) and is clipped like the one shown in Fig. 1C. When the positive portion of the audio waveform applied to the noninverting input of *IC1A* becomes more positive than the voltage at the inverting input, the output of the comparator goes to +12 volts, this forward-biases *D1* and *D5*, and provides base drive for *Q1* and *Q3*. A similar thing happens when the negative portion of the audio waveform is clipped. The voltage applied to the inverting input of *IC1B* becomes more negative than the voltage at the noninverting input, so the output of this comparator switches to a +12-volt level. This forward biases *D3* and *D5*, providing base drive for *Q1* and *Q3*.

When *Q3* is supplied with base current, it turns on and the clipping indicator LED glows. However, the clipping interval can be so short that the eye will not readily detect the brief flash of the LED. That's why *Q1*, *IC3*, and their associated components have been included. Together they function as a pulse-stretching circuit. Here's how.

When the output of either comparator goes high, *Q1* receives base current and its collector drops to ground potential. A negative pulse is passed by *C1* to pin 2 of *IC3*, triggering this monostable multivibrator. The output of the timer IC (pin 3) goes high for an interval determined by the time constant of *R19C5*. For the values given, the width of the output pulse is about 0.25 second. This output pulse is OR'ed with the output of gate *D1D3* and applied to resistor *R21*. Transistor *Q3* receives base drive and sinks current for *LED1*, causing the clipping indicator LED to glow.

The pulse-stretcher turns the LED on for one quarter of a second even if the clipping interval is much shorter. A subsequent trigger pulse received while the monostable is timing will not retrigger it. However, one received immediately after a timing cycle will cause the process to be repeated. If the clipping interval is longer than the width of the output pulse (which can be extended to any desired interval by increasing the value of *R19* or *C5* or both), the OR'ing action of *D5* and *D7* will keep *Q3* in a conducting state. Therefore, the clipping indicator LED will continue to glow even after the output of the monostable has returned to its ground state. It will glow un-

til the audio amplifier recovers from the clipping condition.

The project requires a bipolar power supply of ±12 volts dc. These operating voltages can usually be tapped from the audio amplifier's power supply. Zener diodes and series current-limiting resistors can be used to drop the amplifier's $+V_{CC}$ and $-V_{CC}$ supply voltages to the desired values. Alternatively, a small line-powered supply can be built into the project's enclosure. Current demand is relatively modest—a few milliamperes for the −12-volt supply and about 50 mA from the positive rail.

Because dynamic voltage comparison is the method employed to sense clipping, this project enjoys a significant advantage over such power-monitoring devices as peak-reading meters and strings of LEDs. A peak-reading meter only indicates that the audio output has reached a given level. It will not necessarily indicate that clipping is taking place. For the sake of illustration, let's consider what happens to an amplifier with an unregulated power supply when it is driven by an audio signal with many high-level transients.

Suppose that our amplifier can deliver 75 watts per channel of continuous power to 8-ohm loads and has an IHF dynamic headroom of 2.04 dB. This means that it can deliver 120 watts of output power into 8 ohms for brief intervals. Consequently, the power supply voltages under full load are +34.6 volts and −34.6 volts. When the demand on the power supply is light, the available voltages are +43.8 and −43.8 volts.

If the supply's filter capacitors have charged up to these higher voltages and a short-lived, high-level transient arrives at the amplifier's audio input, the output stage can momentarily generate an 87.6-volt peak-to-peak waveform without clipping it. However, driving the amplifier this hard causes the voltages across the filter capacitors to decrease. If the amplifier is called upon to reproduce a second high-level transient before the filter capacitors have had an opportunity to recharge sufficiently, clipping will result.

It can thus be seen that a peak-reading audio power meter will not *necessarily* indicate that the amplifier is clipping. In our example, the lowest possible power supply voltages are +34.6 and −34.6 volts, so we can safely say that any audio output signal with a peak power of up to 75 watts as indicated on the peak-reading monitor will not be clipped. Above that power level, however, the meter reading alone will not tell us whether clipping is taking place. By contrast, a flash of the indicator LED in this project warns of the onset of clipping, a warning which takes into account the dynamics of the amplifier's power supply.

Construction. Either printed circuit or perforated board can be used in the assembly of the Amplifier Clipping Indicator. In any event, the use of IC sockets is recommended. Be sure to use the minimum amount of heat and solder consistent with the formation of good solder joints. Also, observe the polarities and pin basings of semiconductors and electrolytic capacitors.

After the project's circuit board has been completed, connect it to *BTS1* and the indicator LED(s) with suitable lengths of hookup wire. Then secure the board to the project enclosure with standoffs and machine hardware. Mount *BTS1* on the rear panel of the enclosure

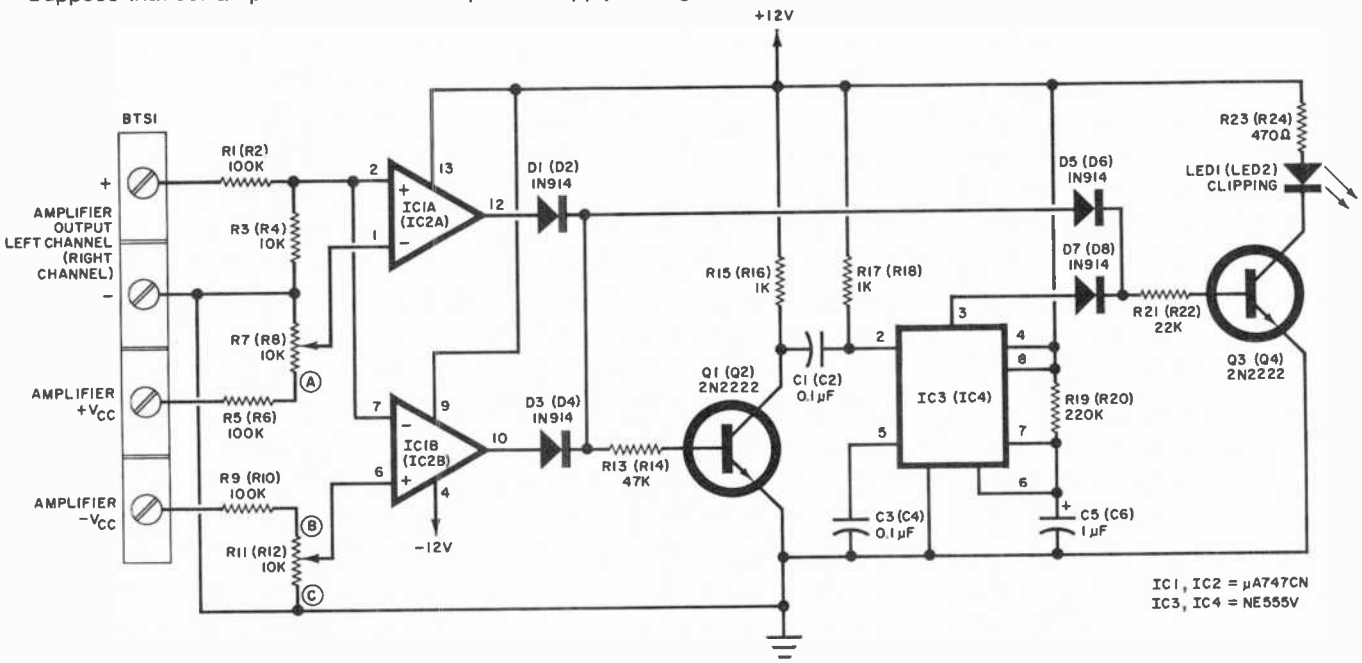


Fig. 2. Schematic of the clipping indicator circuit for one channel.

PARTS LIST

BTS1—Four-position (Six-position) barrier terminal strip
C1 through C4—0.1-µF disc ceramic
C5,C6—1-µF tantalum
D1 through D8—1N914
IC1, IC2—µA747CN dual operational amplifier
IC3,IC4—NE555V timer
LED1,LED2—Light emitting diode
Q1 through Q4—2N2222
The following are ¼-watt, 5% tolerance carbon composition fixed resistors unless otherwise specified.
R1,R2,R5,R6,R9,R10—100,000 ohms
R3,R4—10,000 ohms
R7,R8,R11,R12—10,000-ohm, linear-taper trimmer potentiometer
R13,R14—47,000 ohms
R15,R16,R17,R18—1000 ohms
R19,R20—220,000 ohms
R21,R22—22,000 ohms
R23,R24—470-ohms, ½-watt, 10% tolerance
Misc.—Suitable enclosure, printed circuit or perforated board, bipolar 12-volt power supply, IC sockets or Molex Soldercons, LED mounting collars, machine hardware, hookup wire, solder, etc.

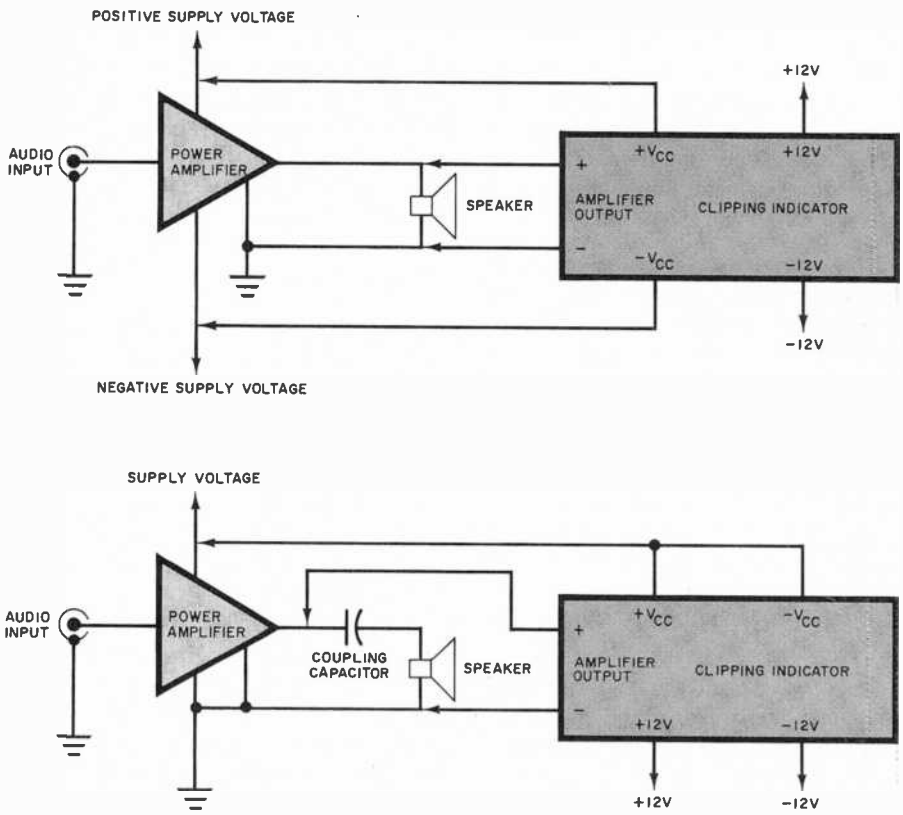


Fig. 3. Diagram showing details of interconnection for amplifiers with bipolar (A) and single-ended (B) power supplies

with machine hardware and the indicator LED(s) on the front panel with rubber grommets or mounting collars made especially for this purpose. As mentioned earlier, operating power for the project can be obtained from a small supply included inside the enclosure or tapped from the amplifier itself if a bipolar dc supply is employed. If the latter approach is taken, the required zener diodes and series resistors will easily fit inside the project enclosure.

Another possible approach, if there is room in the amplifier chassis, is to mount the entire project inside the amplifier and locate the indicator LEDs on the front panel. If this is done, *BTS1* can be eliminated and the connections to the speaker outputs and $+V_{CC}$ and $-V_{CC}$ hard-wired.

Note that the circuit as shown will function properly with audio amplifiers having supply voltages of up to ±60 volts (or +80 or −80 volts in the case of an amplifier with a single-ended supply). That bipolar voltage corresponds to a clipping power of 225 watts into 8 ohms. The project is therefore useable with the vast majority of audio amplifiers commercially available. If you have an amplifier employing greater supply voltages, the circuit can be suitably modified simply by increasing the attenuation factors of the input voltage dividers (increasing the values of *R1*, *R5*, and *R9*).

Interconnection and Adjustment. If your audio amplifier employs a bipolar dc power supply (most do), connect the $+V_{CC}$ and $-V_{CC}$ terminals of *BTS1* to the power supply outputs inside the amplifier. (Note that making these connections will, in most cases void the warranty on your amplifier.) Also, connect the AMPLIFIER OUTPUT terminals of *BTS1* to the amplifier's speaker output terminals in agreement with the polarities indicated in Fig. 2. These connections can be made with standard "zip-cord" or speaker wire. Refer to Fig. 3A for details.

Slightly different connections should be made if your audio amplifier employs a single-ended power supply and a coupling capacitor or transformer between the final amplifying devices and the speaker output terminals. The required connections are as follows: connect the $+V_{CC}$ *and* $-V_{CC}$ terminals of *BTS1* to the "hot" side of the power supply output; and connect the "hot" AMPLIFIER OUTPUT terminal of *BTS1* to the "hot" side of the amplifier output *before* the output coupling (dc blocking) capacitor or transformer. Refer to Fig. 3B.

The circuit's trimmer potentiometers can now be adjusted. Referring to Fig. 2, note the points near *R7* and *R11* designated *A*, *B*, and *C*. If your audio amplifier has a bipolar power supply, adjust the wiper of *R7* so that it is at position *A* and the wiper of *R11* so that it is at position *B*. If your amplifier's power supply is single-ended, adjust the wiper of *R7* so that it is at position *A* and the wiper of *R11* so that it is at position *C*.

Two pieces of test equipment are needed to adjust the trimmer potentiometers properly. The first is a sine-wave generator whose output is of sufficient amplitude to drive the audio amplifier into clipping. (One volt peak-to-peak of drive signal is usually more than adequate.) The second item can be either an oscilloscope or a multimeter, but the former is preferred. We will first describe the procedure to be followed if an oscilloscope is available and then that to be employed if one is not.

Connect a patch cord between the output of the signal generator and the input of the audio amplifier. Then connect the probe running from the oscilloscope's vertical amplifier input to the audio output of the power amplifier. Apply power to the project, signal generator and audio amplifier. Then adjust the amplitude of the generator's output, the gain of the audio amplifier, and the various oscilloscope controls for a stable, sinusoidal trace. The output of the audio amplifier should not be connected to a speaker.

Increase either the gain of the amplifier or the amplitude of the generator output until the oscilloscope trace just begins to reveal clipping of the waveform. Then decrease either the amplifier gain or signal output so that the amplitude of the waveform decreases a few volts below each clipping limit. (This provides a small safety margin so that the indicator LED will start to flash just before clipping actually begins.)

Without disturbing the amplifier, generator, or oscilloscope control settings, adjust trimmer *R7* until the LED starts to flash on positive signal peaks. Make a pencil mark on the circuit board denoting the correct position of the wiper and then return the control to its original setting. Next, adjust *R11* so that the indicator LED starts to flash on negative signal peaks. Once the correct setting of *R11* has been found, don't disturb it. Return to *R7* and adjust its wiper so that it corresponds to the position marked on the circuit board. Decrease the amplitude of

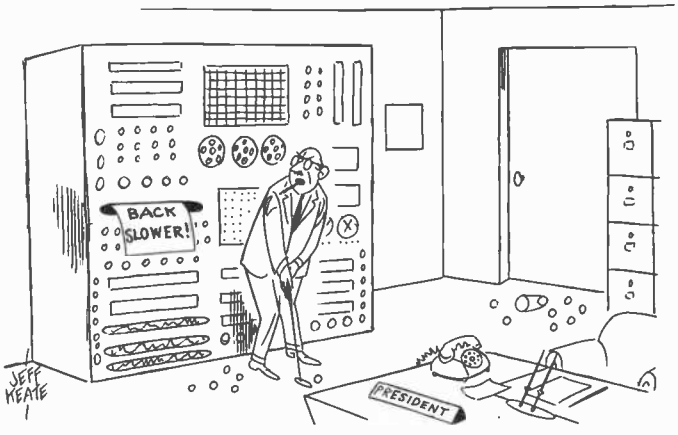
the generator output or the gain of the amplifier, noting that the indicator LED will be extinguished. If you have built more than one Amplifier Clipping Indicator, say, for use with a stereo or four-channel audio amplifier, repeat the procedure just described for each.

Those who do not have acess to an oscilloscope can use a VTVM, VOM, or similar multimeter to adjust the project. First, the power supply limitations of the amplifier with which the project will be used must be determined. Connect the signal generator to the amplifier as described above and adjust the generator for a 60-Hz output. Connect the amplifier's speaker output to an 8-ohm load (a resistor is best) and apply a moderate amount of drive to the amplifier input. With the power supply loaded, measure its output voltage(s). Increase the gain of the amplifier or the amplitude of the drive signal and note whether the power supply voltages decrease. If they do, measure the *minimum* values.

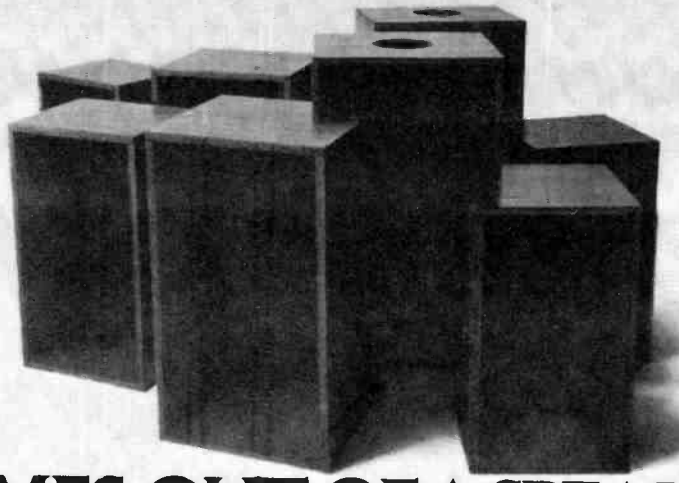
Having performed these measurements, determine the peak-to-peak voltage swing that the output can generate. For example, if the minimum voltages that a bipolar power supply generates under maximum drive conditions are +30 and −30 volts, the continuous peak-to-peak signal that the amplifier can pass at the onset of clipping is 60 volts p-p. Next, calculate the rms output voltage using the equation $V_{rms} = V_{p\text{-}p}/2.828$. For our example, the rms output voltage is 21.2 volts.

Connect the multimeter probes across the 8-ohm load and adjust the amplifier's gain or the amplitude of the input signal so that the calculated rms voltage is indicated by the meter. Then decrease the gain or the drive signal so that the meter reading is a few volts below the calculated value. (This provides the safety margin previously discussed.) Now adjust the trimmer potentiometers in the same manner described in the procedure employing the oscilloscope. Repeat the procedure for the circuit associated with each additional channel of amplification (if any).

Use. The Amplifier Clipping Indicator is now ready for use. With it, you'll be able to adjust drive level and/or amplifier gain so that your amplifier will never go into heavy clipping. Keep in mind that the indicator LED will begin to flash slightly before the the onset of clipping. If the LED starts to blink, back off on the drive level or gain control. Your high-frequency drivers will be glad you did! ◇



"If I want your advice I'll ask for it!"



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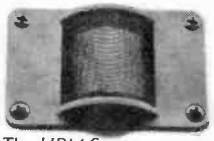
Most speaker companies try to impress you by describing the "incredible" sound that comes out of their speakers.

At Pioneer, we think the best way to describe how good HPM speakers are is to tell you what went into them.

Instead of a conventional tweeter, you'll find HPM speakers have a unique *super*tweeter. In brief, it works on a thin piece of High Polymer Molecular (HPM) film that converts electrical impulses into sound waves without a magnet, voice coil, cone or dome.



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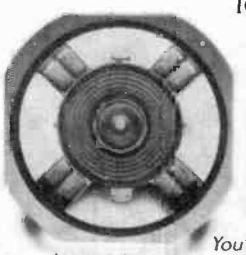

You'll never hear a sound out of these die cast aluminum frames.

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And this virtue isn't something you'll find in only our most expensive HPM speaker. It's found in *every* HPM speaker.

At this point, we suggest you take your favorite record into any Pioneer dealer and audition a pair of HPM speakers in person.

If you think what went into them sounds impressive, wait till you hear what comes out of them.

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During the heating season, you can feel warmer at 65°F, if you humidify the heated air.

SOLID-STATE HUMIDITY CONTROL

BY ANTHONY J. CARISTI

IN THESE days of high energy costs, each of us must pitch in to help reduce energy consumption. In particular, if you are a home owner, you can help simply by turning down the thermostat. At the same time, however, you will want to turn up your "comfort" level. One way to do this is to increase the relative humidity in your home by modernizing the humidification system in your warm-air furnace. The Solid-State Humidity Control described here does just that, economically and reliably.

This automatic humidity control is an easy-to-build, low-cost device that couples to a solenoid-controlled water valve and special humidifier spray nozzle. (Spray nozzles of various water capacities are readily available at many hardware and plumbing-supply outlets at reasonable cost.) To reduce parts cost, you can use a solenoid valve recovered from an old washing machine, if available. The spray nozzle itself mounts anywhere in the direct stream of the heated air so that the fine water mist turns to vapor.

Why Humidify? All heating systems, whether warm-air, hot-water, or steam, should have some form of humidification to promote a healthy environment for you, your family, pets, furnishings, plants, etc. This is especially important during the winter months when the air inside of the home is closed off from the outside air and is heated.

When air is heated, its relative humidity decreases from a healthy 30–50% to as low as an arid 10–20%. The latter is far too low for comfort. It irritates sensitive membranes (which accounts for all those sore throats you get during the winter); is a poor conductor of electricity (hence, the build-up of annoying static-electricity charges on your body when you cross a rug); and makes temperatures in the 50° to 70° F range appear to be colder than they really are.

By raising the humidity level in the air in your home during the winter months, you can alleviate many of these prob-

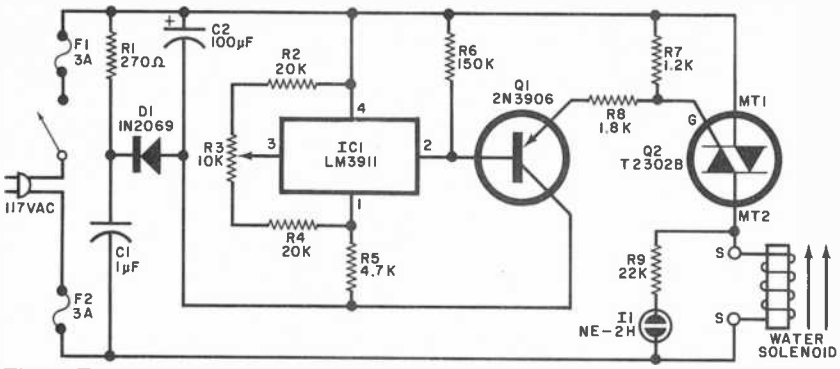


Fig. 1. Temperature sensor IC1, in furnace plenum chamber, determines when solenoid operates to spray fine water mist into chamber.

PARTS LIST

C1—1-μF, 200-V nonpolarized capacitor
C2—100-μF, 25-V tantalum capacitor
D1—1N2069 or similar rectifier
F1,F2—3-ampere slow-blow fuse (MDL-3 or equivalent)
I1—NE-2H neon lamp
IC1—LM3911N temperature-controller (National)
Q1—2N3906 or similar transistor
Q2—T2302B triac (RCA)
The following resistors are ¼-W, 10%, unless otherwise specified:
R1—270-ohm, 2-watt, 10% resistor
R2,R4—20,000 ohms metal film (see text)
R3—10,000-ohm subminiature trimmer
R5—4700 ohms
R6—150,000 ohms
R7—1200 ohms
R8—1800 ohms
R9—22,000 ohms
S1—Spst switch (optional)
Misc.—Printed-circuit board; fuse holders for F1 and F2; 120-volt ac water solenoid (W.W. Grainger No. 6X230 or similar); spray nozzle (see Note below); 4-conductor (color-coded) cable; hookup wire; etc.
Note: The required spray nozzle is available from Wm. Stein Mfg. Co., 29 E Halsey Rd., Parsippany, NJ 07054. Specify part No. A-37 (0.37 gallon/hr) or No. A-50 (0.5 gallon/hr). The following are available from A. Caristi, 69 White Pond Rd., Waldwick, NJ 07463: pc board at $3.60; IC1 at $3.00; and Q2 at $3.00.

lems. In terms of saving energy (fuel), you can reduce your thermostat setting while maintaining a relative humidity of 30% to 50% and feel warmer at 66° to 70° F than you would at 75° in arid air.

Circuit Operation. The heart of the humidity controller is a special integrated circuit, *IC1*. This four-terminal LM3911 has an entire temperature-control system on a single chip. Included in this IC are a temperature sensor, stable voltage reference, and operational amplifier. As shown in Fig. 1, the internal op amp is wired as a comparator with external resistors so that the pin-2 output switches voltage as the temperature of the IC's case traverses the set-point determined by the reference voltage on pin 3. Since the IC has a built-in 6.8-volt reference supply, the temperature switch-point of the controller is held stable regardless of power-line voltage.

The output current from *IC1* is insufficient to drive the gate of triac *Q2*. Therefore, *Q1* is used to amplify this current to a sufficient level.

When the temperature of *IC1* drops below the set-point, the voltage at pin 3 cuts off *Q1*. Conversely, as the temperature rises above the set-point, *IC1*'s output switches negative and sends *Q1* into conduction. This, in turn, applies sufficient current to the gate of *Q2* to cause the triac to trigger on and energize the water solenoid. Neon lamp *I1*, connected across the solenoid (with dropping resistor *R9*), provides visual indication that the solenoid has been energized and the water is on.

By physically locating *IC1* in the warm-air stream of the furnace, we can ensure that the water solenoid will be energized only when the temperature of the heated air is sufficient to vaporize the mist from the spray head. When the burner shuts off and the air cools, the spray is automatically terminated. Potentiometer *R3* in the input circuit of *IC1* allows you to select warmer or cooler switching temperatures, permitting you to adjust duty cycle of the spray and, thus, the degree of humidification.

Dc power for *IC1* and *Q1* is provided by *R1*, *C1*, *D1*, and *C2*, with *R1* and *C1* forming a voltage-divider network. Since *C1* is purely reactive, it dissipates no power and remains cool. This makes it possible to develop a relatively low voltage across *R1* without need for a power transformer or high-wattage resistor. Current through *D1* charges *C2* to about 20 volts. Fuses *F1* and *F2* protect the circuit against excessive damage in the event of component failure. As either side of the circuit can be connected to the "hot" leg of the power line, both sides are fused.

Construction. The circuit is best assembled on a printed-circuit board, etching-and-drilling and components-placement guides for which are shown in Fig. 2. When laying out the board for etching, be sure to maintain the heavy conductor traces where indicated.

Wire the board as shown, taking care to properly orient *D1*, *C2*, *Q1*, and *Q2*. Be sure to use a nonpolarized capacitor for *C1*.

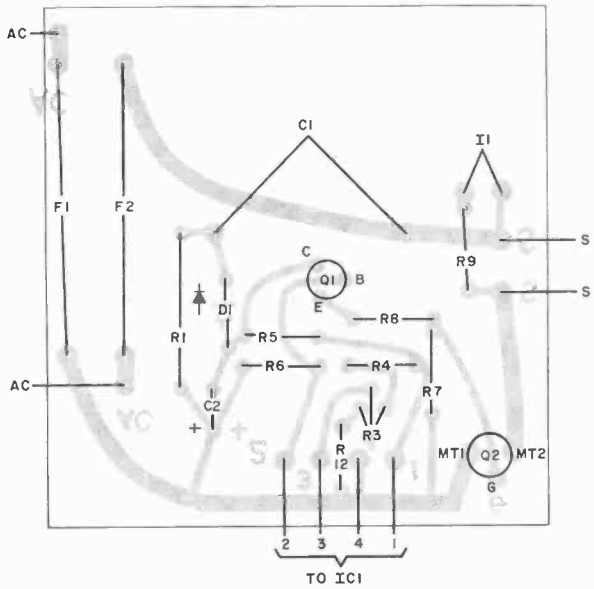
Metal-film resistors are specified for *R2* and *R4* in the Parts List to maintain greatest temperature set-point stability. If you substitute 10% composition resistors, you can use 18,000 ohms instead of the specified 20,000 ohms.

Note that *IC1* mounts off the board, inside the heated-air chamber (plenum) of your furnace, where it will be able to sense burner operation. Connection between *IC1* and the board is accomplished with a four-conductor, preferably color-coded, cable. Pay strict attention to pin connections when wiring *IC1* to the board via its cable, referring back to Fig. 1 as necessary. (The length of the interconnecting cable is not critical.)

When mounting *IC1* in the plenum, make absolutely certain its terminals are insulated from all metal parts in the furnace, since the IC is electrically connected to a circuit that does not have an isolation transformer. Should the IC touch any metal part of the furnace, the resulting short circuit will destroy the IC. Also, do not locate *IC1* where it will come into contact with the water supply.

The water solenoid valve terminals connect to the pc board at the two points labelled with an S. Use at least 20-gauge wire for the connections. Power input to the circuit, labelled AC on the board, can be made via a conventional line cord and plug. You can install an optional power switch in series with the ac line, if desired.

Typical installation of the system is illustrated in Fig. 3. The water connection between supply and spray nozzle can be made via ¼" (6.4-mm) copper tubing and plumbing fittings as required. Mount the spray nozzle to the wall of the plenum chamber so that it sprays into the heated section of the warm-air chamber. Do *not* place it in the cold-air return. To



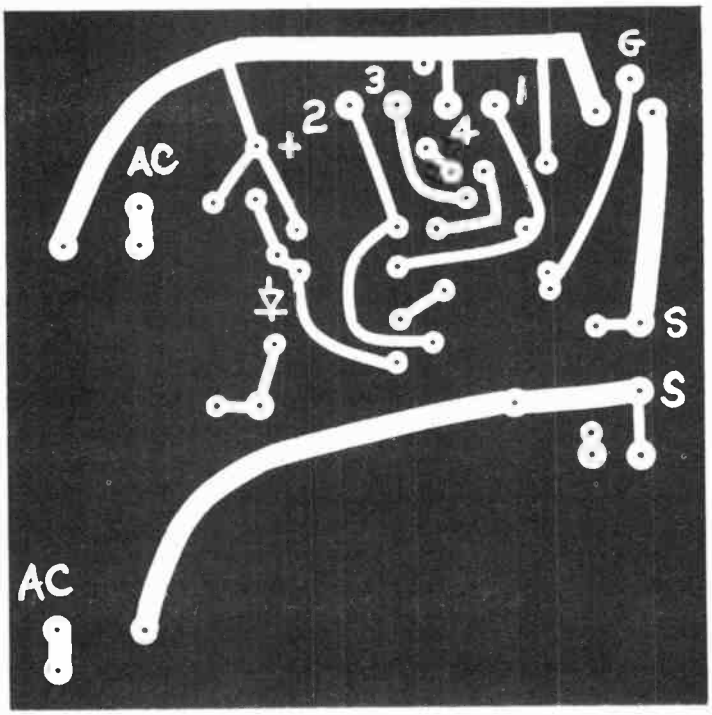


Fig. 2. Actual-size foil pattern for pc board is at right; component installation above. Note that IC1 is not on the board. When mounting board, make sure it is isolated from ground.

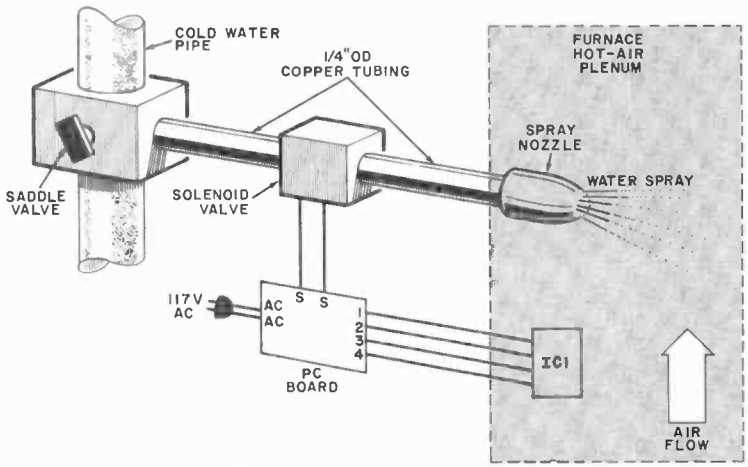


Fig. 3. Typical installation showing plumbing. An optional power switch can be connected to the ac line.

do so will cause improper operation and possible damage to your furnace.

Checkout and Use. Before installing the control system, check for correct circuit operation. You do not need the water-supply connection for this check.

First, make certain that *IC1* is fully insulated from all metal objects and your person. Then connect the solenoid terminals to points S on the board. Rotate *R3* over its range. At some point, you should hear the solenoid click and see the neon lamp light simultaneously. This setting will be close to room temperature. Adjust *R3* so that *I1* just extinguishes to obtain an approximate setting for the potentiometer. This done, disconnect the project from the ac line and install the pc board permanently.

Install the spray nozzle in the plenum. Refer to the Parts List for specifications on two sizes of spray nozzles. Use part No. A-37 for smaller or No. A-50 for larger homes.

Final adjustment of *R3* can be made by placing the furnace in operation and setting the pot to operate the solenoid just after the furnace blower comes on. This will provide maximum humidification for your heating system. If you require less humidification, readjust R3.

In Closing. If you wish to conserve energy and/or reduce your heating costs while maintaining a comfortable living environment, simply modernize your humidifier system with the automatic controller described here. ◇

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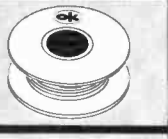

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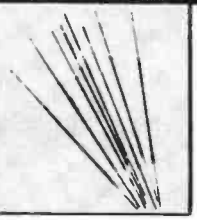

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Wire for wire wrapping, AWG-30 (0.25mm) KYNAR* wire, 50 wires per package stripped 1" both ends.

*KYNAR PENNWALT

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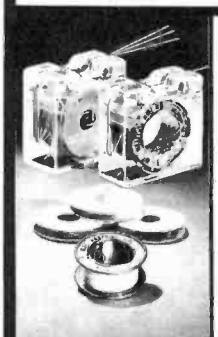
30 W 50-010	30 AWG White Wire 1" Long	$.99
30 R 50-010	30 AWG Red Wire 1" Long	$.99
30 B 50-020	30 AWG Blue Wire, 2" Long	$1.07
30 Y 50-020	30 AWG Yellow Wire 2" Long	$1.07
30 W 50-020	30 AWG White Wire 2" Long	$1.07
30 R 50-020	30 AWG Red Wire 2" Long	$1.07
30 B 50-030	30 AWG Blue Wire, 3" Long	$1.16
30 Y 50-030	30 AWG Yellow Wire 3" Long	$1.16
30 W 50-030	30 AWG White Wire 3" Long	$1.16
30 R 50-030	30 AWG Red Wire 3" Long	$1.16
30 B 50-040	30 AWG Blue Wire 4" Long	$1.23
30 Y 50-040	30 AWG Yellow Wire 4" Long	$1.23
30 W 50-040	30 AWG White Wire 4" Long	$1.23
30 R 50-040	30 AWG Red Wire 4" Long	$1.23
30 B 50-050	30 AWG Blue Wire 5" Long	$1.30
30 Y 50-050	30 AWG Yellow Wire 5" Long	$1.30
30 W 50-050	30 AWG White Wire 5" Long	$1.30
30 R 50-050	30 AWG Red Wire 5" Long	$1.30
30 B 50-060	30 AWG Blue Wire 6" Long	$1.38
30 Y 50-060	30 AWG Yellow Wire 6" Long	$1.38
30 W 50-060	30 AWG White Wire 6" Long	$1.38
30 R 50-060	30 AWG Red Wire 6" Long	$1.38



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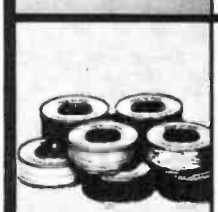

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HK-24	24 AWG	50 FT.	SOLID CONDUCTOR	$1.35
HK-26	26 AWG	50 FT.	SOLID CONDUCTOR	$1.35
SHK-18	18 AWG	25 FT.	STRANDED CONDUCTOR	$1.20
SHK-20	20 AWG	25 FT.	STRANDED CONDUCTOR	$ .98
SHK-22	22 AWG	50 FT.	STRANDED CONDUCTOR	$1.35
SHK-24	24 AWG	50 FT.	STRANDED CONDUCTOR	$1.35
SHK-26	26 AWG	50 FT.	STRANDED CONDUCTOR	$1.35

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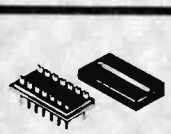

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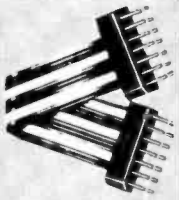
QUANTITY: 2 PLUGS, 2 COVERS



RIBBON CABLE ASSEMBLY DOUBLE END

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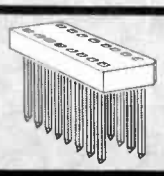
DE 14-8	WITH 14 PIN DIP PLUG – 8"	$3.95
DE 14-12	WITH 14 PIN DIP PLUG – 12"	$4.07
DE 14-16	WITH 14 PIN DIP PLUG – 16"	$4.12
DE 14-24	WITH 14 PIN DIP PLUG – 24"	$4.15
DE 16-2	WITH 16 PIN DIP PLUG – 2"	$4.15
DE 16-4	WITH 16 PIN DIP PLUG – 4"	$4.25
DE 16-8	WITH 16 PIN DIP PLUG – 8"	$4.35
DE 16-12	WITH 16 PIN DIP PLUG – 12"	$4.47
DE 16-16	WITH 16 PIN DIP PLUG – 16"	$4.52
DE 16-24	WITH 16 PIN DIP PLUG – 24"	$4.55
DE 24-6	WITH 24 PIN DIP PLUG – 6"	$6.05
DE 24-8	WITH 24 PIN DIP PLUG – 8"	$6.50
DE 24-12	WITH 24 PIN DIP PLUG – 12"	$6.90
DE 24-16	WITH 24 PIN DIP PLUG – 16"	$7.10
DE 24-24	WITH 24 PIN DIP PLUG – 24"	$7.70



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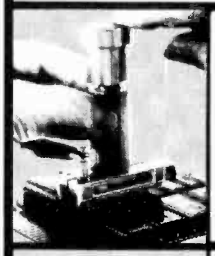

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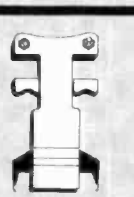

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GROUND STRAP NOT INCLUDED

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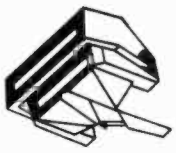
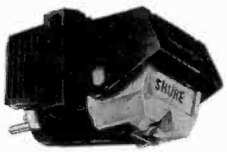
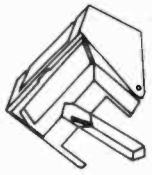
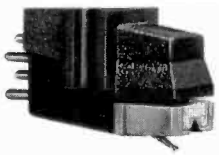
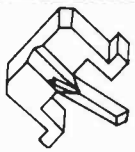
IF YOU OWN:	UPGRADE WITH:	THIS IS THE RESULT:
 **V15 Type III SERIES**	**VN35HE** Hyperelliptical stylus 	A dramatic reduction of harmonic and intermodulation distortion (formerly available only to owners of the incomparable V15 Type IV) is now possible with the V15 Type III and the M95 Series of cartridges simply by replacing the stylus. The Hyperelliptical stylus configuration contacts the record groove in a "footprint" that is longer and narrower than the popular Biradial tip design, making it pre-eminent for reproduction of the stereo-cut groove.
 **M95 SERIES**	**N95HE*** Hyperelliptical stylus 	
 **M70 SERIES**	**N72EJ** Biradial (Elliptical) stylus **N72B** Spherical stylus 	Improved trackability, especially at high frequencies, due to a new, redesigned low-mass N72 stylus assembly.
ANY M91, M92, M93	**N91ED*** stylus	Much improved trackability due to the lower effective tip mass of the nude Biradial (Elliptical) stylus tip. Less tracing distortion compared with a Spherical stylus tip.
ANY M71, M73, M75	**N75 TYPE 2*** Series styli	Improved trackability at higher frequencies due to a stylus assembly with a lower effective tip mass.
ANY M44 Series	**N55E*** stylus	Lower tracking force with a Biradial (Elliptical) stylus, lower distortion, lower effective tip mass.
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CIRCLE NO. 65 ON FREE INFORMATION CARD

BY JOSEPH J. CARR

Practical, low-cost references for checking accuracy of test instruments

Precision References for Current & Voltage

PRECISION voltage and current references are routinely used in a variety of applications. These references are useful for calibrating vertical deflection factors of oscilloscopes and indications of voltmeters and ammeters, for example. They also find use in data conversion, where almost all analog-to-digital (A/D) and digital-to-analog (D/A) converters employ a reference voltage or current. Regulated dc power supplies that employ error amplifiers also require precision voltage references. (The output of an error amplifier controls regulator action, which is, in turn, controlled by the difference between actual output-supply and reference voltages.)

Precision references were quite costly only a few years ago. Now, owing to low-cost ICs, good precision references can be built at low cost.

Before we examine IC voltage and current references in detail, let us review some of the older methods for obtaining references so that principles will be more readily understood.

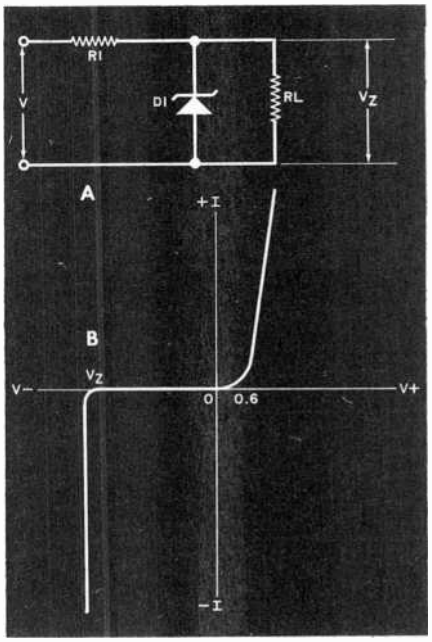

Fig. 1. Zener-diode reference supply. The circuit is shown at A, while the characteristic curve is below at B. The fact that the zener voltage is dependent on temperature must be kept in mind in circuit design.

Zener Diode. A simple circuit in which a zener diode is the regulator element is shown in Fig. 1. Also shown is a typical zener-diode characteristic curve. In the V+ forward-bias region, the zener diode behaves much like any other silicon diode that conducts a +I forward-current when V+ is greater than about 0.6 volt. In the V− reverse-bias direction, however, there is a distinct difference between zener and conventional silicon-diode behavior.

Normally, a conventional silicon diode does not conduct current when reverse biased (except when applied reverse-bias voltage exceeds the diode's rated PIV). A zener diode acts quite conventionally between 0 and some V− value called the "zener potential," or V_Z. When V− reaches or exceeds V_Z, the diode breaks over and begins to conduct a reverse current.

As long as ambient temperature is held constant, V_Z will also be constant. Bear in mind that the V_Z value is different for different types of zener diodes and that even then there is a "nominal" voltage. This means that a large number of identical zener diodes will have values that cluster closely around V_Z.

When you build a precision power supply or reference source, you must keep either of two considerations in mind. You must provide a constant-temperature environment or use temperature-compensated circuitry. Then either hand-select the zener diode or provide a means for adjusting the output of the circuit so you can compensate for incorrect zener potentials.

Unfortunately, temperature cannot always be maintained constant in practical circuits, especially where cost is a factor. An attempt at solving temperature dependence by using several zener diodes to produce the desired V_O output voltage is shown in Fig. 2. The actual V_Z value for the different diodes will vary with changes in temperature, but if all diodes used are in the same thermal environment, any temperature change affects all diodes equally. The output voltage, which is the differential voltage between the two points shown, remains constant regardless of temperature changes. Output potential V_O = (V5 + V6) − V3.

A problem with circuits such as that shown in Fig. 2 is that the output voltage is not ground referenced. If a ground-referenced potential is required, V_O should be applied across the differential inputs of an operational amplifier. The output potential from the op amp would then be the product of op-amp gain A_V

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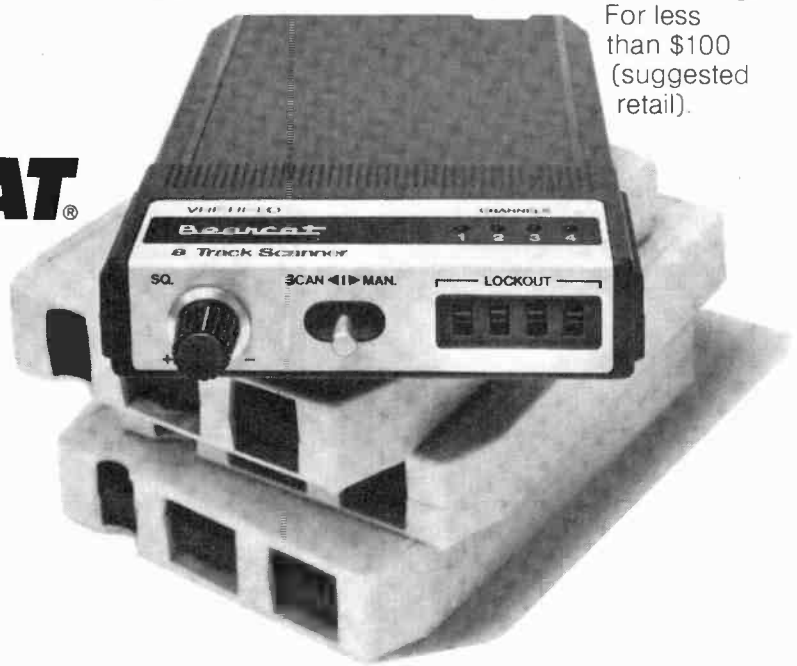

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CIRCLE NO. 24 ON FREE INFORMATION CARD

Experimenter's Corner

By Forrest M. Mims

FREQUENCY-TO-VOLTAGE CONVERTERS

LAST MONTH, we became acquainted with the Teledyne 9400 and the National Semiconductor LM331, two relatively new chips designed primarily to convert an input voltage into a pulse train with a linearly proportional output frequency. Prior to the introduction of these and similar voltage-to-frequency (V/F) converter chips, moderately complicated discrete circuits or expensive hybrid modules were required to perform V/F conversion.

Important features of the 9400 and LM331 are that both chips can also be used for frequency-to-voltage (F/V) conversion applications. Whether operated in conjunction with a V/F converter or alone in a straightforward F/V mode, both the 9400 and LM331 have many interesting applications. We'll look at several, but first a brief explanation of how a typical F/V converter works.

F/V Conversion. The F/V operation of a V/F converter chip is very straightforward and is even easier to understand than operation of the same IC in its V/F mode. Figure 1 is a simplified functional diagram of the LM331 connected as a F/V converter.

In operation, the incoming signal is applied directly to the noninverting input of the comparator. The inverting input of the comparator is biased at a voltage determined by the values of divider resistors *R1* and *R2*. The comparator output switches states each time the amplitude of the incoming frequency exceeds or drops below the reference voltage.

The one-shot is triggered by a positive transition at the output of the comparator. This in turn, closes the current switch and allows the current source to charge output filter capacitor *C2* for a period determined by the time constant *R3C1*. Bleeder resistor *R4* continually discharges *C2* so that the charge stored in this capacitor at any instant approximates the average charge available from the current source. In short, the charge stored in *C2* (and thus the voltage across it) is directly proportional to the input frequency.

Incidentally, can you think of a drawback to the basic circuit in Fig. 1? (Hint: Consider the time constant *R4C2*. How will this affect the circuit's ability to respond to an input signal whose frequency is rapidly changing?)

LM331 F/V Converter. In last month's column, I described some straightforward V/F applications for the LM331. Shown in Fig. 2 is a working F/V converter whose operation is similar to that of the functional diagram in Fig. 1. This schematic shows how to use the LM331 as a simple F/V converter.

In operation, the incoming signal is coupled to the comparator in the LM331 via *C1*. Resistors *R2* and *R3* provide the reference voltage to the comparator. The operation of the one-shot in the LM331 is determined by the time constant *R6C2*, and the output signal is filtered by *C3* and *R7*. Potentiometer *R5* provides a very useful calibration feature. Together with *R4*, it controls the current that charges *C3*. In short, *R4* and *R5* in Fig. 2 are equivalent to *R5* in Fig. 1.

Figure 3 shows the highly linear response of a breadboard version of the circuit shown in Fig. 2. When the circuit was powered by a 15-volt supply, its response was linear beyond 10,000 Hz. When I powered the circuit with a single 9-volt battery, however, its response was linear only up to about 6500 Hz. This happened because the largest possible output voltage the circuit can provide is 6.5 volts when powered by a 9-volt supply.

For both tests, *R5* was used to calibrate the circuit so that a 3000-Hz input would result in a 3.00-volt output and that a 1000-Hz change in the input frequency would cause the output to change by precisely 1.00 volt. This very simple alignment procedure yielded excellent results, as Fig. 3 indicates.

When the F/V measurements were made for a third time with the circuit calibrated so that a 5000-Hz input signal yielded a 5.00-volt output, the following strikingly linear results were obtained:

Input Frequency (Hz)	Output (volts)
0	0.00
100	0.10
500	0.50
1000	1.00
2000	2.00
3000	3.01
4000	4.00
5000*	5.00
6000	6.00
7000	7.00
8000	7.97
9000	8.94
10000	9.91

* Calibration point.

These measurements were made with the help of a DVM and a digital frequency counter. This excellent linearity is typical of the results obtained from breadboard V/F and F/V converter circuits employing the LM331 or 9400.

9400 F/V Converter. Last month, we experimented with a very linear V/F converter built around a 9400 IC. Figure 4 shows a 9400 connected as a F/V converter to decode data transmitted by an infrared LED driven by a 9400 V/F converter. This pair of circuits, which is adapted from a design by Michael O. Paiva, Teledyne Semiconductor's Product Marketing Manager, makes an ex-

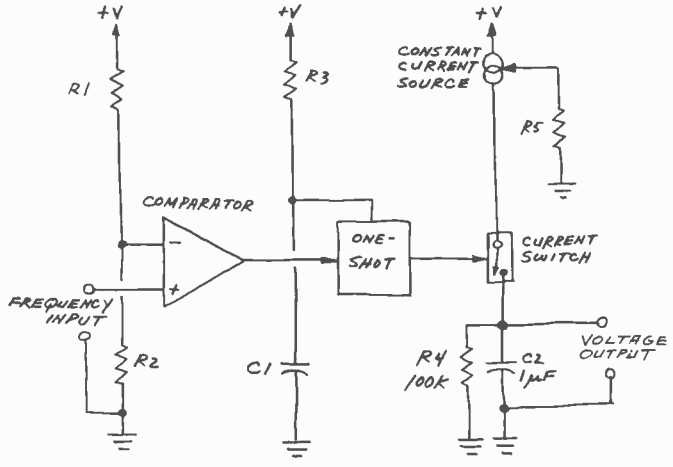

Fig. 1. A typical frequency-to-voltage converter.

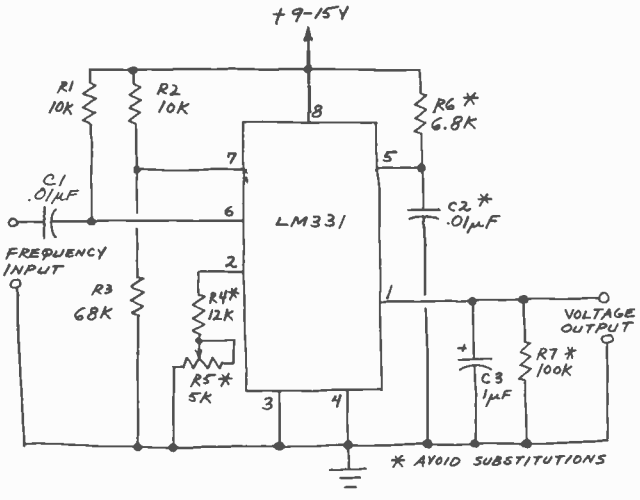

Fig. 2. Frequency-to-voltage (F/V) converter using LM332.

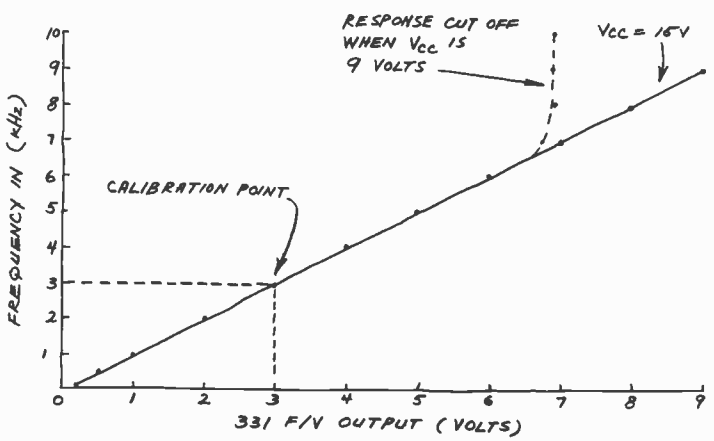

Fig. 3. Plot of output voltage vs. input frequency for a frequency-to-voltage converter using an LM331.

cellent analog data transmission system.

The transmitter portion of the circuit is essentially identical to Fig. 2 in last month's column. The only significant change is the addition of *R7*, a miniature 8-ohm speaker and an infrared LED. Resistor *R7* is required to limit current through the LED to a safe value. The speaker is entirely optional. Because the frequency of the pulse train generated by the transmitter's V/F converter remains within the audio range, the speaker provides a convenient way of monitoring the circuit's operation, particularly during preliminary testing and evaluation. The speaker can be removed later if desired.

The receiver consumes only about 3.5 mA when powered by a 9-volt battery. Its output voltage appears at pin 12, so a DVM can be used for a readout. It's more convenient, however, to connect a small 0-to-1 or 0-to-10-mA panel meter directly to the output as shown in Fig. 4.

A DMM operating in its current-reading mode can be connected in place of the meter for more accurate measurements. I experimented with both methods and found the conventional meter best for initial adjustments and tests, while the DVM proved to be superior for taking data such as that used to plot graphs.

The transmitter LED and receiver phototransistor can be replaced by an optoisolator if electrical isolation is the only reason for using this circuit. If this is done, it might be necessary to increase the value of *R7* in the transmitter to reduce the LED's forward current and prevent the receiver from responding in a nonlinear fashion. In other applications, the signal from the transmitter LED can be sent through the air or through a plastic or glass optical fiber.

I spent most of one day experimenting with this analog transmission system and made a few observations you might find useful should you decide to duplicate it. First, the receiver operates erratically when the optical signal at *Q1* is excessive. If the signal is too weak, the meter indicates zero output current. But when the signal is too strong, the meter needle may slam or swing wildly back and forth. These same effects can occur if the value of *R12* is reduced significantly.

While experimenting with the system, I experienced considerable trouble when the fre-

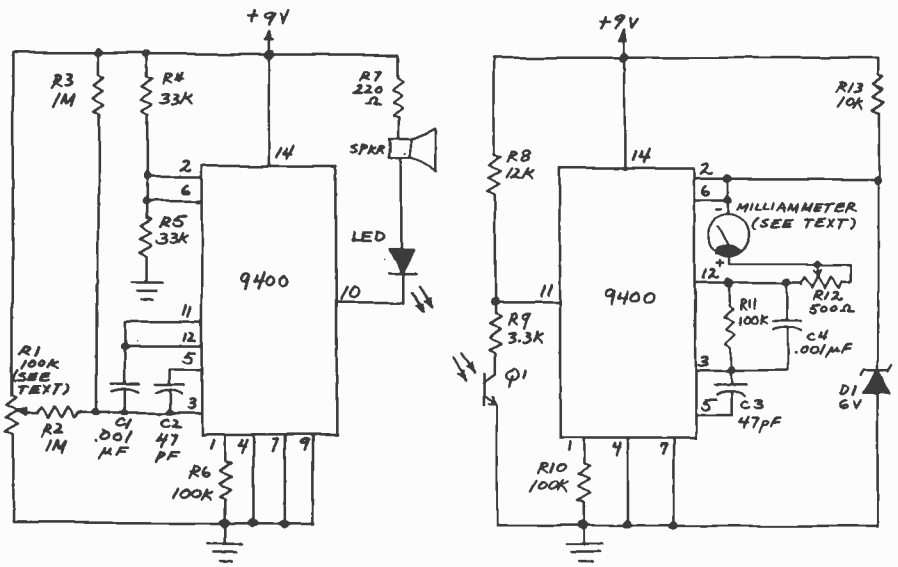

Fig. 4. Analog data transmission system designed by Michael Paiva.

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Like many technological discoveries, voice stress analyzers grew out of military research during the Vietnam war. Army intelligence needed something better than the standard polygraph to interrogate prisoners. A simple method that could be used without the subject's knowledge. The voice stress analyzer was the result!

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In the past only the largest, most profitable companies felt they could justify spending $1500 to $5000 to purchase a voice stress analyzer. However, like everything else in the electronics field, these high prices reflect the heritage of a prototype, and not the quality of a reliable voice stress analyzer.

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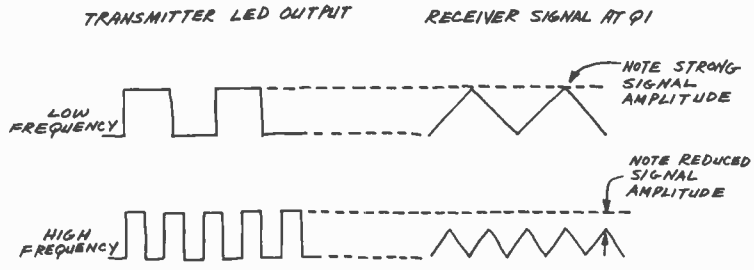

Fig. 5. Reduction in receiver signal of 9400 F/V circuit at a high input frequency.

quency of the incoming signal exceeded a few kilohertz. Although the receiver would readily respond to frequencies in excess of several kilohertz when the signal was coupled directly into pin 11 of the 9400, the receiver meter would indicate zero when the signal was received from the transmitter LED via the phototransistor.

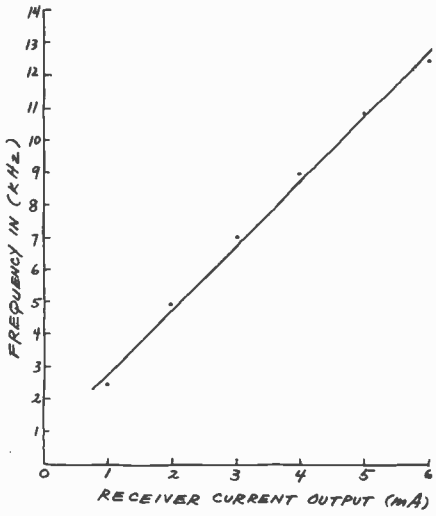

Fig. 6. Receiver output current vs. input frequency for 9400 analog transmission system.

The problem was traced to the integrating effect of *Q1*, *R8* and *R9* in the receiver. When the incoming pulse train has a low to moderate frequency, the individual pulses are sufficiently wide to produce a signal at pin 11 having enough amplitude to trigger the receiver. As the transmitter frequency is increased, however, the pulses become correspondingly narrower. The *Q1/R1/R2* combination then produces an output pulse having insufficient amplitude to trigger the receiver. This effect is illustrated in Fig. 5.

With the component values specified in Fig. 4, the analog system can transmit an input ranging from 0.25 to 8 volts. The received signal, as displayed on a milliammeter, will range from a minimum of 0.2 mA to a maximum of about 6 mA. Figure 6 is a plot of the transmitted frequency versus the receiver output current. Increasing *C2* in the transmitter to 220 pF will lower the maximum frequency and restrict the maximum receiver output current to about 0.8 mA, thus allowing use of a 0-to-1-mA meter. Shown in Fig. 7 is a plot of the transmitted frequency versus the receiver output current when C2 is 220 pF.

Before attempting any practical application of the analog transmission system it is necessary to make a graph that plots the transmitter's input voltage versus the receiver's output current. Last month's column included graphs showing the operation of a V/F converter, and we've just looked at graphs describing the operation of a F/V converter. It's very easy to make graphs like these, so I'll leave to you the preparation of a graph showing the operation of the analog transmission system. All you have to do is record the receiver output current for each 1-volt increase in transmitter input and plot the results. You don't have to measure the transmitter's output frequency.

Other F/V Applications. After you've gained some experience with the basic F/V circuits described in this column and the V/F circuits featured last month, you should be well prepared to move ahead on your own. Try to obtain copies of the 9400 and LM331 data sheets. Besides providing valuable operating tips, they suggest many interesting applications.

Also, remember that you can use either the 9400 *or* LM331 in most F/V (and V/F) applications. The chips are not directly interchangeable and they're not even functionally identical. But their operation in both V/F and F/V modes is very similar. For example, with the help of the National Semiconductor data sheet, you should be able to adapt the analog transmission system shown in Fig. 4 for use with LM311 instead of 9400 ICs. ◇

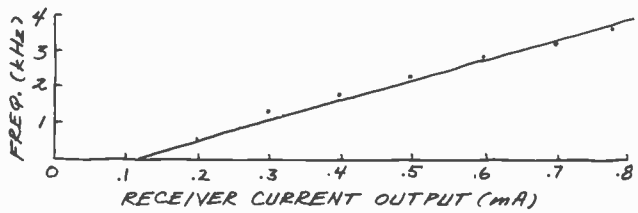

Fig. 7. Analog transmission system with 0-1-mA output.

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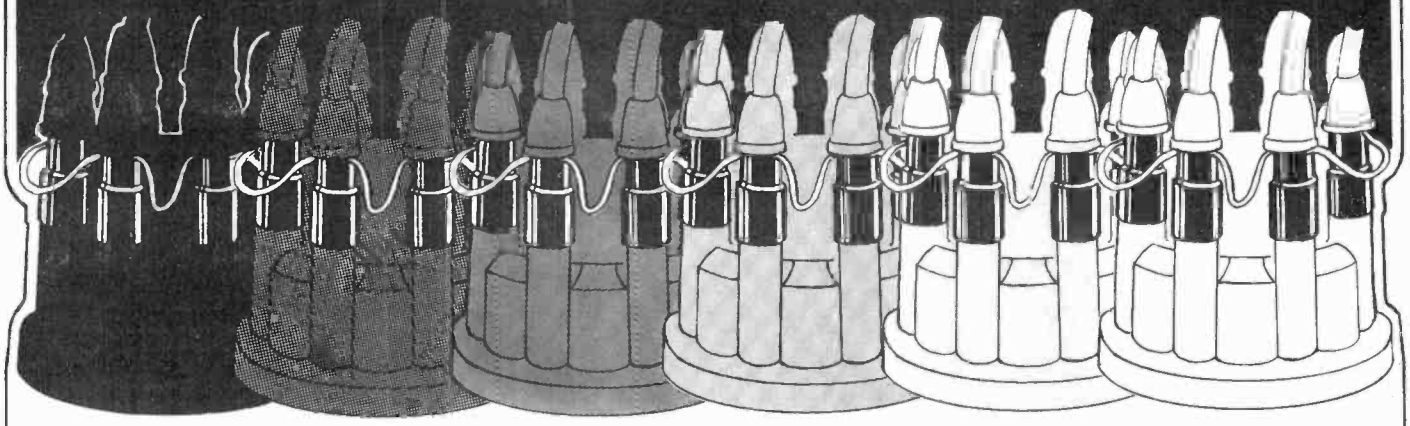

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Product Test Report

Realistic DX-300 Communications Receiver

Modestly priced shortwave receiver features digital frequency display

THERE HAS always been a need for low-cost general-coverage receivers for the shortwave listener and novice (or prenovice) ham. Indeed, a number of such receivers are available from different manufacturers. Most of them, however, have limited frequency coverage, excessively fast tuning rates, little or no bandspread, and imprecise dial calibration that makes identifying a station by its position on the dial nearly impossible. Although they are often called "communication" receivers, they are usually unsuited for any serious logging. An exception to this is Radio Shack's new Realistic Model DX-300.

The DX-300 largely overcomes the limitations cited above, while still selling for an affordable price. It continuously covers from 10 kHz to 30 MHz, with the frequency appearing in a five-digit LED display. The display section is based on a frequency counter whose specified accuracy and resolution are 1000 Hz anywhere in the receiver's tuning range. The triple-conversion superheterodyne receiver has a drift rate of less than 1000 Hz/hr after a one-hour warmup. All common transmission modes can be received, including AM, SSB, and CW.

The receiver has a built-in ac power supply and can also operate independently of commercial power on eight internal C cells or an external 12-volt battery. Built-in are a loudspeaker and facilities to drive headphones or an external speaker. A carrying handle is recessed into the right side of the cabinet. Overall size is 14½" W X 10" D X 6" H (362 X 252 X 146 mm), and weight is 13.2 lb (6 kg) without batteries. Price is $379.95.

General Description. Tuning is via two concentric controls. The outer control is for MHz selection and affects only the megahertz portion of the numeric display, from 0 to 29. The inner tuning knob has a convenient spinner crank, covers a 1000-kHz range, and affects only the three least-significant digits of the display. The main tuning knob covers approximately 65 kHz per revolution. A small FINE TUNE control covers about 1 to 2 kHz in a 180° rotation.

A signal-strength meter reads in S units to 30 dB or S9. Near the meter is a PRESELECTOR dial with six calibrated scales that cover the full tuning range of the receiver. A PRESELECTOR BAND switch below it permits selection of the appropriate range, which is indicated by a LED below the selected scale. A separate PRESELECTOR TUNE control can be used to peak the receiver's front end to the tuned frequency.

The ATTENUATOR switch permits insertion of 0, 20, or 40 dB of loss into the antenna input to prevent overload from strong signals. The AUDIO bandwidth switch is for selecting NARROW, WIDE, or NORMAL audio bandwidth to suit the type of reception and minimize noise.

The MODE switch has positions for LSB or USB (and CW), AM, AM with automatic noise limiter (anl), and STANDBY. On the rear apron of the receiver are phono jacks for TAPE OUT and EXT SPEAKER, miniature KEY jack (for using the receiver as a code practice oscillator), a connector for powering the receiver from an external 12-volt dc supply, and several antenna terminals. A uhf-type coaxial connector is provided for the main hf antenna, which is the only one affected by the ATTENUATOR. There are screw terminals for a long-wire antenna and ground and MUTE. (The last performs the same function as the MODE switch in STANDBY.) A hinged door on the back of the receiver provides access to the battery compartment.

The owner's manual gives few details about the receiver's circuits, other than to state that the first conversion signal is derived from a 4-MHz crystal oscillator that is used to generate a "comb" of signals at 1-MHz intervals to up-convert received signals to a 54.5-to-55.5-MHz first i-f. The MHz knob tunes filter circuits to select the desired conversion oscillator frequency. Second conversion is to a 2-to-3-MHz bandpass i-f, and final conversion, with the tunable oscillator covering 2.455 to 3.455 MHz, is to 455 kHz. Selectivity is provided by a six-element ceramic filter at 455 kHz.

Apparently, after subtracting the 455-kHz i-f, the MHz selector simultaneously switches the first one or two digits of the LED display to update the band, while the three other digits are the readout of an IC counter that measures the frequency of the tunable third local oscillator. The only other technical information supplied is that the DX-300 uses a dual MOSFET first mixer for maximum dynamic range and a rather impressive semiconductor complement.

Laboratory Measurements. Our laboratory measurements were limited

Continued on page 100

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• Frequency Range: 10 Hz to 600 MHz guaranteed (5 Hz to 750 MHz typical). • Sensitivity: ≤ 10 mV RMS, 10 Hz to 100 MHz, prescaler mode; 50 mV RMS, 100 MHz to 450 MHz; 70 mV RMS, 450 MHz to 600 MHz • Impedance: 1 MΩ, 10 MHz & 100 MHz range; 50Ω, 600 MHz • Temperature Stability: 0.1 ppm/°C • Gate Time: Switch-selectable, 0.1 sec., 1 sec., 10 sec. • Ageing Rate: ≤ ±5 ppm/yr • Accuracy: 1 ppm +1 digit. • Input Protection: 150 V RMS, 5 Hz to 10 kHz; 90 V RMS, 10 kHz to 2 MHz; 30 V RMS, 2 MHz to 100 MHz; 10 V RMS, 100 MHz to 750 MHz. • Power Requirement: Battery-operated, 4.5 to 6.5 VDC @ 300 mA. External power supply, 7.5 to 9 VDC @ 300 mA • Size: 8"W x 6.5"D x 3"H (203 x 165 x 76 mm) • Weight: Without batteries, 1.2 lbs. (0.54 kg).

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Continued from page 98

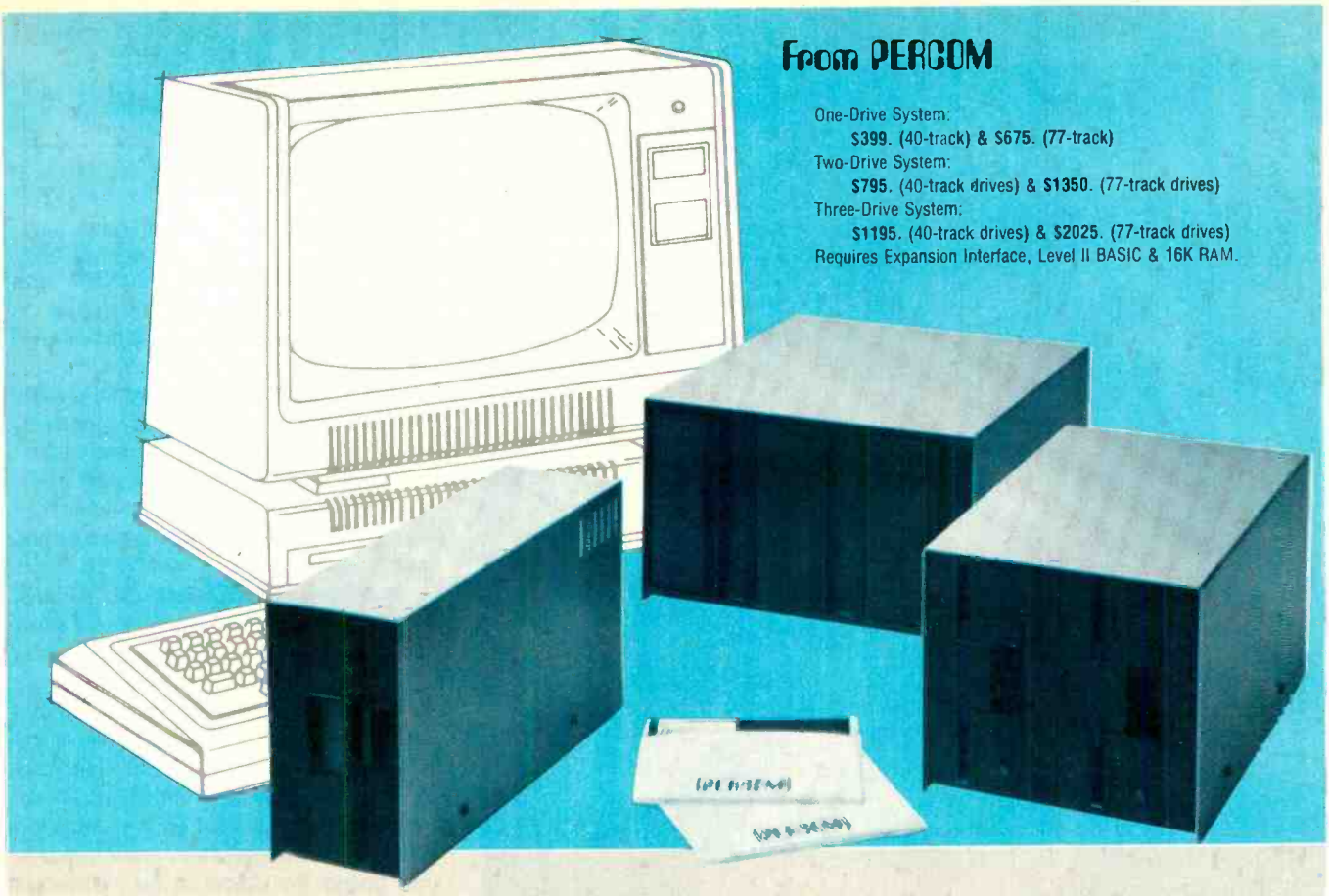
to checking sensitivity (on a few hf bands in AM and SSB), selectivity, image response, and internal spurious signals. The remainder of the evaluation was done by actual use tests.

Sensitivity for a 10-dB (S + N)/N ratio was not as good as rated. It was off by a factor of six to eight times on AM and two to three times on SSB. On most hf bands, AM sensitivity was between 2 and 4 microvolts and SSB/CW sensitivity was 0.65 to 0.9 microvolts. However, the receiver was more than sensitive enough for its purpose. We found that its useful reception capability was limited by its selectivity rather than its sensitivity. Selectivity was considerably better than rated. Even so, it was inadequate for critical reception.

The "70- or 80-dB" (depending on band) image response rating provided in the specification does not indicate which of the three possible images in the triple-conversion receiver is being rated. The only image likely to cause interference problems is from the first conversion, where there exists the possibility of a signal 110 MHz above the tuned frequency causing interference. We measured the image response at 5.1 MHz, with a 115.1-MHz interfering signal. Rejection was a very impressive 110 dB, which clearly indicates that image interference is hardly likely to cause problems with the DX-300. (This is a major advantage of a superheterodyne with an initial up-conversion to a very high i-f.)

We searched for "birdies" with the antenna disconnected, tuning over the full range of the receiver. At frequencies of less than 1.6 MHz, there were a large number of very weak responses, but at higher frequencies, they became less common. None of the latter would be audible with an antenna connected since they would be masked by atmospheric noise. We counted only those birdies that were strong enough to give a substantial reading on the S meter. There were five such responses between 300 and 1000 kHz and on the average of one per band on the higher bands. Since they were typically at S3 to S4, they could hardly be considered serious, except for one at 2.729 and another 3.228 MHz that read well over S9.

Continued on page 102



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PRODUCT TEST REPORT

Continued from page 100

User Comment. The DX-300 was able to receive a great many signals on all the mf and hf bands, using only its 48" (1.22 m) telescoping antenna. AM signal tuning was easy, and the digital display was as accurate as rated, positively identifying the frequency of any station being received. The anl was very effective against ignition noise, removing it almost totally with very little effect on the audio quality.

In the case of SSB and CW signals, while the tuning rate was suitably slow, the selectivity of the receiver was inadequate. While amateur SSB receivers customarily have an i-f bandwidth of 2.4 to 2.7 kHz, the 6-kHz bandwidth of the DX-300 places it at a great disadvantage on the crowded ham bands. Also, the nonadjustable bfo frequency was too far from the suppressed carrier frequency, giving the audio a thin, distorted quality on SSB. We noted that the S meter did not function on SSB and CW and that it was necessary to turn up the audio gain and use the r-f gain control to adjust volume in these modes. This suggests that the DX-300 does not use a product detector, which further contributes to its unsuitability for SSB reception (and may have accounted for much of the distorted sound we heard from in that mode). To its credit, however, no detectable drift, either audible or on the counter display was noticed during several hours of listening to SSB signals. The stability of the test unit was obviously much better than its ratings.

Although the DX-300 does not altogether meet the critical demands of an Amateur communication receiver, it is very well-suited to general SWL use. The absence of images, precise frequency calibration, and very wide tuning range of the receiver give its owner an unsurpassed choice of receiving possibilities. The antenna will be the ultimate limitation on what is heard, especially on the lower frequencies, where a long wire is needed. Considering its low price and many features, the DX-300 is an excellent value for the serious SWL, or even for the beginning ham.

—Julian Hirsch,
Hirsch-Houck Laboratories.

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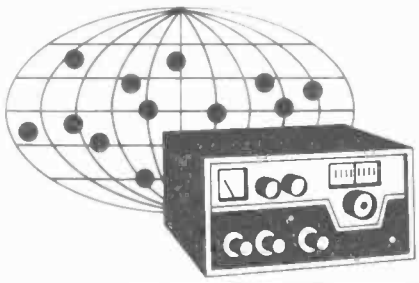

DX Listening

By Glenn Hauser

REVOLUTION BY RADIO

THIS YEAR, North American DX listeners in the know had a front-row seat on the drama of the Nicaraguan revolution. You can't have a revolution these days without a clandestine radio station to play the key roles of informing, propagandizing, and maintaining morale—and the Sandinistas were no exception. As long as two years ago, reports began to appear in the press about a *Radio Sandino*. But, its broadcasts must have been sporadic and low-powered.

News agencies in the area which monitored it were, as usual, loath to publish the station's frequencies, in order to prevent the general public from listening to news sources they preferred to keep for themselves. This continued to be a problem through the end of the Somoza regime. Although *Radio Sandino* was frequently quoted, news organizations were not about to let on that anyone with a shortwave radio could tune in, if they knew when and where to look. Fortunately, there exists a "DX press" capable of rapidly disseminating such valuable information via broadcasts such as *RCI DX Digest*, and publications such as *NASWA FRENDX*.

Radio Sandino was first reported from North America by Aaron Hywarren in Manitoba, June 11, 1978, on 7449 kHz around 0515 GMT. But there were no reports during the Sandinista offensive in the fall of 1978. Then, a German DXer, Wolfgang Buschel, on a Christmas vacation in Guatemala, heard *R. Sandino* on 7325 kHz at 1100-1300 GMT, and announcing afternoon and evening transmissions. But it was not until March 1979, that monitors in North America were able to hear *R. Sandino* on a regular basis. It was on 7587 kHz, though this varied slightly as did all the frequencies.

Though the communist element in the Sandinista Front was played down by the American press at the time of Somoza's departure, those who actually listened to *R. Sandino* could easily recognize rhetoric, and even music, already run into the ground in 18 years of anti-Yanqui broadcasts from *Radio Habana Cuba*. But Sandino also included more practical items, like instructions on putting together Molotov cocktails, and how to use an M-1 rifle, coupled with exhortations to "go out and kill as many Somozans as you can for the glory of the revolution." As one listener, Tim Hendel in Miami, put it in the *Review of International Broadcasting*, it was "spicy, raw, first-hand radio."

At this time, it still took some skillful tuning to pull in R. Sandino, but by April the station's power had obviously been greatly increased (at

one time a twelvefold increase was claimed) and more and more DX listeners were hearing it. *R. Sandino* always claimed to be broadcasting from a hidden location "somewhere in Nacaragua", but press reports put it just across the border in Costa Rica.

By now, popular sentiment in Costa Rica was very much with the Sandinistas, and stations such as *Radio Reloj* were relaying Sandino broadcasts. At what point this crossed the line from "news" to open support is not clear, but R. Reloj had the distinction of being denounced by the Somoza government, along with R. Habana Cuba and R. Moscow, as stations not to be listened to by loyal citizens.

Coincidentally in late April, Cuba and the USSR began relaying each other's international broadcasts (as detailed in this column in August). On May 11, BBC monitors were tuned to 11700 kHz at 2159 GMT, which as usual was relaying R. Habana Cuba programs from the USSR through a satellite audio feed. Suddenly, on came the opening of a *R. Sandino* program, abruptly cut off a few minutes later. This major gaffe gave away the fact that R. Sandino programs were on hand in the Habana studios, were quite likely produced there, and perhaps were transmitted from Cuba.

As the offensive accelerated, so did the transformations of *R. Sandino*. The programming became slicker, more sophisticated. Frequencies came and went. For about 12 days in May it broadcast on the 49-meter band around 6060 kHz, a long-time Habana frequency.

At about the same time, a new Costa Rican station appeared out of nowhere called *Radio Noticias del Continente*, it had a lengthy series of test transmissions, supposed to be on 9615 kHz, but varying all over the 31-meter band. Its true colors came out when it began regular programming in June, including relays of *R. Sandino*, and leftist programs directed to several South American countries. Costa Rica had not previously been involved in international broadcasting on such a scale. A listener in Houston, David L. Walcutt, observed that *R. Noticias* sounded like a "Cuban station by proxy," with communist rhetoric akin to the Soviet's *R. Peace & Progress*. Due to nonoverlapping schedules, it now seems possible that one of *R. Sandino*'s transmitters may have been used by *R. Noticias*.

R. Sandino's 7587-kHz transmitter was evidently the one which briefly went to 49 meters, but these broadcasts faced too much interference and were replaced May 31 by a new frequency of 7316 kHz, first reported by Robert L. Foxworth in New York. Now, however, there was a new twist—jamming by the Somoza side. Generally stronger transmitters would tune up a few kHz from *R. Sandino*, playing much more music, and sometimes carrying programming of Somoza's *Estacion X*, or of *Radiodifusora Nacional*. This was highlighted frequently by a song praising the National Guard, "Viva la Guardia Nacional," which was enough to turn one's stomach. Listeners not understanding Spanish may have easily confused the two, but Somoza's stations seldom if ever identified and, when they referred to the Sandinistas, called them "communists," which *R. Sandino* did not.

On June 8, Foxworth nabbed *R. Sandino* on a new frequency, 7702 kHz, replacing 7316. These two frequencies continued to alternate every week or two until the Sandinista victory. They were obviously the same transmitter. *R. Sandino* referred to all three as in the "41-meter band," though in fact they were on 38, 39 and 40 meters.

On June 21, *R. Sandino* resumed its 7587-kHz frequency, in addition to 7702, but never with programming in parallel. The same programs were transmitted from different tapes started at different times, and thus very likely from two different sites—probably Costa Rica and Cuba. The transmission on 7587 generally suffered from more interference, and most of the time was jammed in the same way as the one on 7702. The question then arose as to whether one of the two Sandinos might not be a "black" clandestine—pretending to be the real one—but there seemed to be no difference in the stance of the programs, and the same announcers were heard on both.

On June 13, *R. Sandino* was exerting its authority, with instructions to foreigners on how to get out of the country without being killed. On June 16, its now famous slogan "patria libre o morir" (free country or

death) emerged, as Air Force pilots were urged to bomb their own installations and then flee the country to be received abroad as patriots. As the modulation crispened, the rhetoric grew even more stringent. On June 17, DX listeners heard the first proclamation of the "new democratic provisional government of national reconstruction," which later made headlines. *R. Sandino* often played a tape consisting of placid marimba music fading into "the sound of liberating rifles." And Somoza was now accused of being a "war criminal and genocidist." National Guard soldiers were given a 24-hour ultimatum to join the other side or be condemned.

On June 18, Somoza's jamming stations ran a speech over and over, probably by Somoza himself, lamenting that Nicaragua was going through a period "worse than the earthquake".

R. Sandino had settled into a routine of transmissions lasting about two hours, at 1030, 1900 and 0300 GMT, when despite the fighting, on June 25, Nicaragua changed from EST to CST. Transmissions were then retimed to an hour later by GMT. By now, the Sandinistas controlled more of the country, and there were reports that they had taken over various stations, giving them new names such as *Radio Insurreccion*. Jean-Jacques Bloch in Maryland heard, on July 1, a station on 5955 kHz at 0702-0720 GMT, which may have been *R. Esteli*, under Sandinista control. Esteli was one of the earliest towns to be claimed by the FSLN.

On July 10, *R. Sandino* asserted a bit prematurely that the "Somoza dictatorship is overthrown." On July 13, Pitt McNeil in Washington, DC, heard a Sandinista program via *R. Reloj de Costa Rica*, and 15 minutes *later* the same program from *R. Sandino* itself. This could mean that *R. Reloj* was closely involved in the program production, or that they had taped an earlier airing of the same program on *R. Sandino*. On July 15, Bob Rankin in Kansas reported that the 7316 program sounded as if it were relayed off the air, unlike 7586.

July 19 was the climactic day for the FSLN and for *R. Sandino*. The jamming had departed with Somoza, and *R. Sandino* was finally unhindered in its enthusiastic proclamations of victory "from free Nicaragua", a memorable and historic broadcast. On this date, the programming was interrupted for a few minutes as high-speed radio-teletype was transmitted from the same source on the same frequency. The 7586-kHz channel proved to be running about two and a half minutes behind 7316—and the latter was simulcast on 750-kHz mediumwave (audible here under WSB), formerly Somoza's *Estacion* X—so now, at least, 7316 was surely operating from Nicaragua as it had claimed to be long before.

After that date, *R. Sandino* was no longer to be heard on any 7-MHz frequencies. Its mission accomplished, and in control of the country's domestic radio stations, shortwave was no longer necessary. Why the 7-MHz band in the first place? The 7.3-to-7.9-MHz range goes far back in Nicaraguan broadcasting history. Until 1963, the World Radio-TV Handbook listed five stations in this out-of-band area. The clandestines and counter-clandestines of today may have chosen it because of the remaining availability in Nicaragua of receivers, and possibly transmitters covering it.

The use of 7 MHz also suggests that, except in its last days, *R. Sandino* was probably not transmitted from Nicaragua, nor even from Costa Rica next door. The skip distance on this band would be too great for good reception in such a small area as Nicaragua, from a transmitter within Nicaragua or Costa Rica. This is why the tropical bands are all on frequencies of 2, 3, 4 and 5 MHz, where skip distances are shorter, especially at night. However, 7 MHz would be just about the right band to skip a signal into Nicaragua from, say 800 miles away (the distance of Cuba from Managua). Pitt McNeil points out, on the other hand, that it would have been logistically inconvenient for *R. Sandino* to operate from anywhere other than the FSLN command post in Costa Rica.

R. Sandino provided North Americans who understood some Spanish the opportunity to sit in on a revolution-in-the-making. There is a lot of other clandestine radio activity in the world, especially in Southeast Asia, Southern Africa, and the Middle East, but little of it is in English or a language Americans are likely to understand—and none of these operations can be heard as easily as *R. Sandino* was.

Before July was over, however, I heard *R. Sandino* reincarnated, this time giving time checks—something it could never do before with

pre-recorded programs—as "the hour of Sandinista power." A very weak transmitter would open in the morning around 1400 GMT on 11727 kHz, and by 2200 would drift upward steadily to 11733 kHz.

This was obviously not the 100-kilowatt transmitter *Radiodifusora Nacional* had during Somoza's regime, but used only sporadically on 11875 and 5945 kHz (though it may have been used for the 7-MHz jamming). Perhaps once the country has begun to recover from the ravages of civil war, Nicaragua will add its shortwave voice to Cuba's in fomenting revolution in other Latin American countries.

Updating Listings. The following changes and additions should be made in the "English Broadcasts" listings that appeared in the October issue:

GMT/UTC	Station	Change
0900-1100	AFRTS	add 11805, 9700, 9585, 9575, 6030
1000-1005	UN Radio	15245, ex-5955
1000-1030	V. of Vietnam	7470, ex-9840
1030-1200	V. of Asia, Taiwan	5980 (Sun 1030-1040)
1100-1300	R. Australia	delete 11880
1100-1245	TWR, Bonaire	15255, not 15225
1100-1400	VOA	delete 9730, 5955
1200-1215	V. of Kampuchean People	11938, 9694 (both frequencies and length vary)
1200-1230	Kol, Israel	25640, 21675 not 25625, 21495
1200-1255	R. Peking	add 17855, 15520,15270
1230-1300	R. Sweden	15240, ex-21635
1230-1551	WYFR, Family R.	21525, 17785 (Sun. only)
1300-1400	R. Australia	11705, not 9770
1357-1655	V. of Philippines	11950, 9580 (Sun -1555)
1400-1430	R. Norway	15175, not 17840
1400-1600	AFRTS	9700, not 9770
1430-1500	R. Finland	21475, ex-17785
1500-1600	BBC	15260, ex-11775 (Sat. & Sun. only)
1530-1615	R. Tampa, Tokyo	not NSB
1530-1630	V. of Vietnam	12035 and 7470, ex-15012 and 14990
1545-1600	R. Canada Int.	Daily, not Mon-Fri.
1600-1615	R. Pakistan	21486, 21450, 17910 not 21595, 17640
1600-1630	R. Norway	17795, not 17755
1600-1709	BBC	15260, ex-11775
1700-1800	WYFR, Family R.	21615, 17870, 17845, 15440
1709-1745	BBC	15260, ex-11775 (Sat., Sun.)
1745-2000	BBC	add 21710
1800-1900	WYFR, Family R.	21615, 21525, 17875, 17845, 15440
1830-1835	UN Radio	15350, ex-15410
1830-1900	V. of Rev., Guinea	Mon. & Fri. only not 1800-1900. (Freq. time changes)
1830-1900	R. Uganda	15250 (not daily)
1900-2000	HCJB, Ecuador	17895, 15225, not 17765, 15420
1900-2100	WYFR, Family R.	21615, 21525, 17845
2000-2030	R. Norway	15125 (SSB)
2100-2300	WYFR, Family R.	17845, 11855
2115-2200	BBC	delete 11750
2130-2200	R. Sofia	11850, ex-15135 (Freq. changes)
2130-2200	HCJB, Ecuador	17895, 15225, not 17765, 15295

(continued on page 108)

(continued from page 107)

2200-2215	R. Japan	add 15305 (via Portugal)
2200-2230	R. Norway	add 15125 (SSB), 15175, 11870, 9550, not 17795, 15345
2200-2245	BBC	add 9590
2200-2400	AFRTS	25620, ex-17765
2215-2345	R. Cairo	9805
2230-2300	Kol Israel	11985, not 12085
2245-2300	BBC	add 9590
2300-2330	R. Vilnius	12060, 11735
2300-2330	R. Korea	11840, ex-15345
2300-2400	R. Moscow	21565, 9720, 9530, not 21560
2330-2400	R. Finland	delete (moves to 0330)
0000-0030	R. Norway	11870, not 11860
0000-0055	R. Peking	add 17855
0000-0100	AFRTS	25620, 21570, 15330, 11790
0000-0200	R. Moscow	21565, 9720, not 21560
0030-0100	R. Sweden	11905, ex-15290
0030-0100	R. Kiev	17845 and 12060, ex-15405, 15525,
0030-0200	HCJB, Ecuador	15115, ex-15265
0100-0120	RAI, Italy	9575, not 15315
0100-0145	R. Berlin Inter.	11975, ex-11970
0100-0155	R. Peking	17855, not 15520
0100-0200	AFRTS	25620, 21570, 11790, 9755, not 17765, 15430, 9685, 6030
0145-0215	Swiss R. Int.	15130 (SSB)
0200-0230	R. Norway	9590, ex-9610
0200-0255	R. Peking	not 17855
0200-0300	R. Moscow	21565, 15425, 9720, not 21560, 15225
0200-0300	AFRTS	21570, 11790, 9755, 6030, not 15430, 9685
0200-0305	TIFC, Costa Rica	9645, 5055 (Mon. 0135-0305), not 0250-0400
0230-0315	R. Berlin Inter.	11975, ex-11970
0230-0245	R. Pakistan	17880 or 17830
0300-0330	R. Kiev	17760, 12000, ex-15405, 11920,
0300-0400	AFRTS	21570, 17765, 11790, 9755, 6030, not 15430, 9685
0300-0500	HRVC, Honduras	4820
0300-0530	VOA	15240, ex-15245
0330-0400	R. Finland	9675 (frequent changes), ex-2330-2400
0400-0430	R. Norway	11895, 11870, not 11860, 9645
0400-0430	AFRTS	21570, 17765, 15330, 11790, 9755, 6030, not 9685
0400-0700	R. Moscow World Service	11735, 9720
0430-0700	AFRTS	15330, 11790, not 15430
0545-0600	UN Radio	6055, not 6135
0600-0630	R. Norway	9645, not 11860
0600-0630	R. Australia	17755, not 17555
0657-0955	V. of Philippines	11950, 9580
0707-0715	UN Radio	11840, ex-9540
0730-0745	UN Radio	11840, ex-9540 ◇

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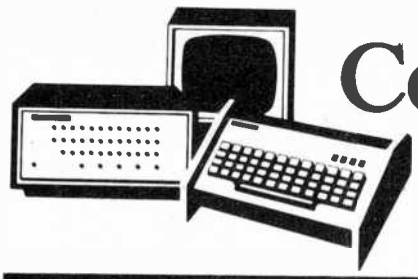

Computer Bits

By Hal Chamberlin

COMPUTER MUSIC

COMPUTERS can create music either by controlling external (usually bus-connected) sound-synthesizer hardware or by using software to create the desired waveforms within the computer. Although the software approach has the greater potential, at this time, better results are obtained using hardware synthesis.

Probably the first software synthesis "music" program was written for the original Altair-8800 computer. It allowed the minimal 256-byte machine to play a simple melody a few dozen notes long using an AM radio in close proximity to the computer or an audio amplifier connected to a front-panel LED as the output method. A more sophisticated program along these lines, called the Music System, was later offered by Processor Technology. It allowed three *simultaneous* tones to be synthesized using the Interrupt Enable line of the S-100 bus as the output signal. Using three independent tones, it was possible to create chords, the melody line, counterpoint, or bass parts of music.

Although these purely software techniques required little or no hardware for sound generation, they invariably created buzzy reed-like tones. It is safe to say that every computer on the market (and even one brand of hand-held calculator) has a music program of this sort available for it. Although sound quality is extremely limited, some of the software for entering notes into the computer is quite imaginative.

The better software synthesis systems make use of a digital-to-analog converter (DAC). Basically, a DAC is a device that can accept a high-speed data stream from the computer and generate a waveform directly corresponding to those numbers, much like plotting a graph. Though DAC's used to be very expensive devices, one can now be built from scratch for a few dollars (see "Computer Bits," Sept. 1976) or purchased ready to plug into a computer for about $50.

The secret of success when using a DAC is to write a program that can compute the data corresponding to desired sounds at a rate high enough (8000 numbers/second or more) for acceptable sound quality. The October 1976 "Computer Bits" column in fact gave a listing of a program that could synthesize accurate telephone TouchTones complete with the necessary sine waveshape using nothing but a DAC. Since TouchTones are actually two tones sounding simultaneously, producing waveshapes other than square or pulse, this was the first step toward improved microcomputer music synthesis.

The sine waveform was actually obtained from a table in memory. Knowing this, it should therefore be possible to change the stored waveform to anything desired and thus add the dimension of *timbre* to low-cost microcomputer music synthesis. This in fact is exactly what Newtech Computer Systems, Inc. did with its model 80 music board for S-100 bus computers and associated software. In addition, the TouchTone program was modified for three simultaneous tones with greater pitch accuracy and routines were added for computing waveforms having desirable harmonic content. The most important point, though, is that these two systems represented a quantum leap in microcomputer software synthesis sound quality.

A couple of years ago, Micro Technology Unlimited announced its DAC based music synthesis system for the KIM-1 microcomputer. The DAC board supplied with the system was an improved design with full 8-bit resolution, a sophisticated low-pass filter (essential to realize the full potential of 8-bit conversion), and a low-power audio amplifier.

HUH Electronics, with its "Petunia," was the first source to offer a DAC-based music system to Commodore PET users. Although the DAC hardware and associated software were below the level established by Newtech and Micro Technology, they nevertheless gave PET owners much better sound quality than previously. Now Micro Technology Unlimited has adapted its KIM-1 system to the PET, giving the latter's user a "state-of-the-art" software synthesis system. Apple II users can get substantially the same system under the name "Micro Composer" from Micro Music, Inc. The big difference is an extremely sophisticated music-entry program which makes full use of Apple II high resolution graphics capability to display the actual music score *in motion* while the music is being played!

Hardware Synthesizers. During the last three years, several hardware music synthesizers have been introduced. When using a hardware synthesizer, the computer needs only to instruct it as to the desired tone frequency, amplitude, timbre, etc., and the board takes over actual waveform generation. The main advantage of these boards is that the computer has lots of time for other functions such as updating a video display, scanning a keyboard, or directly interpreting a score. In fact, it is even practical to control a hardwave synthesizer from BASIC, an impossibility with a software synthesis system. Another advantage is that more sophisticated tones with amplitude and even timbre envelopes can be easily synthesized.

For S-100 users there are two hardware synthesizer boards currently available. Each can synthesize only one tone, but that tone

can be controlled with a great deal of precision. Thus, chords and multi-part music will require three or more boards.

The Solid State Music SB1 synthesizer board, for example, offers a 9-octave range and a waveform memory capable of holding 8 different, 32-step waveforms. While playing a note, the board is capable of automatically sequencing through four of these waveforms, which results in a more interesting and realistic timbre. A hardware envelope generator with programmable shape is also present.

The ALF Products AD8 synthesizer board spans only 7 octaves, but gives more accurate pitches while the timbre is stored as a single 128-point waveform. A sophisticated four-part envelope generator in which each part is independently programmable is also provided. A distinct advantage of the ALF board is that its digitally synthesized waveform is filtered by a programmable lowpass filter which gives it a cleaner sound quality.

Hardware synthesizers for other computers are not nearly as comprehensive as the preceeding two, but they do exist. ALF has a synthesizer board for the Apple II which can generate three tones at once (see Computer Bits, October 1979 for details). The tones are limited to rectangular waveforms, but independent envelopes are provided. The RCA COSMAC VIP is endowed with a synthesizer accessory as well. This board can produce two square-wave tones with amplitude envelopes. A companion board can produce percussive sounds, such as drums, under program control.

Future Prospects. Future prospects for microcomputer synthesized music are exciting indeed; most of the activity is likely to be in the DAC-software area. New developments will be fueled primarily by continuing decreases in the cost of memory and disk storage coupled with increases in microcomputer speed. An experimental PET-based music system using DAC hardware has been demonstrated which can give an independent amplitude envelope to each *harmonic* in a tone. This results in fairly realistic instrument sounds as well as increased ability to conjure up new sounds. The technique requires a lot of memory, but "fully-stuffed" systems are becoming quite common these days.

By now most readers have read about the advantages of digital audio. Digital audio playback systems using home video recorders are being brought to market, and systems using video disks are expected in the future. These promise fidelity significantly higher than that available from today's tapes and disks.

The significance of this is that digital audio systems are nothing more than DAC's being fed a string of numbers—although more bits and higher speeds are used than have been discussed. With the increasingly common *double-density* floppy disks and even hard disks being used with microcomputers, it becomes feasible to use software to compute highly accurate sound waveforms and write resulting numbers on the disk.

After the numbers are written (which may take many times the duration of the piece), they can be read back at high speed and sent to the DAC. The synthesized sound quality possible with this approach is so high that there is essentially no limit as to what can be achieved in this way. ◇

Software Sources

By Leslie Solomon
Technical Director

TRS-80 Battleship. This new and updated version of the old game Battleship is available for TRS-80 16K Level-II machines. It provides one-on-one battle in easy, medium or hard modes, with graphic display. $15.98 from Semi-Sentient Software, Box 683, New York, NY 10001 (Tel: 212–858–3400).

6502 Macro Assm/Editor. The 6502 ASSM/TED is written for the PET, Apple-II and SYM computers, with versions being prepared for the KIM, OSI, Atari, and Aim systems. It is written in assembly language and occupies 8K starting at 2000 hex. ASSM/TED provides 27 commands and 22 pseudo ops. Features include macro and conditional assembly support; macro nesting; extensive text editing commands including automatic line numbering and string search and replace, tape load/record and append commands; vectors for interfacing to a disk; free format assembler and command source input; and a source syntax format assembler and command source input; and a source syntax similar to MOS Technology specs. $49.95 (specify PET, Apple or SYM). Carl Moser, Software Consultant, 3239 Linda Drive, Winston-Salem, NC 27106.

6800 FORTRAN. Producing relocatable object code in Motorola-compatible format, this compiler runs under the Smoke Signal DOS-68 DOS and is complemented by Smoke Signal's Linking Loader. The Fortran requires 24K of RAM, has data initialization capability, arithmetic and logical IF statements, and handles sequential access files with four files opened at one time. Library Fortran subroutines can be built. The integer range is from −32,767 to +32,767 and its magnitude range is approximately 10^{-78} through 10^{78} with 7.2 decimal digits of precision. Price is $99. Smoke Signal Broadcasting, 31336 Via Colinas, Westlake Village, CA 91361 (Tel: 213–889–9340).

8086 BASIC. BASIC-86 is designed to run with the 16-bit 8086 processor, and supports all the well-known commerical language features of the other Microsoft BASIC's. It is compatible with Microsoft 5.0 for use with the 8080. It features double-precision arithmetic, trace facilities, full PRINT USING, nested IF/THEN/ELSE, error trapping, renumbering and edit modes. BASIC-86 also supports some new features including WHILE/WEND, CHAIN and COMMON statements to link programs and share variables, dynamic string space allocation, and variable names up to 40 characters in length. It meets all the qualifications of ANSI subset standard for BASIC. It is available in two versions: Extended at $350 and Standalone Disk at $600 both for Intel SBC 86/12. Microsoft, 10800 NE 8th, Suite 819, Bellevue, WA 98004 (Tel: 206–455–8080).

Apple Statistic Package. This software package for the Apple II includes its own scientific management system and a battery of programs for curve fitting, probability, general statistics, distribution and test statistics. It utilizes the high resolution mode of the Apple for curve fitting using linear, exponential, logarithmic or power relationships. System probability elements include analysis for permutations, combinations, and factorials. Random tables are included, plus a host of distributions. Requires 32K of RAM and one disk $89.95. Charles Mann & Associates, Micro Software Div., 7594 San Remo Trail, Yucca Valley, CA 92284 (Tel: 714–365–9718).

1802 Graphics. The Super Graphics Control Program contains the modifications necessary to create a full-screen graphics display on the TEC, Netronics, VIP or Super Elf systems. The program features 31 commands full function cursor, auto-repeat, debounce, and tone cursor. The program takes between 1024 and 1536 bytes depending on

the resolution selected. The program produces an audio-visual error message when improper command syntax is detected. The listing is 10 pages long and costs $6.50. John T. Carter, 36 Grouse Drive, Brentwood, NY 11717.

TRS-80 BASIC. Over 70 nontrivial commands are added to TRS-80 BASIC using Infinite-BASIC. Any combination of these added commands can be packaged and loaded into any selected memory location to minimize memory requirements. Complete matrix functions added include: matrix read, inverse, transpose, identity and simultaneous equations; add, subtract or multiply scalars, vectors or multidimensional arrays; dynamically reshape, expand, delete arrays; change arrays in mid program; copy array elements; set arrays to scaler, zero arrays, and move arrays; tape array read and write including string arrays. Complete string functions added include: left and right justify, truncate, rotate, text justification, string centering, deletion or insertion of substrings, pack strings, convert to upper or lower case; translate characters, reverse strings, verify, test number of occurrences; masked string search for simple or array variables; encrypt or decrypt strings; compress/uncompress character string arrays to six bits or less per character; and a sorting program that can handle 1000 elements in nine seconds. $49.95. RACET Computes, 702 Palmdale, Orange, CA 92665 (Tel: 714-637-5016).

Software Listings. The following listings are available in book form and include all working details: CP/68 (M6800) Operating System ($34.95) is a disk-based system that can be expanded and has a device independent I/O, sequential and random file access, dynamic allocation and expansion of files, command files, chaining and overlaying of user programs, fits in less than 8K and can be relocated anywhere in memory and has an extended instruction set including 19 6809-type instructions. XA6809 Cross Assembler for M6800's ($24.95) is a two-pass macro cross assembler that generates relocatable and linkable code (uses LINK68). Resident in a 6800 machine it can produce 6809 code. It produces a listing, a sorted symbol table, a cross-reference file and relocatable object code. STRUBAL+ Compiler ($49.95) is written in 6800 assembler language and is a three-pass extensible compiler that provides disk-based high-level language for computers having at least 24K of RAM. STRUBAL is a structured language featuring elements of BASIC, PL/M, COBOL and assembly language (requires LINK68). RA6800ML Resident Assembler ($24.95) is a two-pass macro assembler that generates relocatable and linkable object code (requires LINK-&). It produces a listing, sorted symbol table, cross reference file and relocatable object code. All Motorola defined opcodes are recognized. LINK68 Linking Loader ($7.95) is a one-pass linking loader that allows separately translated, relocatable and linkable modules to be loaded and linked to form a single executable load module. It produces a load map and a load module in MIKBUG format, and requires only 2K. Hemenway Associates Inc., Tremont St., Boston, MA 02108.

TRS-80 DOS. The DOS+ is available in both 35- and 40-track versions and will execute all TRS-80 commands. It also works with

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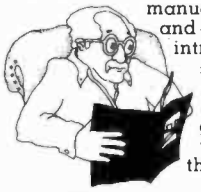

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SOFTWARE (Continued)

assembler language or high-level languages that use DOS routines for character input and output. It features a basic reference command for variables and numbers, a renumber routine, a keyboard debounce routine, a print screen option under DOS or BASIC to a line printer, copy commands for back up between drives, execution of DOS commands from BASIC, scrolling and invocation commands, a hexdump utility to examine or modify disk or memory locations, an editor/assembler with disk I/O and cross-reference feature, a disassembler, a load module for transferring machine tapes to disk, storing and retrieving Level I programs on disk, a diskdump routine, and a DIRCHECK program to test a directory and list/display the contents in alphabetical order. $99 for 35-track and $110 for 40-track versions. Microcomputer Technology Inc., 2080 S. Grand Ave., Santa Ana, CA 92705 (Tel: 714-979-9923).

TRS-80 Software. Radio Shack has introduced a new series of programs for business, engineering, educational, laboratory and home use (including games). They are available for both Level I and Level II machines, and on diskette. The programs include General Ledger (diskette only), Disk Mailing List (diskette only), Cassette Mailing List, Inventory Control System (diskette only), Statistical Analysis (Level-I only), Double-Precision Subroutine (Level-II only), Advanced Statistical Analysis (Level-II), RS232C Communications Software (Level II)

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LM320T5	1.25	2N3055	.85
LM320M5	1.25	2N3904	6/1.00
LM320T12	1.25	2N3906	6/1.00
LM320T15	1.25	2N4401	6/1.00
LM322N	1.75	2N4403	6/1.00
LM323K	5.50	1N4003	15/1.00
LM320K5	5.00	1N4005	12/1.00
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for use with phone interface, Real Estate (Level II), Level-I BASIC Course, Math 1, Algebra 1, Level-II BASIC Course, Other programs include Editor/Assembler, T-Bug Monitor, Level-II Line Renumber. Games include Blackjack/Backgammon, Quick Watson, Microchess with three levels of play, Micro Music, Micro Movie and Micro Marquee. Available at Radio Shack stores and dealers.

STRING Bit. This is a collection of FORTRAN character string handling routines, including a library of custom routines that can be user expanded. It is ideally suited for FORTRAN applications requiring command identification, parsing and interpretation, editing, character string file management, inquiry systems and report preparation. It includes source code for all libraries and programs, in FORTRAN, and is distributed on 5" or 8" CP/M compatible soft-sectored diskette for $45. Key Bits, Inc., Box 592263, Miami Fl 33159.

General Ledger. Features ECOSOFT's new Skip Sequential file structure that performs disk write operations with the speed of random access files, but is not limited to fixed file lengths. This results in increased speed and conservation of disk space. The 75K General Ledger package is divided into 18 sub-programs so that hardware requirements are reduced to 12K of user memory, one disk drive and optional printer. Uses North Star Release 4 DOS and BASIC, single or double density. $99.95. ECOSOFT, POB 68602, Indianapolis, IN 46268.

Software Catalog. A catalog of dozens of games and business programs for the TRS-80, PET, and APPLE-II, including TRS-80 PILOT, and a number of general utility programs is available from Mad Hatter Software, 900 Salem Rd., Dracut MA, 01826 (Tel: 617–682–8131).

6502 System Software. The CRS-DOS for the 6502 includes a general purpose monitor, routines for handling parallel and serial I/O, cassette tape file handling, and floppy disk processing routines. Routines include assembler, BASIC (optional), copy disk files, and HELP that produces a list of all commands on the console. The user can program his own routines or add specialized commands to the list. Another feature is that the user has access to all features of the computer system including pages zero and one (stack) and all interrupt processing. The CRS-DOS can process sequential, indexed, indexed sequential, program load or data files. It can be used with an optional Editor/Assembler. $125. CGRS Microtech, POB 368, Southhampton, PA 18966 (Tel: 215–757–0284).

TRS-80 Stuff. Several machine-language games are now available. These include ZCHESS providing seven levels of difficulty and six moves "look ahead" for $17.95; BACK-40 a backgammon game that also permits doubling for $14.95; and DR. CHIPS a program based on the famous ELIZA program for $14.95. The Software Association, P.O. Box 58365, Houston, TX 77058.

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Electronics Library

BASIC, SECOND EDITION

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This self-teaching guide is written in programmed instruction format and is intended for people without experience in computer programming. Although it would be helpful to have access to a computer for programming exercises, the examples and sample printouts relate concepts in an understandable manner. The first 84 pages of the book are more or less an introduction to the BASIC language and serve to acquaint the reader with fundamental procedures. Other chapters of the book cover such subjects as decision making, loops, functions, single- and double-subscripted variables, subroutines, string variables, and files. A final self-test is provided so the reader can verify his understanding of the subject matter and concepts covered. The programmed instruction format is a good one, and it is ideal for self-teaching courses. A few diagrams and numerous sample printouts and programs help the reader understand the lessons covered. *Published by John Wiley & Sons, Inc., 605 Third Ave., New York, NY 10016. 325 pages. $4.95 soft cover.*

ADDBOOK ONE, EXPERIMENTS IN DIGITAL AND ANALOG ELECTRONICS

by Howard V. Malmstadt, Christie G. Enke, and Stanley R. Crouch

This workbook is part of a self-teaching course that presents a program of tutorials and experiments designed to provide the reader with a working knowledge of analog and digital electronics. (Experiments are designed for breadboarding on the publisher's ADD 8000 analog/digital designer.) Four preliminary sections explain operation of the ADD, digital multimeter, oscilloscope, and power supplies. The ten following units contain tutorial material, experiments, new terminology, suggested reading, and many schematics and diagrams. Subject matter covered includes analog and digital signal measurement, operational amplifiers, programmable analog switching, voltage to frequency DVM's, digital logic gates, digital counters and registers, A/D and D/A conversion, and anlog and digital data acquisition systems. Data sheets for all ICs used in the experiments appear in the book's appendices. *Published by E & L Instruments, Inc., 61 First St., Derby, CT 06418. 292 pages. $17.00 soft cover.*

AMATEUR TELEVISION IN A NUTSHELL

by Henry Ruh, WB9WWM, and friends

Those interested in setting up their own amateur fast-scan television stations will find much valuable information in this book. Written by the Publisher of Amateur Television Magazine, the book also contains a number of construction and set-up articles contributed by active ATV'ers. The work features an easily understood explanation of video communications, construction projects for a complete ATV station (employing current, solid-state designs), directories of ATV operators, repeaters, and equipment manufacturers, and tips on selecting gear. Special operating aids include an ATV log, camera alignment, video signal, and signal reporting charts. The book contains many schematics, photographs, and diagrams. *Published by Amateur Television Magazine, Box 1347, Bloomington, IN 47401. 72 pages (8½" × 11"). $5.00 soft cover.*

PROJECT OF THE MONTH

BY FORREST M. MIMS

CMOS TONE SEQUENCER

TONE sequencers can be used to generate electronic music, as toys, annunciators, or warning alarms, and in remote signalling. The sequencer shown in Fig. 1 requires only three CMOS chips to provide a sequence of up to ten individually programmable tones.

In operation, two of the inverters in a 74C04 are cross-coupled to form an astable multivibrator that generates clock pulses for a 74C192 BCD counter. The rate at which clock pulses are delivered to the counter is determined by the values of *R1* and *C1*.

lected in sequence as the 74C192 counts incoming pulses, and this steps the frequency of the tone generator through the range of tones determined by the individual resistors.

The 74C192 is a BCD counter (0000–1001) with a 4-bit output word. Because the 4051 accepts a 3-bit address, the highest-order bit from the counter is ignored. (This is why pin 7 of the 74C912 is not connected.) The net result is that the sequencer repeats the two lowest order tones (addresses 000 and 001) once each cycle when the *full* counter output is 1000 and 1001. If a full 4-bit counter such as the 74C193 is used, no repetition occurs because the counter will present all eight address combinations to the 4051 twice during each 16-step sequence.

The circuit's tone generator can drive a small, high-impedance earphone directly. For more volume, connect the circuit to a small speaker using a driver transistor or unused inverter as shown in Fig. 2. Alternatively, connect the circuit to a small amplifier through *C3* and *R10* as shown in Fig. 1.

When the value of *C2* is 0.1 μF, the frequency of the tone generator ranges from 34 to 6500 Hz for a resistance range between pins 5 and 9 of the 74C04 of

OUTPUT FREQUENCY VS. RESISTANCE

Resistance (ohms)	Tone frequency (Hz)
470	6,481
680	5,201
1,000	3,937
1,500	3,081
2,200	2,320
3,300	1,792
4,700	1,192
6,800	938
10,000	629
15,000	441
22,000	330
33,000	226
47,000	160
68,000	110
100,000	70
150,000	52
220,000	34

the clock rate by adjusting *R1*. When a tone is heard, quickly disable the clock by shorting *C1* with a short jumper wire. Then rotate the shaft of the potentiometer until the desired tone is heard. Remove the pot, measure its resistance and

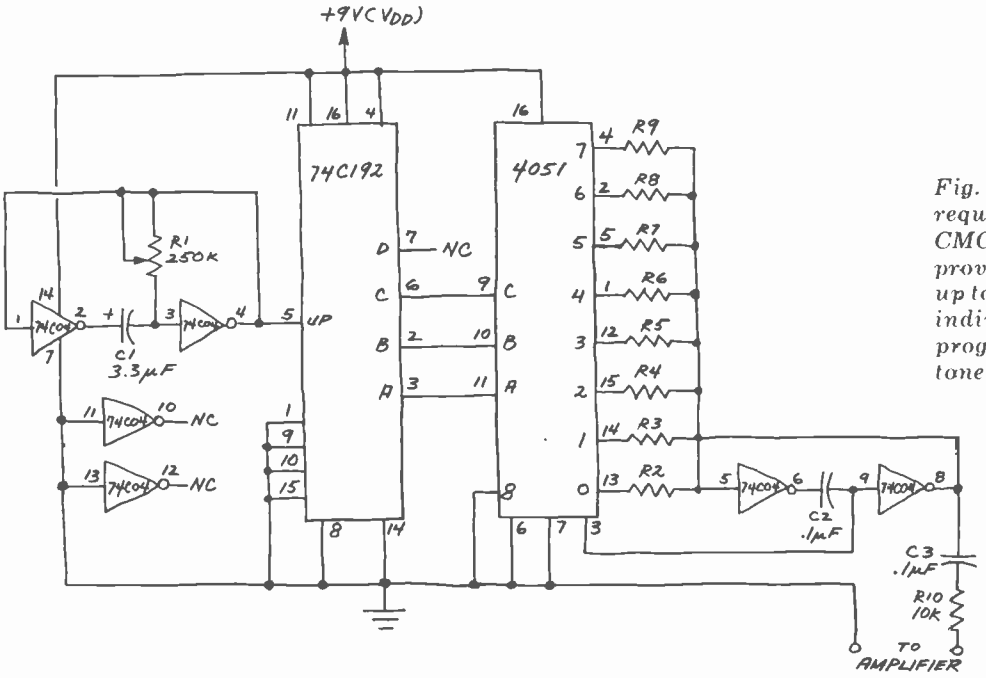

Fig. 1. This circuit requires only three CMOS chips to provide a sequence of up to ten individually programmable tones.

The tone generator is made from two of the remaining inverters in the 74C04. Its frequency is determined by *C2* and the effective resistance between pins 5 and 9. This resistance is provided by one of the eight resistors (*R2* through *R9*) connected to the outputs of the 4051 analog multiplexer/demultiplexer. At any given instant, only one resistor is selected by the 4051 in response to the address applied to its inputs. This resistor is automatically connected between pins 5 and 9 of the 74C04. The resistors are se-

220,000 to 470 ohms. The output frequencies I measured for a selection of standard resistance values are shown in the table above.

These measurements are plotted in Fig. 3 on a log-log graph to help you select the resistance values for tones not listed in the table.

If you prefer to select the tones experimentally, connect a 100,000-ohm potentiometer between pin 13 of the 4051 and pin 5 of the 74C04. Leave the remaining 4051 outputs unconnected. Slow down

record the value next to *R2* on a notepad which lists component designations *R2* through *R9*.

Next, connect the pot between pin 14 of the 4051 and pin 5 of the 74C04 to select the resistance of *R3*. Continue this procedure until the values of all eight resistors have been selected. Then install fixed resistors having resistances close to the measured values.

Modifying the Circuit. This project is ideal for experimenters because it is eas-

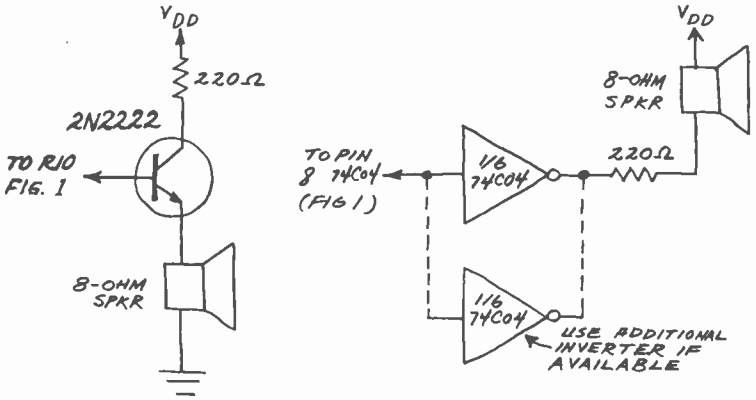

Fig. 2. Two simple ways to add a small speaker to sequencer.

ily modified. The simplest modification is to replace *R2* through *R9* with trimmer resistors to permit the tone frequencies to be easily changed. For higher tone frequencies, reduce *C2* to 0.01 μF.

Adding a Second Clock. Referring to Fig. 1, note that there are two unused inverters in the 74C04. Normally, the inputs of the unused inverters and the unused data inputs of the 74C192 must be tied to ground or V_{DD} since these are CMOS chips.

These two gates can, however, be used to make a second clock circuit which is connected to the DOWN input of the 74C192. Use a 3.3-μF timing capacitor and a 1-megohm potentiometer for the timing resistor. Disconnect pin 4 of the 74C192 from V_{DD} and reconnect it to the output of the second clock. This dual UP-DOWN clock arrangement will liven up the otherwise predictable tone sequence.

Single Sequence Operation. It's possible to modify the circuit to emit a single sequence of seven tones each time a switch is toggled.

Referring to Fig. 1, here's how the circuit is modified:

1. Connect pins 1, 9, 10 and 15 of the 74C192 to V_{DD} instead of ground.
2. Disconnect pin 11 of the 74C04 from ground and connect it to pin 7 of the 74C192.
3. Disconnect pin 11 of the 74C192 from V_{DD} and connect it to pin 10 of the 74C04.
4. Disconnect pin 14 of the 74C192 from ground and connect it to the pole of a spdt switch. Connect one position of the switch to V_{DD} and the other to ground.
5. Remove *R9* from the circuit (unless you want a continuous output tone while the circuit is in standby condition awaiting the switch to be toggled).

To operate the circuit, throw the switch so that its pole is grounded. Then throw the switch so the center pole is connected to V_{DD}. The speaker will emit a steady tone indicating the 74C192 is cleared to address 0000 and *R2* is connected to the tone generator. When the switch is thrown once more, the complete tone sequence will be generated. After the seventh note, the counter will inhibit itself (can you figure out why?) and the circuit will be ready for another tone cycle to be initiated. ◇

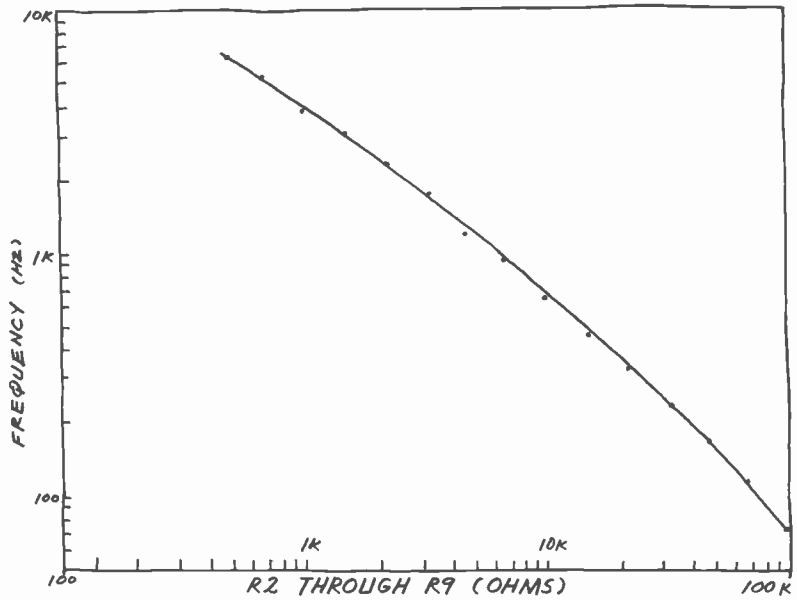

Fig. 3. Tone frequency versus resistance of R2 to R9.

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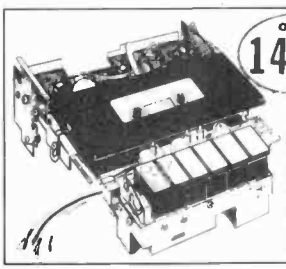

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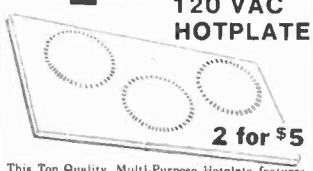

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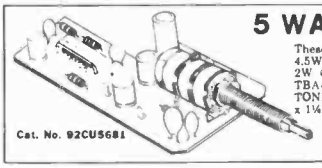

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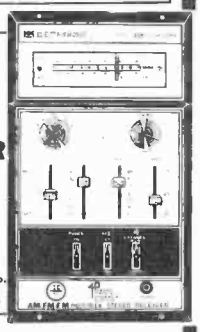

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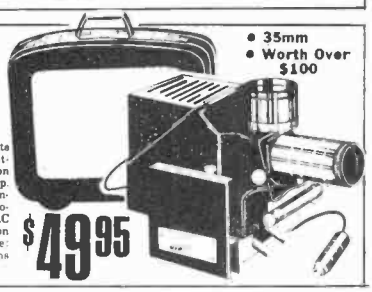

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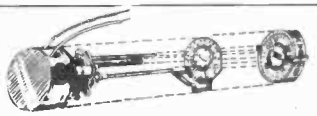

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100	50	Axial	.35
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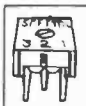

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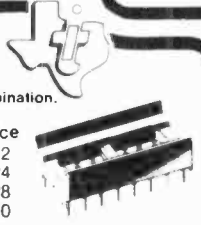

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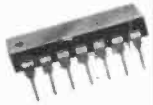

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Feature very high input impedance, low noise. Fast 13V/μS slew rate is ideal for low TIM distortion audio amplifiers. Internally compensated. Up to ± 18V supply.
[A] **LF 353N.** Dual BIFET Op amp. 8-pin DIP. **276-1715** 1.89
[B] **TL 084C.** Quad BIFET Op amp. 14-pin DIP. **276-1714** 2.99

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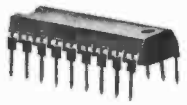

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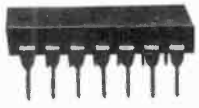

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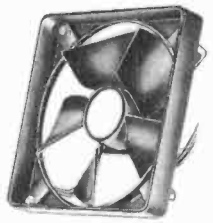

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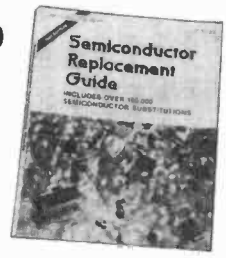

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- Four individually programmed clocks to time zone of your choice
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- Continuous AM or PM indication using 12 hr. format

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Dimensions: 5" x 18"

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ASST. 2	5 ea	180 OHM	220 OHM	270 OHM	330 OHM	390 OHM	50 PCS	1.75
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ASST. 3	5 ea	1.2K	1.5K	1.8K	2.2K	2.7K	50 PCS	1.75
		3.3K	3.9K	4.7K	5.6K	6.8K		
ASST. 4	5 ea	8.2K	10K	12K	15K	18K	50 PCS	1.75
		22K	27K	33K	39K	47K		
ASST. 5	5 ea	56K	68K	82K	100K	120K	50 PCS	1.75
		150K	180K	220K	270K	330K		
ASST. 6	5 ea	390K	470K	560K	680K	820K	50 PCS	1.75
		1M	1.2M	1.5M	1.8M	2.2M		
ASST. 7	5 ea.	2.7M	3.3M	3.9M	4.7M	5.6M	50 PCS	1.75

ASST. 8R Includes Resistor Assortments 1-7 (350 PCS.) $9.95 ea.

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Spec Sheets – 25¢
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TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialler	$14.95
AY-5-9200	Repertory Dialler	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (88 keys)	14.95
HD0165	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	7.95
74C923	Keyboard Encoder (20 keys)	6.25

ICM CHIPS

ICM7045	CMOS Precision Timer	24.95
ICM7205	CMOS LED Stopwatch/Timer	19.95
ICM7207	Oscillator Controller	7.50
ICM7208	Seven Decade Counter	19.95
ICM7209	Clock Generator	6.95

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MCM6571	128 X 9 X 7 ASCII Shifted with Greek	13.50
MCM6574	128 X 9 X 7 Math Symbol & Pictures	13.50
MCM6575	128 X 9 X 7 Alpha Control Char. Gen	13.50

MISCELLANEOUS

TL074CN	Quad Low Noise bi-fet Op Amp	2.49
TL494CN	Switching Regulator	4.49
TL496CP	Single Switching Regulator	1.75
11C90	Divide 10/11 Prescaler	19.95
95H90	Hi-Speed Divide 10/11 Prescaler	11.95
4N33	Photo-Darlington Opto-Isolator	3.95
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TIL308	.27" red num. display w/integ. logic chip	10.95
MM5320	TV Camera Sync. Generator	14.95
MM5330	4½ Digit OPM Logic Block (Special)	3.95
LD110/111	3½ Digit A/D Converter Set	25.00/set
MC14433P	3½ Digit A/D Converter	13.95

LITRONIX ISO-LIT 1
Photo Transistor Opto-Isolator
(Same as MCT 2 or 4N25)
49¢ each

SN 76477
SOUND GENERATOR
Generates Complex Sounds
Low Power - Programmable
$3.95 each

TV GAME CHIP AND CRYSTAL
AY-3-8500-1 and 2.01 MHZ Crystal (Chip & Crystal includes score display, 6 games and select angles, etc. 7.95/set

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XR205	$8.40			XR2242CP	1.50
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XR215	4.40			XR2556	3.20
XR320	1.55			XR2567	2.99
XR-L555	1.50	JE2206KB	19.95	XR3403	1.25
XR555	.39	XR1800	3.20	XR4136	1.25
XR556	.99	XR2206	4.40	XR4151	3.95
XR567CP	.99	XR2207	3.85	XR4194	4.95
XR567CT	1.25	XR2208	5.20	XR4202	3.60
XR1310P	1.95	XR2209	1.75	XR4212	2.05
XR1468CN	3.85	XR2211	5.25	XR4558	.75
XR1488	1.95	XR2212	4.35	XR4739	1.15
XR1489	1.95	XR2240	3.45	XR4741	1.47

DIODES

TYPE	VOLTS	W	PRICE	TYPE	VOLTS	W	PRICE
				1N4002	100 PIV	1 AMP	12/1 00
1N746	3 3	400m	4/1 00	1N4003	200 PIV	1 AMP	12/1 00
1N751	5.1	400m	4/1 00	1N4004	400 PIV	1 AMP	12/1.00
1N752	5.6	400m	4/1.00	1N4005	600 PIV	1 AMP	10/1 00
1N753	6 2	400m	4/1.00	1N4006	800 PIV	1 AMP	10/1.00
1N754	6.8	400m	4/1.00	1N4007	1000 PIV	1 AMP	10/1.00
1N757	9.0	400m	4/1.00	1N3600	50	200m	6/1.00
1N759	12.0	400m	4/1.00	1N4148	75	10m	15/1.00
1N959	8.2	400m	4/1.00	1N4154	35	10m	12/1.00
1N965	15	400m	4/1.00	1N4733	5 1	1w	28
1N5232	5.6	500m	28	1N4734	5.6	1w	28
1N5234	6 2	500m	28	1N4735	6.2	1w	28
1N5235	6.8	500m	28	1N4736	6.8	1w	28
1N5236	7.5	500m	28	1N4738	8.2	1w	28
1N5242	12	500m	28	1N4742	12	1w	28
1N5245	15	500m	28	1N4744	15	1w	28
1N458	25	40m	6/1 00	1N1183	50 PIV	35 AMP	1.60
1N458	150	7m	6/1 00	1N1184	100 PIV	35 AMP	1 70
1N485A	180	10m	5/1.00	1N1185	150 PIV	35 AMP	1.70
1N4001	50 PIV	1 AMP	12/1 00	1N1186	200 PIV	35 AMP	1.80
				1N1188	400 PIV	35 AMP	3.00

SCR AND FW BRIDGE RECTIFIERS

C36D	15A @ 400V	SCR(2N1849)	$1.95
C36M	35A @ 600V	SCR	1.95
2N2328	1.6A @ 300V	SCR	.50
MDA 980-1	12A @ 50V	FW BRIDGE REC.	1.95
MDA 980-3	12A @ 200V	FW BRIDGE REC.	1.95

TRANSISTORS

C106B1	50			2N3904	4/1.00
MPSA05	.30	2N3055	.89	2N3905	4/1.00
MPSA06	5/1 00	MJE3055	1.00	2N3906	4/1.00
TIS97	6/1.00	2N3392	5/1 00	2N4013	3/1.00
TIS98	6/1 00	2N3398	5/1.00	2N4123	6/1.00
40409	1 75	PN3567	3/1.00	PN4249	4/1.00
40410	1 75	PN3568	4/1 00	PN4250	4/1.00
40673	1.75	PN3569	4/1.00	2N4400	4/1.00
2N918	4/1 00	MPS3638A	5/1.00	2N4401	4/1.00
2N2219A	2/1 00	MPS3702	5/1.00	2N4402	4/1.00
2N2221A	4/1.00	2N3704	5/1.00	2N4403	4/1 00
2N2222A	5/1.00	MPS3704	5/1.00	2N4409	5/1.00
PN2222 Plastic	7/1.00	2N3705	5/1.00	2N5086	4/1 00
2N2369A	4/1.00	MPS3705	5/1 00	2N5087	4/1 00
MPS2369	5/1.00	2N3706	5/1.00	2N5088	4/1.00
2N2484	4/1.00	MPS3706	5/1.00	2N5089	4/1 00
2N2906	4/1.00	2N3707	5/1 00	2N5129	5/1.00
2N2907	5/1 00	2N3711	5/1.00	PN5134	5/1.00
PN2907 Plastic	7/1.00	2N3724A	.65	PN5138	5/1.00
2N2925	5/1.00	2N3725A	1.00	2N5139	5/1.00
MJE2955	1.25	2N3772	2.25	2N5210	5/1.00
2N3053	2/1.00	2N3823	1.00	2N5449	3/1.00
		2N3903	5/1.00	2N5951	3/1.00

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

	1-9	10-99	100+		1-9	10-99	100+
10 pf	.05	.04	.03	.001µF	.05	.04	.035
22 pf	.05	.04	.03	.0047µF	.05	.04	.035
47 pf	.05	.04	.03	.01µF	.05	.04	.035
100 pf	.05	.04	.03	.022µF	.06	.05	.04
220 pf	.05	.04	.03	.047µF	.06	.05	.04
470 pf	.05	.04	.035	.1µF	.12	.09	.075
100 VOLT MYLAR FILM CAPACITORS							
.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022	.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	.28	.23	.17	1.5/35V	.30	.26	.21
.15/35V	.28	.23	.17	2.2/35V	.35	.31	.27
.22/35V	.28	.23	.17	3.3/25V	.35	.31	.27
.33/35V	.28	.23	.17	4.7/25V	.33	.28	.23
.47/35V	.28	.23	.17	6.8/25V	.49	.45	.35
.68/35V	.28	.23	.17	15/25V	.75	.68	.59
1.0/35V	.28	.23	.17	22/6V	.75	.60	.50
MINIATURE ALUMINUM ELECTROLYTIC CAPACITORS							
Axial Lead				Radial Lead			
.47/50V	.15	.13	.10	.47/25V	.15	.13	.10
1.0/50V	.16	.14	.11	.47/50V	.16	.14	.11
3.3/50V	.14	.12	.09	1.0/16V	.15	.13	.10
4.7/25V	.15	.13	.10	1.0/25V	.16	.14	.11
10/25V	.15	.13	.10	1.0/50V	.16	.14	.11
10/50V	.16	.14	.12	4.7/16V	.15	.13	.10
22/25V	.17	.15	.12	4.7/25V	.15	.13	.10
22/50V	.24	.20	.18	4.7/50V	.16	.14	.11
47/25V	.19	.17	.15	10/16V	.14	.12	.09
47/50V	.25	.21	.19	10/25V	.15	.13	.10
100/25V	.24	.20	.18	10/50V	.16	.14	.12
100/50V	.35	.30	.28	47/50V	.24	.21	.19
220/25V	.32	.28	.25	100/16V	.19	.15	.14
220/50V	.45	.41	.38	100/25V	.24	.20	.18
470/25V	.33	.29	.27	100/50V	.35	.30	.28
1000/16V	.55	.50	.45	220/16V	.23	.17	.16
2200/16V	.70	.62	.55	470/25V	.31	.28	.26

Transistor Checker

— Completely Assembled —
— Battery Operated —

The ASI Transistor Checker is capable of checking a wide range of transistor types, either "in circuit" or out of circuit. To operate, simply plug the transistor to be checked into the front panel socket, or connect it with the alligator clip test leads provided. The unit safely and automatically identifies low, medium and high-power PNP and NPN transistors. Size: 3¾" x 6¼" x 2"
"C" cell battery not included.

Trans-Check $19.95 ea.

Custom Cables & Jumpers

DB 25 Series Cables

Part No.	Cable Length	Connectors	Price
DB25P-4-P	4 Ft.	2-DP25P	$15.95 ea.
DB25P-4-S	4 Ft.	1-DP25P/1-25S	$16.95 ea.
DB25S-4-S	4 Ft.	2-DP25S	$17.95 ea.

Dip Jumpers

DJ14-1	1 ft.	1-14 Pin	$1.59 ea.
DJ16-1	1 ft.	1-16 Pin	1.79 ea.
DJ24-1	1 ft.	1-24 Pin	2.79 ea.
DJ14-1-14	1 ft.	2-14 Pin	2.79 ea.
DJ16-1-16	1 ft.	2-16 Pin	3.19 ea.
DJ24-1-24	1 ft.	2-24 Pin	4.95 ea.

For Custom Cables & Jumpers, See JAMECO 1979 Catalog for Pricing

CONNECTORS
25 Pin-D Subminiature

DB25P (as pictured)	PLUG (Meets RS232)	$2.95
DB25S	SOCKET (Meets RS232)	$3.50
DB51226-1	Cable Cover for DB25P or DB25S	$1.75

PRINTED CIRCUIT EDGE-CARD

.156 Spacing-Tin-Double Read-Out — Bifurcated Contacts — Fits .054 to .070 P.C. Cards

15/30 SE	PINS (Solder Eyelet)	$1.95
18/36 SE	PINS (Solder Eyelet)	$2.49
22/44 SE	PINS (Solder Eyelet)	$2.95
22/44 WW	PINS (Wire Wrap)	$3.95
50/100 WW (.125 Spacing)	PINS (Wire Wrap) R681-1	$6.95

4-Digit Clock Kit

* Bright .357" ht. red display
* Sequential flashing colon
* 12 or 24 hour operation
* Extruded aluminum case (black)
* Pressure switches for hours, minutes & hold functions
* Includes all components, case and wall transformer
* Size: 3¼ x 1¾ x 1¼

JE730 . . . . . $14.95

Jumbo 6-Digit Clock Kit

* Four .630"ht. and two .300"ht. common anode displays
* Uses MM5314 clock chip
* Switches for hours, minutes and hold functions
* Hours easily viewable to 30 feet
* Simulated walnut case
* 115 VAC operation
* 12 or 24 hour operation
* Includes all components, case and wall transformer
* Size: 6¾ x 3⅛ x 1¾

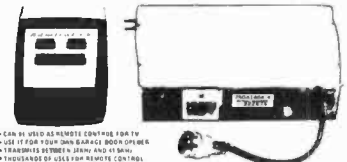
JE747 . . . . . $29.95

* Bright .300 ht. comm. cathode display
* Uses MM5314 clock chip
* Switches for hours, minutes and hold modes
* Hrs. easily viewable to 20 ft.
* Simulated walnut case
* 115 VAC operation
* 12 or 24 hr. operation
* Incl. all components, case & wall transformer
* Size: 6¼" x 3-1/8" x 1¾"

JE701

6-Digit Clock Kit $19.95

REMOTE CONTROL TRANSMITTER & RECEIVER



- CAN BE USED AS REMOTE CONTROL FOR TV
- USE IT FOR YOUR OWN GARAGE DOOR OPENER
- TRANSMITS BETWEEN 260MV AND 415 MHz
- THOUSANDS OF USES FOR REMOTE CONTROL APPLICATIONS
- TRANSMITTER USES A 12V BATTERY
- SCHEMATIC INCLUDED

$19.95

Digital Stopwatch Kit

* Use Intersil 7205 Chip
* Plated thru double-sided P.C. Board
* LED display (red)
* Times to 59 min. 59.59 sec. with auto reset
* Quartz crystal controlled
* Three stopwatches in one: single event, split (cummulative) & taylor (sequential timing)
* Uses 3 penlite batteries
* Size: 4.5" x 2.15" x .90"

JE900 $39.95

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

8080A	CPU	$ 7.95
8212	8-Bit Input/Output	3.25
8214	Priority Interrupt Control	5.95
8216	Bi-Directional Bus Driver	3.49
8224	Clock Generator/Driver	3.95
8226	Bus Driver	3.49
8228	System Controller/Bus Driver	4.95
8238	System Controller	5.95
8251	Prog. Comm. I/O (USART)	7.95
8253	Prog. Interval Timer	14.95
8255	Prog. Periph. I/O (PPI)	9.95
8257	Prog. DMA Control	19.95
8259	Prog. Interrupt Control	19.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	$14.95
MC6802CP	MPU with Clock and Ram	24.95
MC6813API	128X8 Static Ram	5.95
MC6821	Periph. Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	12.95
MC6830L8	1024X8 Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	7.95
MC6852	Synchronous Serial Data Adapt.	9.95
MC6860	0-600 bps Digital MODEM	12.95
MC6862	2400 bps Modulator	14.95
MC6880A	Quad 3-State Bus Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS—MISCELLANEOUS

Z80(780C)	CPU	$14.95
Z80A(780-1)	CPU	16.95
CDP1802	CPU	19.95
2650	MPU	19.95
6502	CPU	11.95
8035	8-Bit MPU w/clock, RAM, 1/O lines	19.95
P8085	CPU	19.95
TMS9900JL	16-Bit MPU w/hardware, multiply & divide	49.95

SHIFT REGISTERS

MM500H	Dual 25 Bit Dynamic	$.50
MM503H	Dual 50 Bit Dynamic	.50
MM504H	Dual 16 Bit Static	.50
MM506H	Dual 100 Bit Static	.50
MM510H	Dual 64 Bit Accumulator	.50
MM5016H	500/512 Bit Dynamic	.89
2504T	1024 Dynamic	3.95
2518	Hex 32 Bit Static	4.95
2522	Dual 132 Bit Static	2.95
2524	512 Static	.99
2525	1024 Dynamic	2.95
2527	Dual 256 Bit Static	2.95
2528	Dual 250 Static	4.00
2529	Dual 240 Bit Static	4.00
2532	Quad 80 Bit Static	2.95
3341	Fifo	8.95
74LS670	4X4 Register File (TriState)	2.49

UART'S

A-Y-S-1013	30K BAUD	5.95

MICROPROCESSOR MANUALS

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

ROM'S

2513(2140)	Character Generator(upper case)	$9.95
2513(3021)	Character Generator(lower case)	9.95
2516	Character Generator	10.95
MM5230N	2048-Bit Read Only Memory	1.95

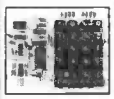
RAM'S

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	7.95
2114L	1024X4	Static 450ns low power	10.95
2114-3	1024X4	Static 300ns	10.95
2114L-3	1024X4	Static 300ns low power	11.95
5101	256X4	Static	7.95
5280/2107	4096X1	Dynamic	4.95
7489	16X4	Static	1.75
74S200	256X1	Static Tristate	4.95
93421	256X1	Static	2.95
UPD414 (MK4027)	4K	Dynamic 16 pin	4.95
UPD416 (MK4116)	16K	Dynamic 16 pin 250ns	9.95
TMS4044-45NL	4K	Static	14.95
TMS4045	1024X4	Static	14.95
2117	16,384X1	Dynamic 350ns (house marked)	9.95
MM5262	2KX1	Dynamic	4/1.00

PROM'S

1702A	2048	FAMOS	$5.95
2716(INTEL	16K*	EPROM	59.95
TMS2516	16K*	EPROM	49.95
(2716)	*Requires single +5V power supply.		
TMS2532	4KX8	EPROM	89.95
2708	8K	EPROM	10.95
2716 T.I	16K**	EPROM	29.95
	**Requires 3 voltages, —5V, +5V, +12V		
5203	2048	FAMOS	14.95
6301-1(7611)	1024	Tristate Bipolar	3.49
6330-1(7602)	256	Open C Bipolar	2.95
82S23	32X8	Open Collector	3.95
82S115	4096	Bipolar	19.95
82S123	32X8	Tristate	3.95
74186	512	TTL Open Collector	9.95
74188	256	TTL Open Collector	3.95
74S287	1024	Static	2.95

JE600 HEXADECIMAL ENCODER KIT



FEATURES:
- Full 8 bit latched output for microprocessor use
- 3 User Define keys with one being bistable operation
- Debounce circuit provided for all 19 keys
- LED readout to verify entries
- Easy interfacing with standard 16 pin IC connector
- Only +5VDC required for operations

FULL 8 BIT LATCHED OUTPUT—19 KEYBOARD

The JE600 Encoder Keyboard provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8 bit microprocessor or 8 bit memory circuits. Three (3) additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with LED readouts. Also included is a key entry strobe.

JE600 . . . . . $59.95
Hexadecimal Keypad only $14.95

DIGITAL THERMOMETER KIT

- Dual sensors—switching control for indoor/outdoor or dual monitoring
- Continuous LED .8" ht. display
- Range: -40°F to 199°F / -40°C to 100°C
- Accuracy: ±1° nominal
- Set for Fahrenheit or Celsius reading
- Sim. walnut case - AC wall adapter incl.
- Size: 3-1/4"H x 6-5/8"W x 1-3/8"D

JE300 . . . . . $39.95

62-Key ASCII Encoder Keyboard Kit

The JE610 62-Key ASCII Encoder Keyboard Kit can be interfaced into most any computer system. The JE610 Kit comes complete with an industrial grade keyboard switch assembly (62 keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and —12V @ 10mA for operation.

FEATURES:
- 60 Keys generate the full 128 characters, upper and lower case ASCII set
- Fully buffered
- 2 user-define keys provided for custom applications
- Caps lock for upper case only alpha characters
- Utilizes a 2376 (40 pin) encoder read only memory chip
- Outputs directly compatible with TTL/DTL or MOS logic arrays
- Easy interfacing with a 16-pin dip or 18-pin edge connector

JE610 . . . . . $79.95
62-Key Keyboard only . . $34.95

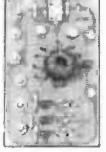
REGULATED POWER SUPPLY NEW

JE200 5V-1 AMP POWER SUPPLY

- Uses LM309K
- Heat sink provided
- PC Board construction
- Provides a solid 1 amp @ 5 volts
- Can supply up to ±5V, ±9V and ±12V with JE205 Adapter
- Includes components, hardware & instructions
- Size: 3½"x5"x2"H

JE200 $14.95

JE205 ADAPTER BOARD — Adapts to JE200 — ±5V, ±9V and ±12V



- DC/DC converter w/ +5V input
- Toriodal hi-speed switching XMFR
- Short circ. protection
- PC Brd. construction
- Piggy-back to JE200 board
- Size: 3½"x2"x9/16"h

JE205 $12.95

$10.00 Min. Order — U.S. Funds Only
Calif. Residents Add 6% Sales Tax
Postage — Add 5% plus $1 Insurance (if desired)

Spec Sheets — 25¢
1980 Catalog Available — Send 41¢ stamp

FREE 1980 CATALOG

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The Incredible "Pennywhistle 103"

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The Pennywhistle 103 is capable of recording data to and from audio tape without critical speed requirements for the recorder and it is able to communicate directly with another modem and terminal for telephone "hamming" and communications. In addition, it is free of critical adjustments and is built with non-precision, readily available parts.

Data Transmission Method	Frequency-Shift Keying, full-duplex (half-duplex selectable).
Maximum Data Rate	300 Baud.
Data Format	Asynchronous Serial (return to mark level required between each character).
Receive Channel Frequencies	2025 Hz for space, 2225 Hz for mark.
Transmit Channel Frequencies	Switch selectable: Low (normal) = 1070 space, 1270 mark; High = 025 space, 2225 mark.
Receive Sensitivity	—46 dbm accoustically coupled.
Transmit Level	—15 dbm nominal. Adjustable from —6 dbm to —20 dbm.
Receive Frequency Tolerance	Frequency reference automatically adjusts to allow for operation between 1800 Hz and 2400 Hz.
Digital Data Interface	EIA RS-232C or 20 mA current loop (receiver is optoisolated and non-polar).
Power Requirements	120 VAC, single phase, 10 Watts.
Physical	All components mount on a single 5" by 9" printed circuit board. All components included.

Requires a VOM, Audio Oscillator, Frequency Counter and/or Oscilloscope to align.

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K. Kit comes complete with:

* 8 each UPD416-1 (16K Dynamic Rams) 250NS
* Documentation for conversion

TRS-16K $75.00

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- 6 EACH 15 MINUTE HIGH QUALITY C-15 CASSETTES
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- ADDITIONAL CASSETTES AVAILABLE #C-15-S $2.95 ea

CAS-6 $14.95
(Case and 6 Cassettes)

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UHF Channel 33 TV Interface Unit

Wide Band B/W or Color System

★ Converts TV to Video Display for home computers, CCTV camera, Apple II, works with Cromeco Dazzler, SOL-20, IRS-80, Challenger, etc.
MOD II is pretuned to Channel 33 (UHF).

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EPROM Erasing Lamp

- Erases 2708, 2716, 1702A, 5203O, 5204O, etc.
- Erases up to 4 chips within 20 minutes.
- Maintains constant exposure distance of one inch
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"Plug/Jack interface to any computer system requiring remote control of cassette functions"

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new

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- 2 each 100K pots (Linear Taper)
- Printed Circuit Board Mount
- Size: 1" x 1-3/16" x 1-3/16"

Micro-Miniature Joystick $4.95

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2.7	12-27007	13-27007	14-27020	15-27020
3.0	–	13-30007	–	15-30020
3.3	12-33007	13-33007	14-33020	15-33020
3.6	–	13-36007	–	15-36020
3.9	12-39007	13-39007	14-39020	15-39020
4.3	–	13-43007	–	15-43020
4.7	12-47007	13-47007	14-47020	15-47020
5.1	–	13-51007	–	15-51020
5.6	12-56007	13-56007	14-56020	15-56020
6.2	–	13-62007	–	15-62020
6.8	12-68007	13-68007	14-68020	15-68020
7.5	–	13-75007	–	15-75020
8.2	12-82007	13-82007	14-82020	15-82020
9.1	–	13-91007	–	15-91020
10	12-10107	13-10107	14-10120	15-10120
11	–	13-11107	–	15-11120
12	12-12107	13-12107	14-12120	15-12120
13	–	13-13107	–	15-13120
15	12-15107	13-15107	14-15120	15-15120
16	–	13-16107	–	15-16120
18	12-18107	13-18107	14-18120	15-18120
20	–	13-20107	–	15-20120
22	12-22107	13-22107	14-22120	15-22120
24	–	13-24107	–	15-24120
27	12-27107	13-27107	14-27120	15-27120
30	–	13-30107	–	15-30120
33	12-33107	13-33107	14-33120	15-33120
36	–	13-36107	–	15-36120
39	12-39107	13-39107	14-39120	15-39120
43	–	13-43107	–	15-43120
47	12-47107	13-47107	14-47120	15-47120
51	–	13-51107	–	15-51120
56	12-56107	13-56107	14-56120	15-56120
62	–	13-62107	–	15-62120
68	12-68107	13-68107	14-68120	15-68120
75	–	13-75107	–	15-75120
82	12-82107	13-82107	14-82120	15-82120
91	–	13-91107	–	15-91120
100	12-11207	13-10207	14-10220	15-10220
110	–	13-11207	–	15-11220
120	12-12207	13-12207	14-12220	15-12220
130	–	13-13207	–	15-13220
150	12-15207	13-15207	14-15220	15-15220
160	–	13-16207	–	15-16220
180	12-18207	13-18207	14-18220	15-18220
200	–	13-20207	–	15-20220
220	12-22207	13-22207	14-22220	15-22220
240	–	13-24207	–	15-24220
270	12-27207	13-27207	14-27220	15-27220
300	–	13-30207	–	15-30220
330	12-33207	13-33207	14-33220	15-33220
360	–	13-36207	–	15-36220
390	12-39207	13-39207	14-39220	15-39220
430	–	13-43207	–	15-43220
470	12-47207	13-47207	14-47220	15-47220
510	–	13-51207	–	15-51220
560	12-56207	13-56207	14-56220	15-56220
620	–	13-62207	–	15-62220
680	12-68207	13-68207	14-68220	15-68220
750	–	13-75207	–	15-75220
820	12-82207	13-82207	14-82220	15-82220
910	–	13-91207	–	15-91220
1000	12-10307	13-10307	14-10320	15-10320
1100	–	13-11307	–	15-11320
1200	12-12307	13-12307	14-12320	15-12320
1300	–	13-13307	–	15-13320
1500	12-15307	13-15307	14-15320	15-15320
1600	–	13-16307	–	15-16320
1800	12-18307	13-18307	14-18320	15-18320
2000	–	13-20307	–	15-20320
2200	12-22307	13-22307	14-22320	15-22320
2400	–	13-24307	–	15-24320
2700	12-27307	13-27307	14-27320	15-27320
3000	–	13-30307	–	15-30320
3300	12-33307	13-33307	14-33320	15-33320
3600	–	13-36307	–	15-36320
3900	12-39307	13-39307	14-39320	15-39320
4300	–	13-43307	–	15-43320
4700	12-47307	13-47307	14-47320	15-47320
5100	–	13-51307	–	15-51320
5600	12-56307	13-56307	14-56320	15-56320
6200	–	13-62307	–	15-62320
6800	12-68307	13-68307	14-68320	15-68320
7500	–	13-75307	–	15-75320
8200	12-82307	13-82307	14-82320	15-82320
9100	–	13-91307	–	15-91320
10K	12-10407	13-10407	14-10420	15-10420
11K	–	13-11407	–	15-11420
12K	12-12407	13-12407	14-12420	15-12420
13K	–	13-13407	–	15-13420
15K	12-15407	13-15407	14-15420	15-15420
16K	–	13-16407	–	15-16420
18K	12-18407	13-18407	14-18420	15-18420
20K	–	13-20407	–	15-20420
22K	12-22407	13-22407	14-22420	15-22420
24K	–	13-24407	–	15-24420
27K	12-27407	13-27407	14-27420	15-27420
30K	–	13-30407	–	15-30420
33K	12-33407	13-33407	14-33420	15-33420
36K	–	13-36407	–	15-36420
39K	12-39407	13-39407	14-39420	15-39420
43K	–	13-43407	–	15-43420
47K	12-47407	13-47407	14-47420	15-47420
51K	–	13-51407	–	15-51420
56K	12-56407	13-56407	14-56420	15-56420
62K	–	13-62407	–	15-62420
68K	12-68407	13-68407	14-68420	15-68420
75K	–	13-75407	–	15-75420
82K	12-82407	13-82407	14-82420	15-82420
91K	–	13-91407	–	15-91420
100K	12-10507	13-10507	14-10520	15-10520
110K	–	13-11507	–	15-11520
120K	12-12507	13-12507	14-12520	15-12520
130K	–	13-13507	–	15-13520
150K	12-15507	13-15507	14-15520	15-15520
160K	–	13-16507	–	15-16520
180K	12-18507	13-18507	14-18520	15-18520
200K	–	13-20507	–	15-20520
220K	12-22507	13-22507	14-22520	15-22520
240K	–	13-24507	–	15-24520
270K	12-27507	13-27507	14-27520	15-27520
300K	–	13-30507	–	15-30520
330K	12-33507	13-33507	14-33520	15-33520
360K	–	13-36507	–	15-36520
390K	12-39507	13-39507	14-39520	15-39520
430K	–	13-43507	–	15-43520
470K	12-47507	13-47507	14-47520	15-47520
510K	–	13-51507	–	15-51520
560K	12-56507	13-56507	14-56520	15-56520
620K	–	13-62507	–	15-62520
680K	12-68507	13-68507	14-68520	15-68520
750K	–	13-75507	–	15-75520
820K	12-82507	13-82507	14-82520	15-82520
910K	–	13-91507	–	15-91520
1.0M	12-10607	13-10607	14-10620	15-10620
1.1M	–	13-11607	–	15-11620
1.2M	12-12607	13-12607	14-12620	15-12620
1.3M	–	13-13607	–	15-13620
1.5M	12-15607	13-15607	14-15620	15-15620
1.6M	–	13-16607	–	15-16620
1.8M	12-18607	13-18607	14-18620	15-18620
2.0M	–	13-20607	–	15-20620
2.2M	12-22607	13-22607	14-22620	15-22620
2.4M	–	13-24607	–	15-24620
2.7M	12-27607	13-27607	14-27620	15-27620
3.0M	–	13-30607	–	15-30620
3.3M	12-33607	13-33607	14-33620	15-33620
3.6M	–	13-36607	–	15-36620
3.9M	12-39607	13-39607	14-39620	15-39620
4.3M	–	13-43607	–	15-43620
4.7M	12-47607	13-47607	14-47620	15-47620
5.1M	–	13-51607	–	15-51620
5.6M	12-56607	13-56607	14-56620	15-56620
6.2M	–	13-62607	–	15-82620
6.8M	12-68607	13-68607	14-68620	15-68620
7.5M	–	13-75607	–	15-75620
8.2M	12-82607	13-82607	14-82620	15-82620
9.1M	–	13-91607	–	15-91620
10M	12-10707	13-10707	14-10720	15-10720
11M	–	13-11707	–	15-11720
12M	12-12707	13-12707	14-12720	15-12720
13M	–	13-13707	–	15-13720
15M	12-15707	13-15707	14-15720	15-15720
16M	–	13-16707	–	15-16720
18M	12-18707	13-18707	14-18720	15-18720
20M	–	13-20707	–	15-20720
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7438	0.24
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74160	0.87
74161	0.87
74162	0.87
74163	0.87
74164	0.87
74165	0.87
74166	1.20
74167	1.95
74170	1.55
74173	1.20
74174	0.88
74175	0.78
74176	0.78
74177	0.78
74179	1.80
74180	0.69
74181	1.95
74182	0.78
74184	1.95
74185	1.95
74188	3.25
74190	0.95
74191	0.95
74192	0.86
74193	0.80
74194	0.87
74195	0.87
74196	0.87
74197	0.87
74198	1.45
74199	1.45
74251	1.09
74283	2.20
74290	0.89
74293	0.89
74298	0.92
74365	0.62
74366	0.62
74367	0.62
74368	0.62

74LSxx

74LS00	$0.27
74LS01	0.27
74LS02	0.27
74LS03	0.27
74LS04	0.28
74LS05	0.28
74LS08	0.28
74LS09	0.28
74LS10	0.27
74LS15	0.27
74LS20	0.27
74LS21	0.27
74LS22	0.27
74LS26	0.32
74LS27	0.27
74LS30	0.27
74LS32	0.32
74LS37	0.32
74LS38	0.32
74LS40	0.27
74LS42	0.66
74LS47	0.78
74LS48	0.76
74LS51	0.27
74LS54	$0.27
74LS55	0.27
74LS73	0.38
74LS74	0.38
74LS76	0.38
74LS78	0.38
74LS83	0.78
74LS85	0.97
74LS86	0.38
74LS90	0.56
74LS93	0.56
74LS95	0.87
74LS107	0.38
74LS109	0.38
74LS112	0.38
74LS113	0.38
74LS114	0.38
74LS123	0.98
74LS125	0.48
74LS126	0.48
74LS132	0.80
74LS136	0.38
74LS138	0.93
74LS139	0.93
74LS151	0.74
74LS153	0.84
74LS154	1.09
74LS155	0.74
74LS156	0.74
74LS157	0.74
74LS158	0.74
74LS160	1.01
74LS161	1.01
74LS162	1.01
74LS163	1.01
74LS164	1.01
74LS168	1.13
74LS169	1.13
74LS170	1.72
74LS173	1.33
74LS174	1.05
74LS175	0.83
74LS181	2.50
74LS190	1.17
74LS191	1.17
74LS192	0.97
74LS193	0.97
74LS194	0.87
74LS196	0.85
74LS197	0.85
74LS221	1.90
74LS253	0.99
74LS257	0.74
74LS258	0.74
74LS266	$0.38
74LS279	0.58
74LS283	0.99
74LS290	0.64
74LS295	0.99
74LS365	0.66
74LS366	0.66
74LS367	0.66
74LS368	0.66
74LS386	0.38
74LS390	1.69
74LS490	1.49
74LS670	2.33

74Sxx

74S00	$0.35
74S02	0.35
74S03	0.35
74S04	0.36
74S05	0.36
74S09	0.38
74S10	0.35
74S11	0.38
74S15	0.38
74S20	0.35
74S22	0.36
74S30	0.35
74S40	0.35
74S64	0.38
74S65	0.38
74S74	0.58
74S78	0.58
74S86	0.58
74S112	0.58
74S113	0.58
74S114	0.58
74S133	0.38
74S134	0.38
74S135	0.49
74S140	0.47
74S151	0.69
74S153	0.75
74S157	0.75
74S158	0.75
74S206	1.75
74S258	1.15
74S280	2.25
74S287	3.20
74S300	1.60
74S305	1.90
74S310	2.85
74S312	1.05
74S316	2.80
74S341	$4.10
74S342	1.20
74S343	4.95
74S346	1.25
74S362	2.15
74S387	4.70

74Cxx

74C00	$0.24
74C02	0.24
74C04	0.26
74C08	0.25
74C10	0.24
74C14	0.90
74C20	0.25
74C30	0.24
74C32	0.25
74C42	0.94
74C48	1.27
74C73	0.71
74C74	0.48
74C76	0.71
74C83	1.37
74C85	1.37
74C86	0.49
74C89	3.95
74C90	0.97
74C93	0.97
74C95	1.09
74C107	0.69
74C151	1.89
74C154	2.90
74C157	1.89
74C160	1.17
74C161	1.17
74C162	1.17
74C163	1.17
74C164	1.09
74C165	1.09
74C173	1.29
74C174	1.15
74C175	1.15
74C192	1.37
74C193	1.37
74C195	1.08
74C200	7.50
74C221	1.89
74C901	0.48
74C902	0.48
74C903	0.59
74C904	0.59
74C905	6.00
74C906	0.59
74C907	0.59
74C908	$1.19
74C909	1.78
74C910	6.00
74C914	1.19
74C918	1.49
74C925	7.80
74C926	7.80
74C927	7.80
74C928	7.80

4xxx

4000	$0.22
4001	0.22
4002	0.22
4006	1.19
4007	0.22
4008	0.78
4009	0.43
4010	0.43
4011	0.22
4012	0.22
4013	0.39
4014	0.95
4015	0.95
4016	0.39
4017	1.04
4018	1.04
4019	0.39
4020	1.13
4021	1.13
4022	0.95
4023	0.22
4024	0.79
4025	0.22
4027	0.39
4028	0.88
4029	1.13
4030	0.29
4031	2.97
4034	2.75
4035	0.99
4040	0.99
4041	0.78
4042	0.78
4043	0.69
4044	0.69
4046	1.79
4047	1.99
4048	0.95
4049	0.39
4050	0.39
4051	1.19
4052	1.19
4053	1.19
4060	$1.49
4066	0.78
4068	0.39
4069	0.26
4070	0.49
4071	0.22
4073	0.22
4075	0.22
4076	1.29
4077	0.59
4078	0.39
4081	0.22
4085	0.69
4089	2.75
4093	0.99
4099	2.10
4503	0.98
4507	0.99
4510	1.13
4511	1.04
4512	0.98
4516	1.22
4518	1.13
4519	0.62
4520	1.13
4527	1.87
4528	0.86
4539	1.10
4555	0.67
4556	0.88
4582	0.88
4584	0.74
4702	7.10
4725	3.95
40014	0.90
40085	1.37
40098	0.54
40106	0.90
40160	1.17
40161	1.17
40162	1.17
40163	1.17
40174	1.15
40175	1.15
40192	1.37
40193	1.37
40194	1.08
40195	1.08

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$ 500.00 – $999.99	LESS 20%	$100.00 and Up	NO CHARGE
$1000.00 and Up	LESS 25%	The above charges include your choice of shipping in U. S. via First Class Mail or UPS	

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CBM 2001-32B	Computer Identical to 2001-16B with 32K bytes of memory . . . $1295.00
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CBM 2023	Printer 80 column dot matrix printer. Plain paper printer with full graphics . . . $849.00
CBM 2040	Dual Floppy Dual drive intelligent mini floppy system 341K net user storage capacity . . . $1295.00
C2N	External Cassette Cassette player/recorder to use with PET 2001/8/16/32 . . . $95.00
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APS 12-1.6	12	1.6	APS 12-4	12	5.0
APS 15-1.5	15	1.5	APS 15-3	15	3.0
APS 24-1	24	1.0	APS 24-2.2	24	2.2

1-9	10 up	25 up	1-9	10 up	25 up
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½ Watt $1.79 per 100

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A-SI-8(Socket for above)	.95
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SI-1050G(50W) $27.80	TR50 $17.90
A-SI-10(Socket for above)	.95

* Note: One Transformer can power two audio amplifiers.

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• ±6V SPLIT SUPPLY

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Plug into real listening excitement!

The new Bearcat 8-Track Cartridge Scanner turns home and car systems into full, 4-channel, 2-band crystal Scanner Radios instantly, without any installation. And tunes in police calls, fire calls, weather warnings, emergency information—automatically!

All for less than $100.

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The exciting, new Bearcat 8-Track Scanner is a great way to get into the real excitement of scanning. Bearcat Scanners. The first and still number one.

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BC-E-A	33 thru 49 MHz	$99.95
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	ICH8530EV/KIT	52.00	Oscillator Controller	ICM7207EV/KIT	9.60
8 Digit Stopwatch	ICM7045EV/KIT	22.05	Microprocessor Kit	6801SAMPLR	49.00
6 Digit Stopwatch	ICM7215EV/KIT	19.25	PC Board for above	6960SAMPLR	32.50

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We're expanding the options for S-100 systems by using the experience we've acquired in the past, mixing in the best technology offered by the present, and building products for the future... products that meet, and often exceed, the demands of the new wave of S-100 professional users. When you move up to S-100, move up to the CompuPro™ line from Godbout Electronics.

NEW! HIGH-PERFORMANCE S-100 MOTHERBOARDS

19 slot: $174 unkit, $214 assm
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6 slot: $89 unkit, $129 assm

(Unkits have edge connectors and termination resistors pre-soldered in place for easy assembly.)

These 3rd generation motherboards are shielded, terminated, and designed to work with the latest 5 and 10 MHz CPUs coming on line. Units in Godbout, Vector, IMSAI, TEI, and similar enclosures. These high quality products are a welcome addition to any system — or the start of a great one.

NEW! The Godbout Box!

At last — a high quality, industrial grade home for your computer. Includes power supply. Use for either desk or rack mount. Check your local computer store for details, or write us direct...this is a product that has been needed for a long time, and we're filling that need in style.

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...AND DON'T FORGET OUR MEMORIES!

All our memory boards are fully static, are zip along with 5 MHz systems, include a 1 year warranty, and are available in 3 different configurations. Here are just some selections from our roster of 14 Econorams**...

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24K Econoram XII	S-100 (1)	$329	$419	$519
16K Econoram XIV	S-100 (2)	$289	$349	$448
16K Econoram XV-16	Heath H8 (3)	$329	$395	n/a
32K Econoram XV-32	Heath H8 (3)	$599	$729	n/a

Notes
(1) Bank select board — 2 independent banks addressable on 8K boundaries.
(2) Extended addressing (24 address lines).
(3) Bank select option for implementing memory systems greater than 64K.
* CSC boards are qualified under our high-reliability Certified System component program (200 hour burn-in, replacement in event of failure within 1 year of invoice date)
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2S "Interfacer" S-100 I/O board $189 unkit, $249 assm, $324 CSC*

Dual serial port with 2 full duplex parallel ports for RS-232 handshake. Crystal timebase, Baud rates to 19.2 KBaud selectable for each port, much more. This no-excuses serial board does things the others only dream about.

NEW! 3P + S "Interfacer II" S-100 I/O board $189 unkit, $249 assm, $324 CSC*

Incorporates 1 channel of serial I/O (with all the features of a port from the 2S "Interfacer"), along with 3 full duplex parallel ports with attention/enable/strobe bits for each parallel port and individual interrupts. The versatility of each port contributes to a very versatile, and extremely flexible, I/O board.

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7818T	.90	320K12	1.85
7905T	1.10	320K15	1.85
7912T	1.10	320K24	1.85
7924T	1.10	309K	1.40
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74LS02	.30	74LS107	.45	74LS195	1.25
74LS03	.25	74LS109	.50	74LS196	1.75
74LS04	.40	74LS112	.50	74LS197	1.75
74LS05	.35	74LS113	.50	74LS221	1.00
74LS08	.35	74LS114	.50	74LS240	4.00
74LS09	.27	74LS122	.50	74LS241	4.00
74LS10	.35	74LS124	1.35	74LS242	4.00
74LS11	.75	74LS125	.90	74LS243	4.00
74LS12	.30	74LS126	.50	74LS244	4.50
74LS13	.60	74LS132	1.00	74LS247	1.42
74LS14	1.25	74LS136	.50	74LS248	2.50
74LS20	.30	74LS138	.95	74LS253	1.00
74LS21	.35	74LS139	.95	74LS257	1.50
74LS22	.29	74LS145	1.25	74LS258	1.75
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7403	.20	7470	.30	74155	.70
7404	.20	7472	.25	74157	.60
7405	.20	7473	.35	74160	.85
7406	.16	7474	.35	74161	.75
7407	.16	7475	.45	74162	1.95
7408	.20	7476	.35	74163	.75
7409	.20	7480	.59	74164	.89
7410	.20	7481	1.20	74165	.95
7411	.25	7482	.99	74166	1.45
7412	.25	7483	.60	74170	1.60
7413	.35	7485	.65	74173	.99
7414	.60	7486	.35	74174	.85
7416	.19	7489	1.75	74175	.70
7417	.25	7490	.45	74176	.80
7420	.20	7491	.55	74177	.75
7423	.22	7492	.45	74180	.65
7425	.20	7493	.45	74181	1.75
7426	.32	7494	.69	74182	.89
7427	.25	7495	.65	74190	1.25
7430	.25	7496	.65	74191	.95
7432	.25	7497	3.50	74192	.75
7436	.55	74100	1.29	74193	.75
7437	.25	74107	.31	74195	.70
7438	.25	74109	.55	74196	.92
7439	.20	74116	1.95	74221	.85
7440	.20	74120	1.60	74251	.80
7441	.70	74121	.35	74273	1.10
7442	.50	74122	.40	74278	3.00
7443	.50	74123	.60	74365	.65
7444	.50	74126	.40	74366	.65
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CD4006	1.00	CD4023	.75	CD4066	.87
CD4007	.26	CD4024	.75	CD4069	.40
CD4008	.25	CD4025	.26	CD4071	.26
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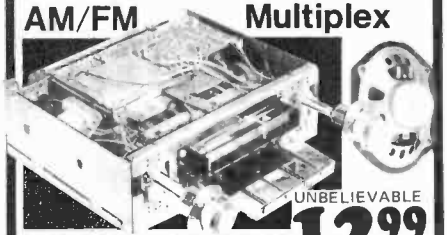

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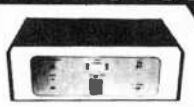

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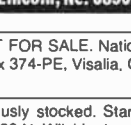

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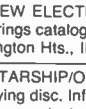

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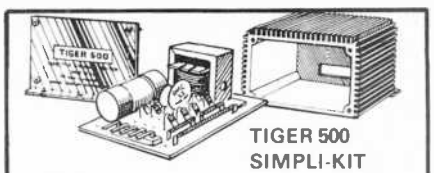

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ELECTRONICS WORLD®

Personal Electronics News

Faster facsimile transmission has been invented at IBM Research. Still experimental, it provides an enhanced means for "fax" machines to transmit text and pictures over telephone or satellite communication channels in digital form. It uses simpler hardware and is speedier than presently possible with digital methods, averaging about a minute, as compared to the 3-to-6-minute transmission times common with today's analog machines. The method involves "data compression" coding that reduces the amount of data transmitted to represent a page of information by more efficiently converting black-and-white images into digital information.

Sound-to-printed page, a compact audio/visual system, has been introduced by Microsonics Corp., Los Angeles, CA. The system consists of a handheld player, a "Microphonograph," and a 2" (50.8-mm) transparent record that can be applied directly to the page of a book or a specifically designed card to give up to 90 seconds of audio information. The user places the Microphonograph over the record on the page and presses the "play" button. Instantly, three different media--pictures, print, and sound--are available. In the card format, the front can display photos, maps, diagrams, and other visual information, while the reverse side of the

card may contain written information or instructions as well as the transparent record. The reader both sees and hears the printed material in short attention-holding segments. Prices start at $20.00.

A Computer Calendar for 1980 is available from the Hayden Book Company, Rochelle Park, NJ 07662. The calendar features 14 original works of computer art; the first commercial use of the Dunn camera using Type 808 Polacolor Land film; and a complete BASIC program for a perpetual calendar. Cost of the 1980 Hayden Computer Calendar is $5.95.

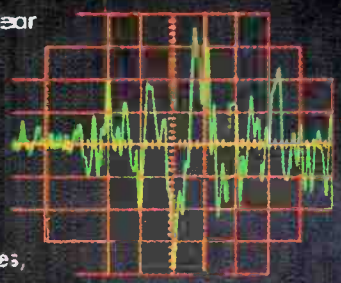
An interactive home computer system that will feature a personal computer connected via cable TV to outside sources will soon be tested by SixStar Cablevision of Los Angeles. Three of the 42 channels available over the firm's cable system will be set aside for data transmissions from households to banks and other businesses and for personal home computing. Almost 50 application programs have been prepared for the system. Monthly service fee will be $4 to $6 more than the standard $7.50 cable fee in the Southern California area where tests will be conducted.

A single multicolor display from Varilite Corp. changes color in response to electrical input variations. The "Varilite" display produces all colors in the spectrum between red and green in a stepless manner. No color wheels are used. The Varilite is said to be the first indicator light that can display analog as well as digital information. It can be used in many applications where a meter or gauge is normally required to indicate a range of information.

A BASIC timesharing alternative is a low-cost distributed processing called Nestar Systems' Cluster/One ™. The "Queen" central unit connects to up to 15 personal "Drone" microcomputers via a high-speed "ClusterBus" parallel data bus. An optional feature provides for an additional 15 Drones. Currently supported as Drone stations are the Apple II and Commodore PET 2001-8, with Radio Shack's TRS-80 soon to be supported. The concept permits each BASIC user to have his own computer rather than a small share of one central processor. Programs and DATA files can be shared among Cluster/One users. They are stored on two IBM-compatible flexible 8" diskettes, each of which can store up to 315K bytes. Disk transfer rates are 250K bits/second. System response time for program loading is typically two seconds.

While our competitors were listening to Technics Linear Phase speakers, we introduced phase two.

When Technics introduced Linear Phase speakers two years ago we took the audio world by surprise. And why not. After all, Technics Linear Phase speakers were the first speakers to actually show you waveform fidelity. Not simply with tone bursts and sine waves, but by actually comparing the waveforms of live musical instruments to the output waveforms of our Linear Phase speakers.



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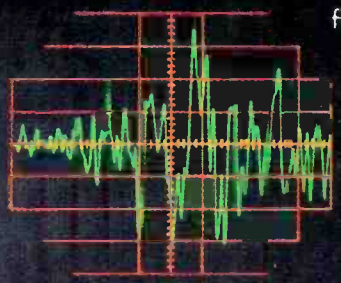

Piano Waveform reproduced by SB-7070

Now with the 3-way SB-6060 and 4-way SB-7070 (shown below), Technics takes you to phase two. Because compared to our first Linear Phase speakers both give you wider frequency extension, flatter frequency response and even more phase linearity, which means even better waveform fidelity.

How did we make such good speakers even better? We started with BASS (Basic Acoustic Simulation System), an IBM 370-based interactive computer system. With it, Technics engineers can do what they only dreamed of doing in the past: Calculate the sound pressure and distortion characteristics of transducers without physically building and measuring countless prototypes.

Next we took these computer-derived drivers and combined them with Technics unique phase-controlling crossover network. And of course we staggered the drivers to align their acoustic centers precisely.

It's easy to see the result of all this technology. Just compare the waveforms. On the left is a waveform of a live piano. On the right, the piano as reproduced by the SB-7070. That's waveform fidelity.

Listen to the 4-way SB-7070. What you'll hear is its smooth transition between low, midrange and high frequencies. Then notice the bass response. It's deep and tight. With much more punch, better definition and even less IM distortion than its predecessor. That's because when the upper bass frequencies are handled by a separate driver, the woofer does a much better job at handling the lower bass frequencies.

You'll also hear vocals that are smooth and natural. That's because the SB-7070's high-midrange driver was designed with "free edge" construction to avoid coloration of the critical upper-midrange frequencies.

And by adding a new, smaller tweeter with improved dispersion characteristics, the SB-7070's high-end frequency response was extended to 32 kHz.

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It's its own computer—it automatically monitors your speech and adjusts it in micro-second increments pumping so much db gain into your speech that you get 400% more power than a standard mike.

TWO MICS WITH ONE SWITCH!

Switch up for a high-pitched transmission for cutting congested city traffic. Switch down for a mellow base in open, uncluttered rural areas.

NOISE CANCELLING

Pull the Processor directly to your mouth and speak directly into the mic. The Processor adjusts to your voice—and blanks out *all* the cab noise while you're speaking. Automatically.

FRESH CHARGE WITH NO BATTERIES!

Patented electronic storage system recharges while you listen to the radio. It provides a fresh electrical charge every time you squeeze the trigger. You never replace batteries.

SOUND SENSITIVE 2 INCHES OR 2 FEET!

A microphone so sensitive it will select your voice and process your speech no matter how close or far you are from the microphone.

Double Guarantee

GUARANTEE I:
The K40 Speech Processor is guaranteed to outperform any microphone it replaces or return it for a complete and full refund within 7 days from the K40 Dealer that installed and tuned it.

GUARANTEE II:
Unconditionally guaranteed for 12 months. Guaranteed against cracking, chipping, or rusting. Guaranteed against mechanical failure. Guaranteed against electrical failure. No exclusions. No gimmicks. For a full 12 months.

$42.50*

American Antenna Elgin, Il 60120

*suggested retail.

CIRCLE NO. 3 ON FREE INFORMATION CARD

SOLD AND SERVICED EXCLUSIVELY BY 3,500 REGISTERED K40 DEALERS THROUGHOUT THE U.S. AND CANADA