Popular Electronics®

WORLD'S LARGEST SELLING ELECTRONICS MAGAZINE FEBRUARY 1982/$1

New Single-IC Video Modulator
FOR CRISPER TV COLOR FROM COMPUTERS & GAMES

Evaluating the Xerox 820 Personal Computer

Elapsed-Time Device Logs TV Use Automatically

Buyer's Guide to Telephone Controllers
● STORED MEMORY ● AUTOMATIC REDIALING ● CALL TIMING

13" Color TV
ument Modules
ILP Audio Power Amplifier

Reddy Chirra improves his vision with an Apple.

Reddy is an optical engineer who's used to working for big companies and using big mainframes.

But when he started his own consulting business, he soon learned how costly mainframe time can be. So he bought himself a 48K Apple II Personal Computer.

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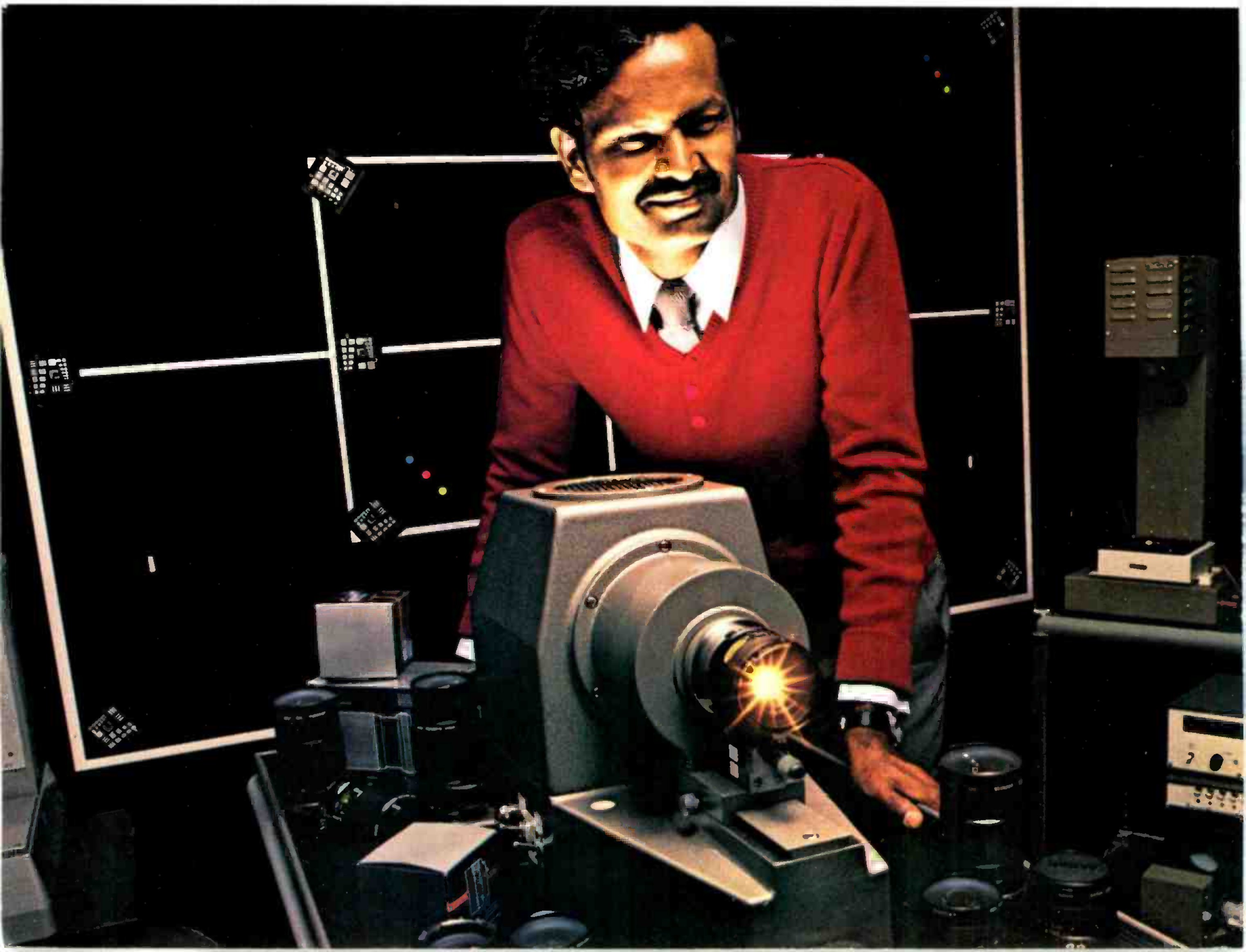

cutting down on shared time and having his own tamper-proof data base.

His Apple can handle formulas with up to 80 variables and test parameters on 250 different optical glasses.

He can even use BASIC, FORTRAN, Pascal and Assembly languages.

And Apple's HI-RES graphics come in handy for design.

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You can get up to 64K RAM in an Apple II. Up to 128K RAM in our new Apple III. And there's a whole family of compatible peripherals, including an IEEE-488 bus for laboratory instrument control.

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The personal computer. apple

FEBRUARY 1982 VOLUME 20, NUMBER 2

Popular Electronics

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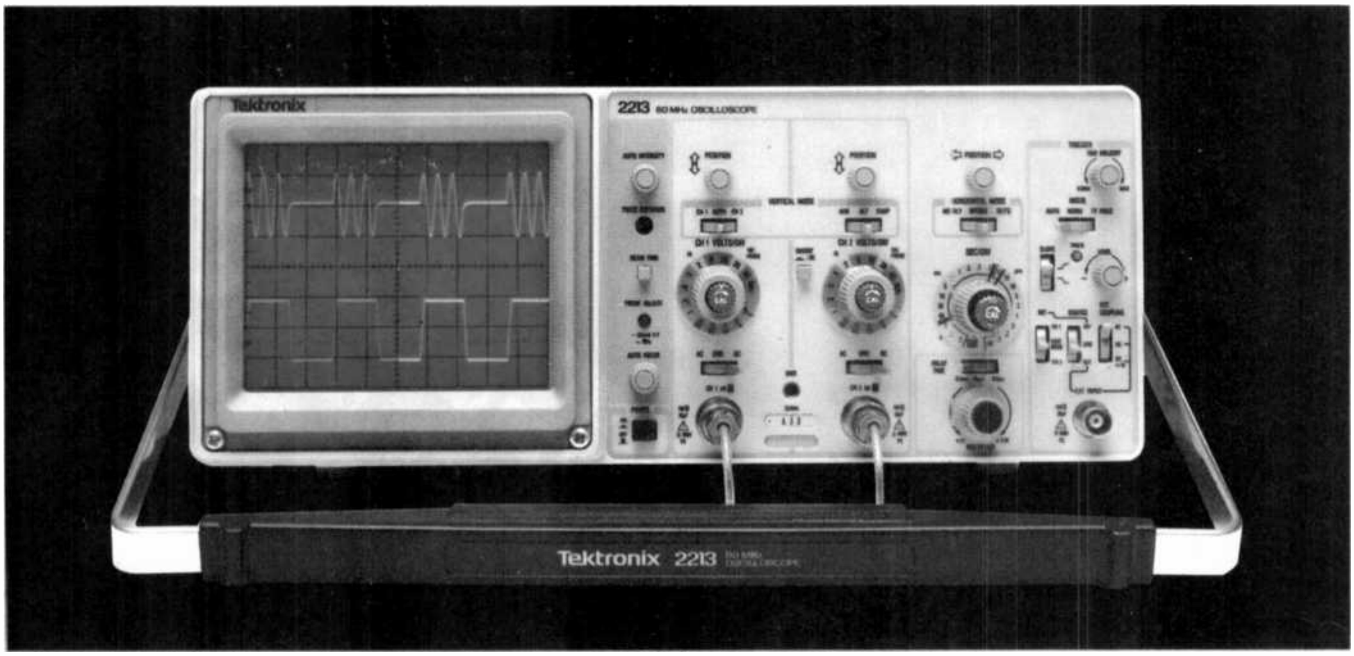

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Now, when you order direct via our new toll-free order desk, you can take delivery on this Tektronix oscilloscope for the lowest price ever offered!

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Bandwidth: Two channels dc—60 MHz from 10 V div to 20 mV div (50 MHz from 2 mV div to 10 mV div)

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Introducing the Sinclair ZX81

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

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

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

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

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

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- Continuous display, including moving graphics
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*Plus shipping and handling. Price includes connectors for TV and cassette, AC adaptor, and FREE manual.

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

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

If you already own a ZX80

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

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

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

Order at no risk**

We'll give you 10 days to try out the ZX81. If you're not completely satisfied, just return it to Sinclair Research and we'll give you a full refund.

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**Does not apply to ZX81 kits.

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

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The $99[95] personal computer.

Introducing the ZX81 kit

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

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

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

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

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

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

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These numbers are for orders only. For information, you must write to Sinclair Research Ltd., 2 Sinclair Plaza, Nashua, NH 03061.

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AD CODE 02PE	PRICE†	QTY.	AMOUNT
ZX81	$149.95		
ZX81 Kit	99.95		
8K BASIC chip (for ZX80)	39.95		
16K Memory Module (for ZX81 or ZX80)	99.95		
Shipping and Handling	4.95		$4.95
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MAIL TO: Sinclair Research Ltd., One Sinclair Plaza, Nashua, NH 03061.

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EDITORIAL

Tilting the Future

As we write, the New Year is approaching (which will give you some idea about the lead time required to produce a monthly magazine), and a flood of trend information is coming in, as usual. Of course, we've all forgotten what last year's prognosticators had foretold, so we start fresh once again.

According to a recent study by Venture Development Corp. (Wellesley, MA), there's a trend toward a "new practicality" among upscale-income homeowners. Asked to comment on a wide range of products and services, leading the respondents' list of desirable new electronic products was intrusion/burglar alarms (27.6%). This was followed by flat-panel TV with 25.1%, home heating-cooling efficiency control/monitoring (24.1%), and home computers (23.5%). Home entertainment products of high interest following this group were projection TV (16.4%), video recorder (15.6%), and video disc player (11.6%).

If the foregoing national study rings true, we are leaning toward becoming a people who plan to spend more time at home, and would hope to do so as safely, inexpensively, and enjoyably as possible through management of electronic contrivances.

New corporate marketing concepts, too, appear with greater frequency at this time of the year, as most companies make grist for annual sales and stockholder meetings. For example, Texas Instruments announced a change in marketing strategy of its 99/4A home computer away from independent computer stores toward the general consumer marketers, now terming its computer an upscale learning aid. In another marketing move, Apple Computer required its authorized dealers to sign a contract modification prohibiting them from selling Apple products by mail so that the maker can properly support the computers. Dealers who did not sign were assumed to have terminated their dealerships effective December 4, 1981.

And what about the new FCC electromagnetic interference regulations? Did you know that it's easier on commercial/business computers than on home computers? Whereas a business computer need only *comply* with the FCC requirements, with existing Class A equipment given until October 1, 1983 to do so, Class B home equipment had to be *certified* by the FCC as of January 1, 1981. (Yes, 1981, not 1982). Compliance means that the manufacturer keeps his test data in the event the FCC wishes to see it, while certification means that the test data be sent to the FCC for approval and the hoped-for issuance of the proper certificate. Also, the FCC might still want to see the equipment before okaying the equipment so that it can be legally sold. Consequently, a "business" computer can get on the market faster than a "home" or "personal" computer. So there's an incentive for some people to call a personal computer a business computer.

Aside from computers, the world of ether has its interesting marketing moves that will influence what people will be viewing and hearing. For example, RCA became an auctioneer at the end of '81. RCA American Communications, Inc., that is. Seven transponders for its not-yet-launched Satcom IV satellite were in the gallery, with 53 bidders competing for a spot that's expected to be operational April 1982. What will this all add to TV programming? We're not sure yet, since speculators can sell their lease to any one they wish (assuming FCC approval that the whole auction is really legal). There'll be more religious programming, it seems, since a religious programmer, Billy Batts, won a transponder-lease bid with $14.1 million.

One never knows when marketing directions will greatly change our lives. A case in point is the development of a microprocessor by Intel Corp. for the now-defunct Busicom desktop calculator. The CPU—Intel's 4004—turned out to be the birth of the microprocessor industry, changing the course of technology. Oh, yes, it all started only ten years ago, with this CPU created by Intel's Marcian "Ted" Hoff, and work guided by Federico Faggin (who later founded Zilog, Inc.). Happy tenth anniversary!

Art Salsberg

Popular Electronics

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

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

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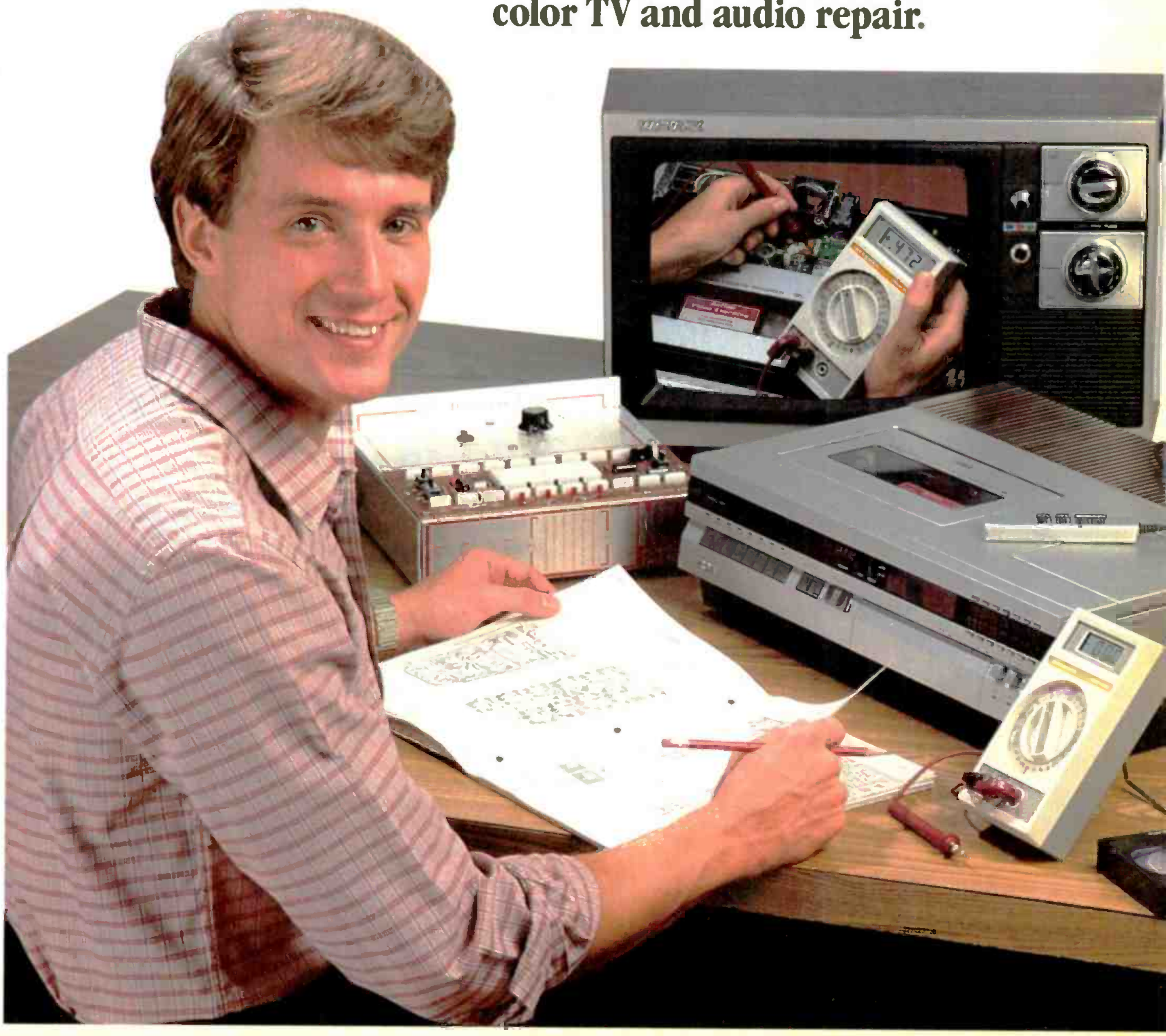
CIRCLE NO. 64 ON FREE INFORMATION CARD

New from NRI! The first at-home training in videocassette recorder repair with exclusive videotaped lessons.

Learn Video/Audio Servicing... includes RCA state-of-the-art VCR, NRI Action Video lessons, plus full training in color TV and audio repair.



Learn as you work with equipment you keep.

Now, you can learn the hottest, most wanted skill in home entertainment electronics…servicing and repairing videocassette recorders and video disc players. Well over 2 million units have already been sold and the demand is just starting! Already, qualified VCR technicians are in short supply…people are waiting up to a month for VCR repair. Good jobs at good pay are going begging. And NRI can get you in on the action with convenient and effective at-home training.

Choice of Specialized Training

NRI offers you three Master Courses in Video/Audio Servicing, each complete, each with equipment and training for the specialty you want.

Each course thoroughly prepares you for color TV plus audio and video equipment. Then, you take the specialized hands-on training on the equipment you select.

You can get specialized audio experience as you build your own AM/FM stereo system complete with speakers. Or gain real bench experience with hands-on TV training as you build a 25" (diagonal) fully-computerized, programmable color TV and professional test instruments. Or train with your own RCA videocassette recorder and NRI's exclusive Action Video servicing lessons on videotape.

State-of-the-Art VCR

This modern VCR features high-technology design with electronic pushbutton tuning, remote control, three recording speeds with up to 6-hour capacity, high-speed visual search, built-in clock/timer, memory rewind and audio dubbing capability. Direct drive motors and azimuth recording give outstanding picture reproduction.

It's yours to keep, as part of your training. You'll not only use it to learn operation and servicing techniques, but to play the absorbing NRI Action Video lessons that come as part of your specialized training. In word and picture, you'll learn theory, construction, and service procedures, see them explained in graphic closeups. And you get this unique training only with NRI!

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No need to quit your job or tie up your evenings at night school. No time away from your family or expensive travel. NRI comes to you. You are a class of one, getting both theory and practical hands-on training backed up by our staff of experienced educators.

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LETTERS

Sources of Learning

The article "Learn More to Earn More" (October 1981) was most revealing and should be of considerable assistance to your readers. One exploding source of learning is the community college. There are some 1200 of them now, offering scores of programs to train people for jobs in technical fields. There are short courses, degree programs, and weekend offerings. Cost is low and admissions are extremely flexible.—*W. A. Harper, American Association of Community and Junior Colleges, Washington, DC.*

Obtaining Assistance

Please tell your readers to try the obvious sources (the "Sams Index" and the manufacturer or his authorized service dealer) before seeking space in your "Operation Assist" column. I know you can't research every request for information that comes in, but a few minutes spent with a "Sams Index" might save space for those of us who really need to find something that is obsolete or rare.—*Michael Wilson.*

Apple II+ Evaluation

In your evaluation of the Apple II+ personal computer (September 1981), why did your configuration include the use of two RAM cards (the Language System Card and the Microsoft RAM card)?—*J. K. Gee, Cerritos, CA.*

We only used one RAM card at a time, finding that replacing the language card with Microsoft's RAM card created no problems.—Ed.

Toxic Gas Alarms

The article "Toxic Gas Alarm" (September 1981) contained some information which might mislead some readers. First, methane is dangerous only if present in sufficient concentrations to be flammable (5%) or asphyxiating. Second, there are several components of smoke (including carbon monoxide) to which the TGS is sensitive; and, in fact, if calibrated as prescribed in the article, the sensor will probably sound off in the proximity of a cigarette smoker. The reader should also be aware that there are other common household vapors and gases (created by such things as nail polish remover, hair sprays, etc.) that may cause "false alarms."—*Norman Burnell, President, Electronic Safety Products Inc., Miami, FL.*

Correcting Computer Prices

We're pleased you covered the new Performance Business Machines Corp. CPC-1000 microcomputer in your November "Computer Bits" column. For the record, the price given ($3450) is for quantities of 1000, not for a quantity of one, as implied. Actual end-user price will be higher, as distributors will do final assembly and system test at their facilities and will, in turn, sell the machine in smaller quantities to computer dealers and others for retail sale.—*Larry Strober, Vice President, Marketing and Sales, Performance Business Machines, San Rafael, CA.*

Worth Every Bit of It

Every now and then one issue of a magazine is worth the subscription price for a whole year. Your December issue qualifies. "The Electronic World" special on Computer Languages is one of the clearest on the subject that I've seen. And the Craig Stark comparison of Audio Cassette Tapes was neat and to the point.—*Glenn Kirkland, Bethesda, MD.*

New DX Listening Schedule

I am very sorry that you have decided to eliminate the Hauser DX column (it was not in December). The English Broadcast columns were especially useful.—*Marvin T. Schmidt, Rogers, AR.*

The Hauser columns have not been dropped. The English Broadcasts listing will be printed twice a year. (It was in the January issue and will appear again in July.) The regular "DX Listening" column will appear in alternate issues. It is felt that this new schedule will enable us to check and verify listings more accurately and keep them up to date.—Ed.

OUT OF TUNE

In "Melodic Telephone Ringer" (November, p 57), resistor *R11* should be 3.3 kilohms in both the Parts List and the schematic. Also on the schematic, the inputs to *IC1*, the optoisolator, should be pins 1 and 2 not 1 and 3.

In "Oscilloscope Time-Base Generator" (November, p 77), the output pins of *IC3* and *IC4* should be labelled 3 for the first stage of each IC and 11 for the second stage.

CLEAR. QUICK. QUIET. ALL THREE, ONLY $1,095.*

You get sharp, easy-to-read printouts. You get them fast, over 150 characters per second, from a printer that's loaded with convenience features.

The Heath/Zenith 25 Printer is a heavy-duty, high-speed, dot matrix printer. It produces up to 300 lines per minute with whisper-quiet smoothness. The entire 95-character ASCII set prints in upper case and lower case with descenders, in a 9 x 9 matrix. All functions and timing are microprocessor-controlled.

The features described below tell only part of the story. You have to see it in action to know how good it really is.

Pick the store nearest you from the list at left. And stop in today for a demonstration of the Heath/Zenith 25 Printer. If you can't get to a store, send $1.00 for the new Zenith Data Systems Catalog of assembled commercial computers and also receive free the latest Heathkit Catalog. Write Heath Co., Dept. 010-864, Benton Harbor, MI 49022.

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Adjustable tractor-feed width with dual sets of tractors for smooth, bi-directional paper movement. Adjustable vertical and horizontal tabs.

Character pitch is hardware or software-selectable at 10, 12, 13.2 and 16.5 characters per inch, for a maximum of 222 characters per line. That gives you great flexibility in setting up forms.

Standard RS-232C interfacing for compatibility with most systems. Also 20mA current loop serial interface.

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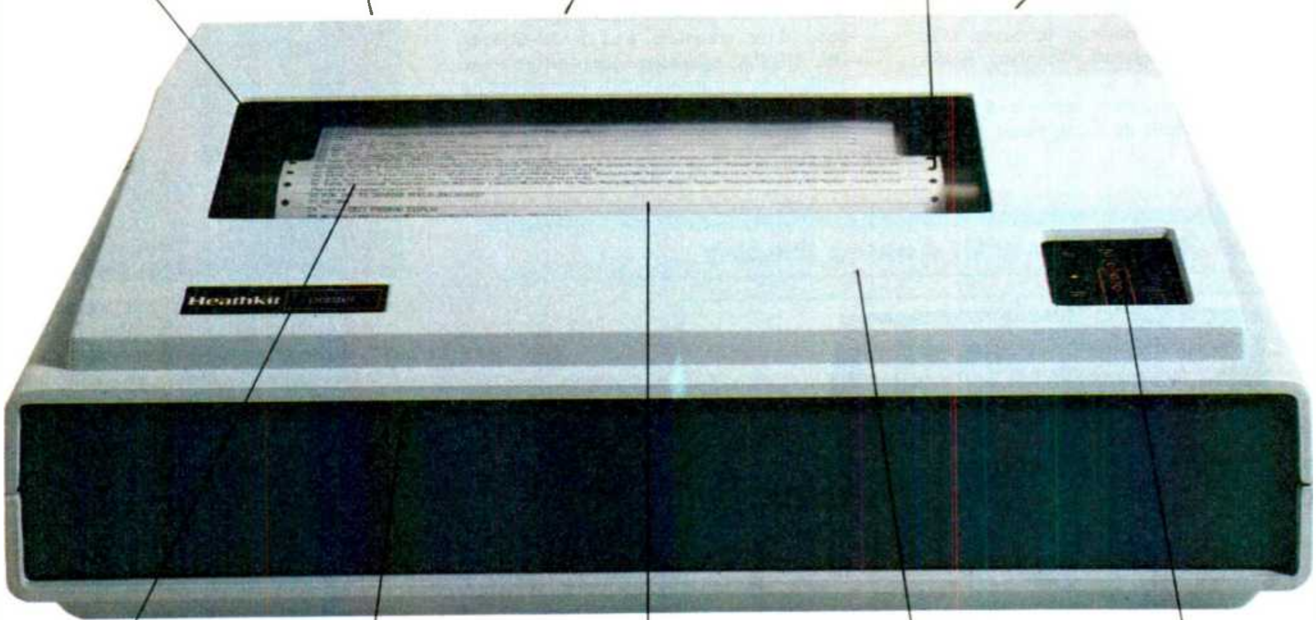

Character set includes 33 block graphic characters for charts and graphs.

Heavy-duty construction for reliable operation and long life under daily use.

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Completely enclosed cabinet muffles sound for quiet operation.

Special detectors tell you when you're out of paper or when paper jams.

*In kit form, F O B. Benton Harbor, MI. Also available completely assembled and tested at $1,595. Prices and specifications are subject to change without notice

CIRCLE NO. 26 ON FREE INFORMATION CARD

CP-204A

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.

3-Head Cassette Deck

Radio Shack is now offering a three-head (ferrite), solenoid-operated cassette deck with double Dolby NR, the Realistic SCT-32. The unit has light-touch controls with color-coded LED status indicators. An automatic record-mute feature works in conjunction with the pause control to permit tape editing. A memory function resets the tape to the desired position, and a timer input permits unattended operation under the control of an external timer (not included). Twin two-color, 14-step fluorescent meters display either the instantaneous signal level, or a real-time view of the highest signal level encountered. A variable bias control and tape selector adjust for normal, chrome, or metal tapes. Specs: frequency response (metal, ±3 dB), 30 Hz to 21 kHz; wow and flutter, 0.6%; THD, 0.8%; S/N, 69 dB. $400.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Ultra-Miniature Cartridges

Audio-Technica's AT55XE is claimed by the manufacturer to be one of the smallest cartridges made, weighing 2.8 grams. It features a 0.3 x 0.7 mm eliptical diamond stylus and a low-mass tubular cantilever. Tracking force is 1.2 to 1.8 grams. The cartridge mounts on any tonearm with standard ½", centered mounting holes. The AT55XE is a moving-magnet cartridge with a frequency response of 15 Hz to 25 kHz; output at 5 cm/s and 1 kHz, 3.5 mV; channel separation (1 kHz/10 kHz), 28 dB/18 dB; and channel balance, 1 dB. $125.

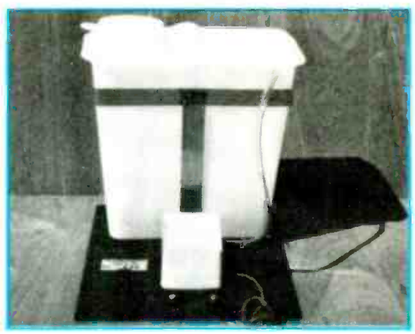
CIRCLE NO. 91 ON FREE INFORMATION CARD

Microcomputer Quay

The Quay Model 500 is a single-board, dual double-density 5¼" flexible disk-drive computer that is CP/M based. A single-sided disk has a formatted capacity in excess of 400K bytes. Disk access is under DMA control, facilitating high-speed data transfers and multi-tasking CPU (Z80A) operation. Read-after-write verification is automatically performed on all transfers to the disk units. System support includes serial console (RS232C or 20 mA) and parallel line printer ports. Memory consists of 32K bytes of dynamic RAM, expandable to 65K. An expansion port supports two additional disk drives. The desktop cabinet is turnkey operated for system security. $2995.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Etching System



Stellmaker Enterprises has designed a power etching kit that includes air pump, air disperser, base with support for a 4½-pint plastic tank, and mounting screws and instructions for assembly. The system will etch pc boards up to 6" x 6". The action of the air pump in agitating the acid is claimed to make for faster and more even etching. $34.50. **Address:** Stellmaker Enterprises, 250 Pequot Tr., Westerly, RI 02891.

Digital Multimeter with Analog Display

Simpson's Model 467 is a hand-held DMM that has a 22-LCD bargraph to supplement its 3½-digit display. The digital section measures dc voltage from 200 mV to 1000 V; dc current from 200 μA to 2000 mA; ac voltage from 200 mV to 750 V; ac current from 200 μA to 2000 mA; and resistance from 200 ohms to 2 megohms. Each of the ranges encompasses five divisions. Basic accuracy is said to be 0.1%. The analog section is designed for observing trends, peaking, and nulling. Peak-hold accuracy is given as approximately 1% of input. Other features include fast pulse-detection for logic analysis, and a visible/audible continuity indication, i.e., the pulse display is held for approximately 100 ms and is accompanied by a tone. Optional accessories include temperature, r-f, and high voltage probes, Amp-Clamp adapter, and carrying case. $245.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Ear-Hanging Headphones

Sony's E33 is a set of two individual MDR-type drivers designed to hang from

each ear without a headband. Each earphone weighs approximately 12 grams, and has a frequency response from 40 to 18,000 Hz. The phones are supplied with a mini-stereo plug, i.e., they are for use with portable stereos such as the Walkman. $35.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Video Cabinet

The Model 2490 cabinet from the Gusdorf Corp. is designed for all 19" sets, plus VCR or videodisc equipment. Doors conceal a storage compartment that can house a collection of software and accessories. The VCR shelf glides out for easy access when loading cassettes or discs. Dimensions are 31½"H × 27"W × 15"D. $87.

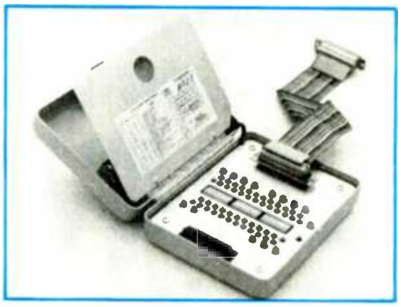
CIRCLE NO. 96 ON FREE INFORMATION CARD

Apple Mass-Storage System

The Apple III ProFile Personal Mass-Storage System is a self-contained hard-disk system featuring an intelligent controller, a 5¼" Winchester-type disk drive, power supply, read/write head, interface card, and driver software. It is said to increase Apple III's on-line storage capacity to 5-million bytes—equivalent to the amount of information stored by 35 floppy diskettes. The increased storage capacity, combined with fast access times, permits, among other things, expanded word processing and graphics capabilities, according to the manufacturer. Seven new software programs have been developed to take advantage of the system—including programs in Pascal, Business BASIC, and VisiCalc III. Profile can be used with any Apple III that has 128K bytes of RAM when used with Apple's new operating system, called the Sophisticated Operating System 1.1. Price is $3500 for the ProFile alone; $6990 for the Apple III/ProFile system.

CIRCLE NO. 97 ON FREE INFORMATION CARD

Interface Analyzer



The Model 700 from Electro Standards Laboratory is an interface analyzer designed as a diagnostic tool for use at the standard EIA RS-232 or CCITT V.24/MIL-188C data interface of modems, multiplexers, terminals, and computers. It monitors all data, timing, and control signals. The Model 700 features tri-state

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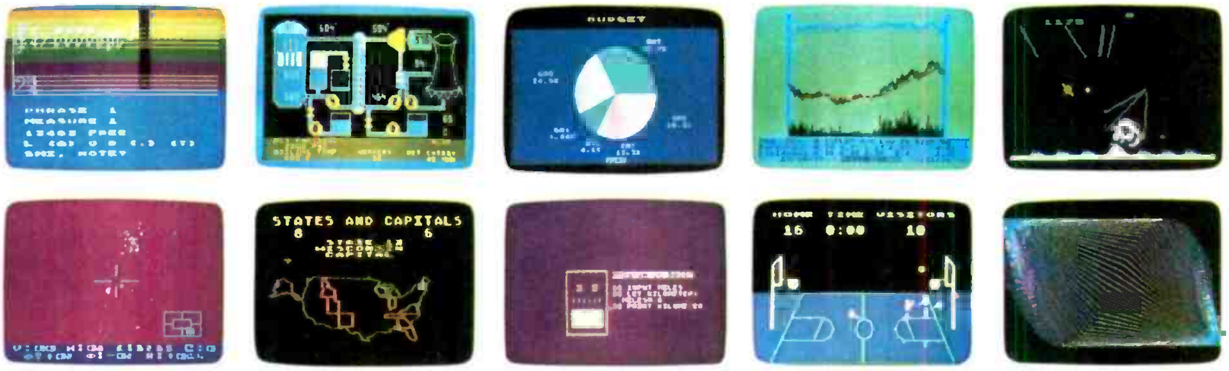

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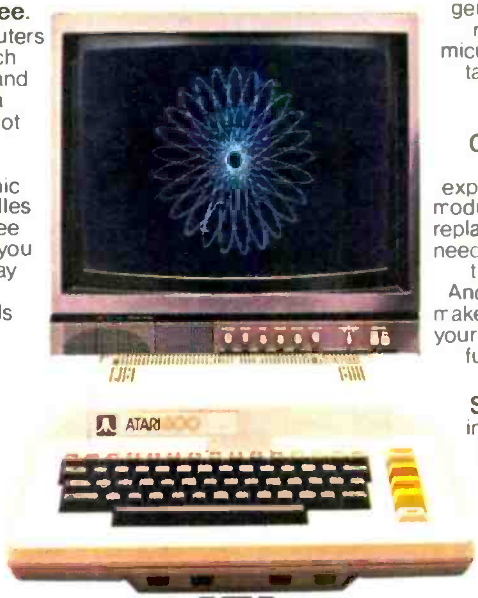

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LEDs to display the polarity, activity, and validity of key interface signals, simultaneously, in red, green, and red-green mixtures. A compartment in the aluminum case holds a folded EIA cable and mini-patchcords. Fifty test points access all 25 pins on each of the DTE or CDE connectors. A reference chart provides a description of EIA/CCITT interface signals. Powered by four 1.5-V AA batteries, the Model 700 is pocket-sized and weighs 15 oz. $275. **Address:** Electro Standards Laboratory Inc., P.O. Box 9144, Providence, RI 02940

Mini Stereo System

The Rotel Micro 70 comprises a tuner, amplifier, and cassette deck. The amp is rated at 20 W/ch into 8 ohms or 24 W/ch into 4 ohms, with 0.08% THD over a frequency range from 20 to 20,000 Hz. The tuner has a MOSFET front end, and phase-locked MPX circuitry. Also, an illuminated dial pointer and tape monitor switch. The tape deck is metal-compatible, uses Dolby NR, and has a 5-LED/ch peak-level indicator. Record/playback head is laminated high-B permalloy; erase head is ferrite core. Wow and flutter, 0.05%. $360.

CIRCLE NO. 98 ON FREE INFORMATION CARD

25″ Color TV kit

The Heathkit GR-2500 color receiver features remote control and on-screen display of channel/time. A PLL Varactor tuning system is said to eliminate noise, contact wear, and the need for channel-to-channel fine tuning. The tuner is capable of receiving 35 CATV service channels and the 82 standard TV channels, as well as off-frequency signals from cable systems, master antenna, or video games. A solid-state automatic fringe-lock circuit is provided for picture stability and fringe-area reception. Digital picture-hold replaces vertical and horizontal customer controls. A comb-filter circuit is said to reproduce up to 330 lines of resolution. The audio section includes two 6″ by 9″ woofers and two 2″ tweeters. The remote control unit (included) has full channel-select, channel-scan, on/off control, and volume adjust; and gives the owner the ability to answer his phone via the optional Space Phone feature. An indicator light shows when the phone is ringing, and an audible ring can be routed through the TV's speaker system. A sensitive microphone is said to permit conversation from anywhere in the room. The kit includes a crosshatch generator for alignment but does not include the cabinet (available separately). $640 (Space Phone: $45).

CIRCLE NO. 99 ON FREE INFORMATION CARD

Radar Detector

The K40 from American Antenna is claimed to detect police radar at a range of 2.96 miles (combined X- and K-bands). The unit may be visor or dash-mounted, attaching with velcro strips. There are separate settings for city (1 mile or less) and highway driving (2 miles or more). A test switch enables a driver to verify that the detector is working properly: a red light flashes and a beeper sounds for ten seconds. The K40 features a waveguide-coupled die-cast antenna said to facilitate radar detection over long distances. Specs: frequency range (X-band) 10.525 GHz ±110 MHz, (K-band) 24.150 GHz ±110 MHz; sensitivity, (X-band) 112 dBm W cm; (K-band) 102 dBm W cm; current, 250 mA from 12 V dc. $380.

CIRCLE NO. 100 ON FREE INFORMATION CARD

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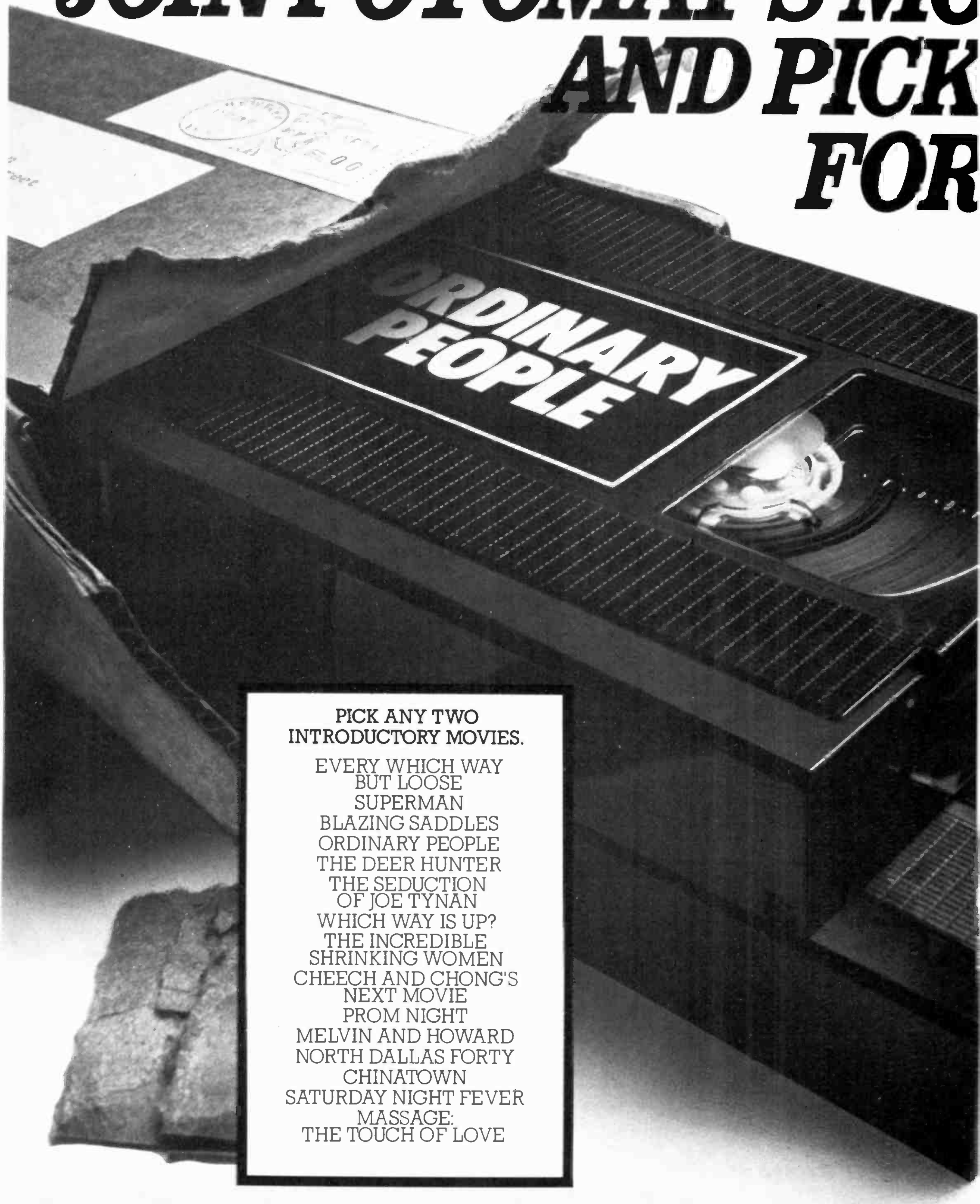

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ENTERTAINMENT ELECTRONICS

By Ivan Berger

Live Recording Revisited

BACK in the days when tape decks still had tubes, I used to do a lot of live recording. My activities were semi-professional, and so was my equipment: a Premier Tapesonic tape deck (half-track stereo at 15 ips on 10½-inch reels), an Ampex mixer, and a variety of low-impedance mikes (mainly Shure, Electro-Voice and Bang & Olufsen, with one Sony condenser).

But now the Premier is ailing, the Ampex is in storage and most of my microphones have been ripped off. So when a cellist friend, Chase Morrison, asked me to tape her recital the other night, I had to scramble together the equipment I had handy: an Akai GX-F95 cassette deck, an Aiwa CM-30 stereo electret microphone, a pair of AKG K340 headphones, and a couple of extension cords. (Bringing the cords was the most important thing I learned in my early recording days.)

One difference became noticeable as soon as I headed out the door: a transistorized cassette deck, even a feature-packed one like the Akai, is only about one-third the weight of a big, tube-operated open-reel deck. I was lucky, though, that I had a suitcase the Akai's size—home tape decks don't have handles like the ones designed specifically for field use.

The mike caused the biggest hassle when I got to the hall. Not that it didn't sound good—it did. But it's designed for handheld or tabletop use with Aiwa's TP-S30 portable stereo cassette recorder, not for this kind of recording situation. The first problem came when I tried to put it on a mike stand—there were no holes threaded for one.When I tried to clamp it to a mike stand, I discovered that this microphone has almost no vibration shielding (there isn't room for much since it's the smallest stereo mike made) and rigid attachment to a stand would make it pick up every footstep and floor vibration. Since it has a small table stand built in, I set that on a beanbag (for a bit of height) and a sponge (for isolation); that worked fine.

Again, because it was designed for use with a hand-held recorder, the mike's cord was only about four feet long. But I had no time to wire up extension cables, nor even any idea how many feet I could extend them without getting into hum problems or high-frequency losses (probably not too bothersome, though, with a mike impedance under 1,000 ohms). So I was forced to keep my tape deck within four feet of the mike—which meant I had to put it on stage.

In the old days, working with very low mike impedances and balanced (separate-ground) lines, I'd have only put the mikes on stage, and run a hundred feet or so of cable to some off-stage nook where I could work inconspicuously. Now I could only be inconspicuous if I wasn't there, which meant setting levels at the start of the concert and only sidling up to start and stop the tape between pieces.

Two modern design trends helped me, there. One was that, instead of my Tapesonic's thin, black VU-meter needle, the Akai had a flourescent bar-graph recording-level display. This made it possible for me to read my levels from more than 30 feet away. Two aspects of this "meter" were especially helpful: The display spots changed color above 0 VU, so I could tell at a glance when my peaks went that high. And a peak-hold feature kept the highest peak illuminated for a second or two; so I didn't have to watch the display like a hawk, but could just look up immediately after hearing each peak.

It also helped that the Akai's dynamic range is wide—not that different, in fact, from my big machine of 15 years ago. (It's rated at 61 dB, on chrome tape without Dolby, plus an additional 10 dB above 5 kHz when Dolby's switched on—as it was, naturally enough.) With less dynamic range, I'd have had to stay right at the controls, "riding gain" as the music got louder or softer. As it was, I had to arrive early enough for Chase to bring her cello out on stage and give me a one-minute recital so I could preset my levels—but that would be good practice even if I could be right at the controls to ride gain.

The other modern design trend I referred to above was the use of color-coded, illuminated transport control buttons. Thanks to them, when I got nervous about whether I had, indeed, remembered to push both buttons and release the pause switch at the start of the piece, I had only to glance up and see one red and one green button glowing to know that I had.

One aspect of the Akai's controls got in my way in the recording. But that's not so much the machine's fault as mine, for going out into the field with a machine designed for living-room use. The GX-F95's designers wanted it to be a living-room showpiece, as un-mechanical-looking and sleek as it could be. So they covered the tape compartment with one smooth, unbroken panel, and recessed most of the controls behind another one, leaving only the electronic displays and control buttons visible.

Even at home, I find covering up the cassette window is a minor nuisance. Without that window, I can't tell when I've wound past the tape's leader (why couldn't cassette leaders be half their present length?) onto the recordable part of the tape, nor can I quickly judge how much unrecorded tape remains.

The recessed controls, though, make a lot of sense at home. Once you've used them to match the deck to your favorite tapes (automatic on the Akai) and so set the line input level to match your system's tape output, you'll rarely need them. So why not cover them up?

In the field, though, some problems arise. The microphone input level controls are the concentric, clutched-together type. This makes it easy to turn the gain up and down for both channels at once, but makes it a little hard to adjust one relative to the other—especially when the controls are recessed, as here. My semiprofessional deck's controls were all big, black, separate knobs—and even then, I quickly replaced them with even bigger, color-coded ones.

The AKG phones worked out fairly well, too. They have a very true sound and wide frequency response. They also have better isolation than any other phones I use. That's doubly important in performance recording, since you can't really monitor recorded sound unless you eliminate outside sounds and you don't want the sounds inside the phone to leak out and distract the audience or performers. My only reservation about the AKGs is low efficiency—few recorders have enough headphone-output power to drive them loudly when the signal levels get low. (On my old semi-pro system, that wouldn't have been a problem: since the Tapesonic had no headphone output at all, I'd added a Shure headphone amplifer, which had plenty of gain.)

How did the tapes sound? A wee bit hissier than the best of my old 15-ips ones, but less hissy than the worst—which makes me wonder how good one of today's 15-ips machines would be. There was no overload distortion whatsoever; that and the hiss suggest I set my levels too cautiously. With the controls out of reach, though, I had little chance to adjust things during the performance. I also had trouble balancing the cello and piano—if only I'd had transformers handy to use with my B&O crossed-ribbon stereo mike, I could have solved that problem, and gotten my tape deck off the stage, to boot. If I'd had time to tape the previous night's rehearsal, I'd have found and corrected both problems.

On the whole, though, I'd call the session a success—today's home gear matches 10-year-old semi-professional equipment in performance, if not always in convenience. ◇

Audio Product of the Month

CHOSEN BY THE EDITORS OF POPULAR ELECTRONICS

ILP Audio Power Amplifier Module

THE ILP MOS200 is an integrated, encapsulated power-amplifier module that, when operated from a ±55-V supply, can deliver 120 W to an 8-ohm load with harmonic and intermodulation distortions typically less than 0.006%. Its rated frequency response (at the −3-dB points) is 15 Hz to 100 kHz. An input of 500 mV is required for rated power output, and the input impedance is 100 kilohms. The amplifier can be used with loads of 4 ohms or higher, although its ratings apply only to 8-ohm operation.

The MOS200 is 3″ square and 4.7″ deep (much of the latter due to integral heat sinks). It weighs about 2 lb. Since the MOSFET output stages are inherently immune to thermal runaway problems and have no internal current limiting or other protective circuits, the amplifier should be used with external fuses in the power-supply leads to protect itself and the speakers from damage in the event of a mishap.

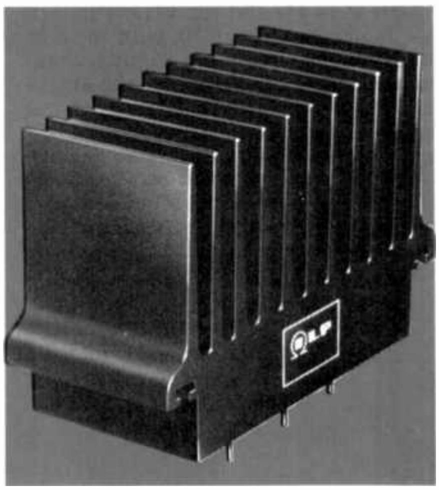
The ILP MOS200 modules are priced at $129.95 each. They are manufactured in Great Britain and distributed in the U. S. by Gladstone Electronics, 901 Fuhrmann Blvd., Buffalo, NY 14203.

General Description. The ILP MOS200 is one of a series of modular power amplifiers designed to permit assembly of a high-quality, high-power amplifier (in a format of one's own choosing) at a moderate cost. The importer carries suitable power-supply components, chassis and panel assemblies, and modular preamplifiers for assembling a complete amplifier.

Another application for these modules is to up-date an existing amplifier if the latter's power supply is adequate. The MOS200 requires a split power supply delivering equal plus-and-minus voltages (nominally ±55 V, and not to exceed ±60 V). Since all the amplifier components and wiring are within the encapsulated body, the external connections (to solder pins extending from the rear of the epoxy body) consist only of the plus and minus dc connections, signal input and output terminals, and a ground terminal. The amplifier must be connected using a "star ground" technique to avoid ground loops. This requires that all "0-V" connections, both of signal and power leads, and including the speaker return leads, be made at a single point at the power supply.

The recommended dc supply fuses are 2.5-A quick-blow types. These are adequate for high listening levels and will withstand full power peaks for the brief periods during which they occur, yet will protect almost any speaker of nominal 8-ohm impedance against an amplifier or power-supply fault that could place a high dc voltage across the output terminals. Although the amplifier has a 100-V input blocking capacitor, the rest of the circuit is direct-coupled.

The MOS200, having a large heat sink integral with the amplifier module, requires only the free circulation of air vertically through the fins for safe operation. In confined spaces, or when high average power levels are to be used, a cooling fan may be required.



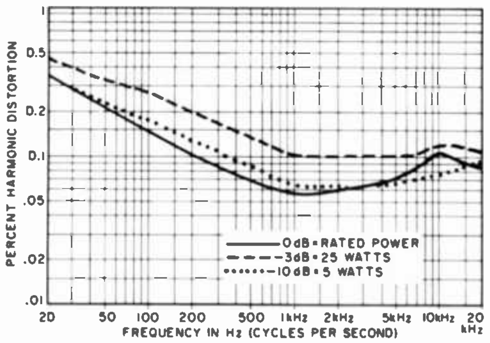
Laboratory Measurements. We installed a pair of ILP MOS200 modules in the cabinet of an older (and obsolete) amplifier whose power supply was able to deliver ±55 V under load. The modules were entirely within the cabinet, but the fan that had been a part of the original amplifier provided internal air circulation. Every effort was made to observe the correct grounding techniques during the conversion.

Since the MOS200 is sold singly, we drove only one channel at a time. (Only the power supply would have been stressed by simultaneous operation of both channels.) Although the modules are not rated in accordance with FTC requirements, we preheated them for one hour at 1/3 rated power and five minutes at full power. The heat-sink fins never became too warm to touch.

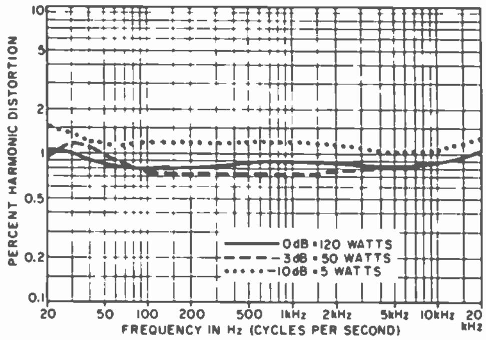
Our initial tests produced disappointing distortion readings, far higher than the published ratings. We found that the amplifier was oscillating (at about 4 MHz) with an output rms amplitude of about 1 V. The total harmonic distortion (THD + N) reading was about 1% at most power levels. Some experimenting with gounding of the signal circuits and bypassing of the power supplies had no effect on the oscillation. However, reducing the supply voltage to less than ±40 V eliminated it entirely.

We therefore made two sets of distortion and power measurements, using supply voltages of ±55 V (HI) and ±35 V (LO). Both modules we tested had essentially similar performance, but we cannot overlook the possibility that the power supply and grounding configuration of our test setup (which could not be conveniently modified) was contributing to, or even causing, the instability.

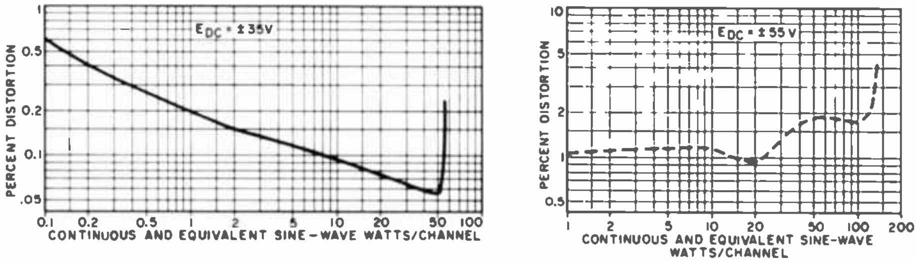
The 1000-Hz clipping power output into 8 ohms was 136 W (HI) and 57 W (LO). The former corresponds to an IHF clipping headroom rating of 0.54 dB. Clipping headroom could not be measured with lower load impedances at the HI voltage, due to blowing the dc power supply fuses; but into 4 ohms, the LO clipping output was about 86 W. The dynamic power output was measured with 20-millisecond bursts of 1000 Hz, in accordance with industry standards. The low duty cycle (two bursts per second) made it practical to measure the clipping output into low load impedances with this signal. The maximum dynamic power into 8 ohms was 129 W (HI), for a dynamic headroom rating of



Harmonic distortion at three power levels with ±35-V power supply. Rated power assumed to be 50 watts.



Harmonic distortion at three power levels with high (±55 V) power supply.



Distortion for LO and HI power supply levels at 1000 Hz.

0.3 dB. With the LO voltage, it was 60 W. Into 4 ohms the HI and LO power outputs were measured at 209 and 85 W respectively; and into 2 ohms, the burst waveform clipped at 290 and 129 W.

At the rated 120 W output into 8 ohms (HI), the distortion was between 0.8 and 1% from 20 to 20,000 Hz and did not vary significantly at lower power levels. With the LO supply voltage, the distortion was about 0.35% at 20 Hz, falling to less than 0.06% in the 700-to-2000-Hz range and increasing to about 0.1% at higher frequencies. As before, the distortion was not materially different at reduced power outputs.

At 1000 Hz (and LO voltage) the distortion fell linearly from 0.6% at 0.1 W to 0.055% at 50 W, just before clipping occurred. With the HI voltage the distortion was about 1% up to 25 W, rising to 2% at 125 W. The amplifier was stable with a reactive load simulating a loudspeaker, which introduced a slight overshoot and ringing on an otherwise nearly perfect square-wave output.

The low-level frequency response was down 0.6 dB at 30 Hz and 50 kHz, and −3 dB at 14 Hz and 135 kHz. The IHF slew factor was about 10, with the output waveform becoming slightly triangular at about 200 kHz when the amplifier was driven with a "full power" input signal. The input sensitivity was 43 mV for a reference output of 1 W, and the A-weighted output noise was −68 dB referred to 1 W with the input open-circuited. With the standard 1000-ohm input termination, the noise reading was −54.5 dB.

The only external connections to the totally encased module are solder pins for positive and negative supply voltages, input and output, and a ground.

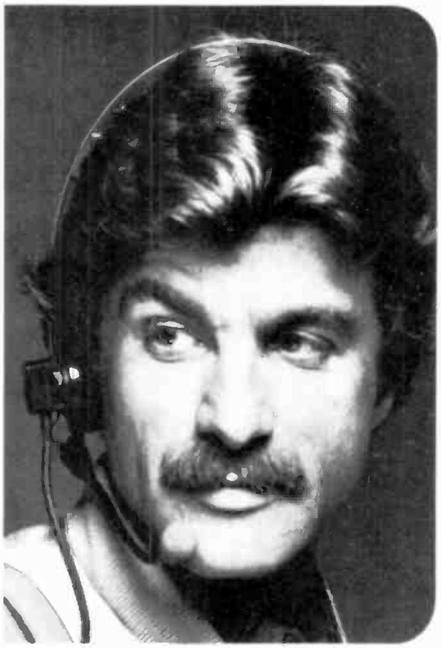
User Comment. We can assume that the high-frequency oscillation we experienced with the MOS200 modules was not necessarily typical or even inherent in the units themselves. Time limitations prevented us from experimenting with different wiring and grounding configurations, which might have corrected the problem.

Ignoring that factor, the MOS200 clearly represents a simple and direct method of obtaining a high-power, high-quality audio power amplifier. It should be especially attractive in cases where an older solid-state amplifier with a suitable power supply is due for replacement since the supply can be used as we did in our test set-up. However, we suggest taking great care to maintain a "star ground" configuration, and it would be advisable to monitor the amplifier output with an oscilloscope to check on its freedom from oscillation. (In our case, the "distortion" was not really audible as such when the oscillation was present, but it seems pointless to invest in amplifiers of this caliber and not obtain the full performance of which they are capable.) The oscillation could be seen at a rather low amplitude even on a narrow-band (500-kHz) scope, but was shown in its full proportions on a wide-band scope, which also enabled its frequency to be determined.

If the available power supply has less than the ±55-V nominal rating of the amplifier, there is no harm in using a lower voltage, except that the amplifier's capability will not be completely utilized. A lower-power version of the amplifier module (the MOS120) is available for ±45-V operation at about 2/3 the price of the MOS200. Judging from the dynamic power measurements we made on the MOS200, the ILP modules have exceptional current output capability, and should be able to drive the lowest load impedances one will ever encounter in a home music system to a satisfactory level.

For the user who is "starting from scratch," a complete ILP amplifier can be assembled from the power-supply component kit, a pair of MOS200 modules, and a rack-mount chassis/cabinet, for about $410.—*Julian D. Hirsch*





TalkTalk™

The world's first hands-free consumer mobile communication system lets you keep in touch while on the go.

Do you remember the CB fad? Six years ago Americans jammed the air waves as everybody discovered the fun of personal communications.

But like all big fads, CB soon died. People hung up their mikes and gave CB back to the truckers who started the fad in the first place.

The personal communications fad is now back with an entirely new concept. TalkTalk is a headphone with a boom mike that lets you talk hands-free with someone else blocks away. Your voice activates a transmitter. When you stop talking, the transmitter automatically shuts off and you receive. The transmitter, receiver and power supply are located in a small case thinner than a pack of cigarettes which you wear clipped to your belt or placed in your pocket.

SAFER THAN HEADPHONES

You hear the receiver through an adjustable headphone which you comfortably wear over your right or left ear. This leaves one ear free to hear the sounds around you—much safer for outside activities than the popular stereo headphones.

You can now communicate, hands-free and in safety, while you cycle, hike, jog, work or play for up to one-half mile and all on a single 9-volt battery that lasts up to 8 hours of typical use. But there's much more.

An antenna circles the headphone so there's no ugly wire protruding from the top of your head and you keep your conversations private because the range is reduced to a block. But if you want to reach out to the unit's half mile range, simply unhook the antenna wire from its clamp and presto, you have an ugly wire protruding from the top of your head.

UNIT CAPTURES SIGNAL

TalkTalk was built in Japan with the same technology used in professional communication systems. For example, the system uses frequency modulation (FM) as opposed to the amplitude modulated signal used in CB. CB frequencies tend to get crowded—with powerful stations often talking on top of each other. Not true with FM. The system's FM receiver uses a "capture effect," to reject all other signals letting you hear only the one signal closest to you. You capture a clear, crisp, easy-to-hear transmission. And since the Federal Communicatons Commission has set aside the TalkTalk's frequency of 49 megahertz for 100 milliwatt maximum power, no other higher power station will bury you. But wait, there's even more.

A voice-activated sensitivity switch lets you adjust your boom mike for all outside noise conditions—low for a motorcycle and medium or high for a bicycle. And a two-staged volume control lets you securely adjust the volume level with no fear of accidentally moving it.

You can keep the system's 6-ounce case in your vest pocket or clip it to your belt with its removable pager-styled clip. In fact, even the clip is impressive. It's a heavy-duty device that can be slipped off when you want to keep the unit in your pocket.

The boom portion of the mike is malleable. That means you can bend it in any direction and it will stay there. Wear the mike close to your mouth, far away, or even bend it out of the way completely.

Use your imagination. We used ours and came up with over 100 activities that make the TalkTalk useful or fun. Sure, the obvious ones like cycling, hiking, sports, work and play came easy. But how about using a pair in a shopping center to keep in touch? Or how about keeping in contact with your home while you walk the dog? TalkTalk can be used for outdoor treasure hunts, or by tour directors and ski instructors. The list goes on.

PLENTY OF UTILITY

And don't forget the surprise of contacting someone else on a TalkTalk like you used to on CB. If enough people use them, you'll be able to ride your bicycle down a path and meet other TalkTalkers as well. There are five separate channels to choose from. If you order a pair, we'll send you a matched frequency set. To order more on that frequency simply specify the frequency on your reorder form.

TalkTalk is manufactured by Standard Communications—an established manufacturer of professional two-way communications systems—assurance that your modest Investment is well protected. The TalkTalk was designed for rugged use but if service is ever required, Standard's convenient service-by-mail center is as close as your mailbox.

To order your TalkTalk, send a check for **$119.95** per unit ($239.90 per pair) plus $4.00 postage and insured delivery to the address below. Illinois residents please add 6% sales tax. Credit card buyers may call our toll-free number below. We'll send your TalkTalk complete with one 9-volt battery, headphone, transmitter/receiver, boom mike and complete instructions along with a one-year limited warranty.

GIVE IT A WORKOUT

When you receive your unit, really give it a workout. See how far you can transmit with the antenna up or down. Use it in a shopping center, on a bike ride or in your factory. See how comfortable it feels and how safe you feel with one ear free to hear outside sounds. Then decide if you want to keep it. If for any reason you are not satisfied, return your unit in its original condition within 30 days and we'll refund your money in full including $4.00 postage and handling.

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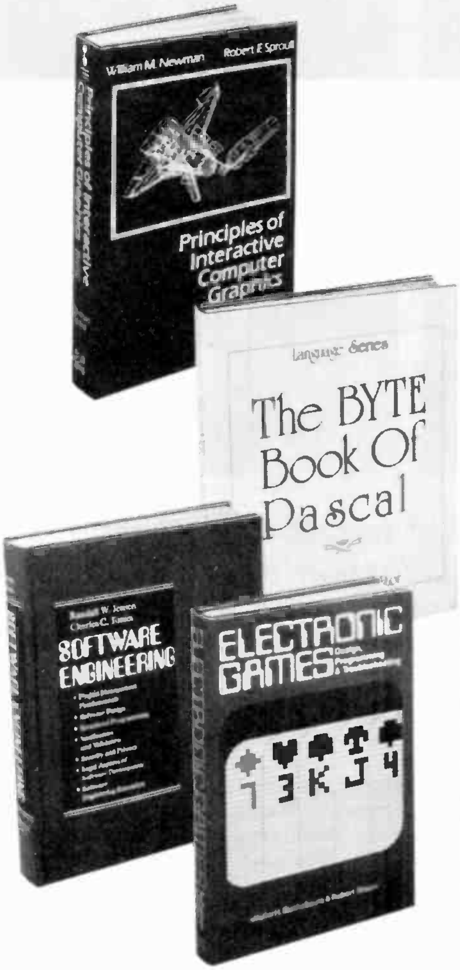

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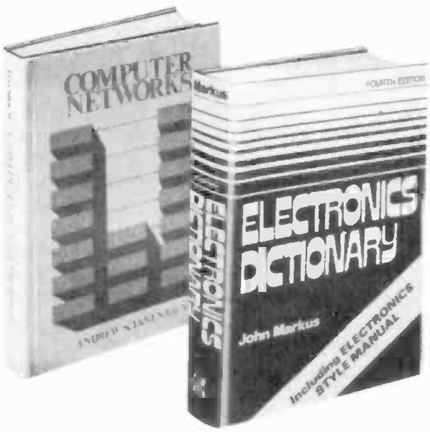

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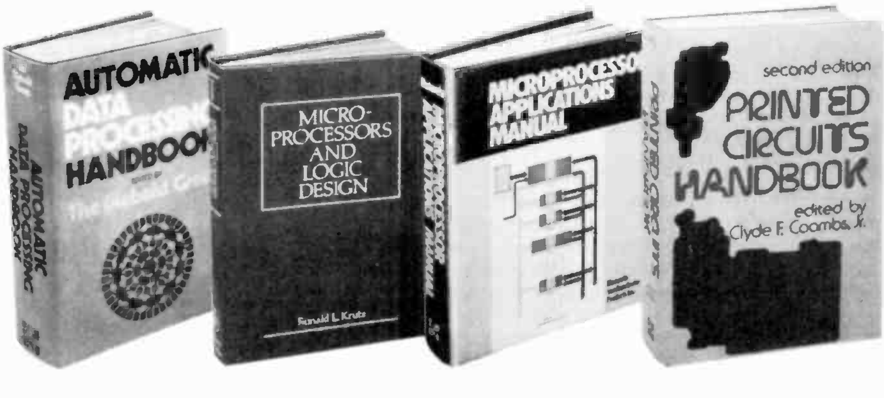

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Popular Electronics Tests

Panasonic Model CT-3031 13" Color TV Receiver

THE model CT-3031 from Panasonic is a 13" color receiver that features a brand new 90° cathode ray tube and an independent picture/sound tuner that can be removed from the cabinet and used as a remote control. The set has quartz-synthesized and phase-locked-loop tuning. A ColorPilot double-pole switch automatically controls tint, color, brightness, and contrast; it is also tunable when engaged. Dimensions are 14"H × 20"W × 15½"D; weight is about 30 lb. Suggested retail price is $500.

The 90° cathode ray tube has been developed by Matsushita to overcome resolution limitations in the main lens of its regular 29-mm in-line color tubes—both in center and edge performance. Accordingly, the new overlapping field lens (OLF) gun partially merges its aperture lenses without widening normal three-beam separation (Fig. 1), offering a larger effective lens diameter, with a nearly circular cross-section. Magnification and spherical aberration are comparable to those of a standard 7.6-mm circular lens, but the OLF has an effective enlargement of 1.7 times greater. A new triode prefocus lens has also been added, improving resolution by about 20%. The spot size, too, is 20% larger than that produced by a standard high bipotential (Hi Bi) shadow-mask lens system.

ColorPilot. "ColorPilot" is actually a static dc switch, connected to inputs of video chroma processor *IC601* (Fig. 2). In the ON position, ColorPilot switch *S601* parallels brightness control *R313* with fixed resistor *R311*, splitting current and increasing bias on internal IC brightness, but lowering I-detector bias by grounding one end of *R641*. At the same time, ground is removed from the junction of *R607* and *D301*, releasing *R607* as a shunt across *R605*, back-biasing *D301*. This raises the *R307* Panabrite potential along with that of the *R604* color control, and produces a general increase in luma/chroma intensity. Dc tint, however, is unaffected. Balloons *A27* and *A29* through *A32* below are simply non-terminated chassis "looker" points, probably used in manufacturing checkout.

Integrated circuit *IC601* is a highly complex array of large-scale integrated transistors, resistors, and diodes that does virtually all the luma/chroma amplifying, controlling, and color detection with the help of one *Q302* common-emitter inverter and a *Q303* low-impedance current amplifier. Video buffer *Q301* is the chroma/luminance driver for the entire chip and supplies not only color and brightness information, but also composite sync to the sync separator in *IC401* (not shown)—which includes both the vertical and horizontal signal oscillators.

The ac-coupled and inverted output of *Q302* passes across the usual multi-microsecond delay line to an emitter peaking circuit, and then to the contrast control. The ensuing contrast block is then acted upon by sync and black-level pedestal clamping, with aid from gate pulse shaping, to ensure a stable sync/signal level during overall reception. These same gating pulses at a 15,734-Hz rate offer timing for the color-killer detector and usually open the automatic phase detector (apc) for burst, as well as governing conduction time of the voltage-controlled oscillator (vco). There is however, a reference generator, controlled by the vco for the two I and Q chroma detectors, which make use of the 3.579545-MHz color sync, or 'burst'.

Chroma also reaches the color control via the burst gate and second bandpass amplifier and, in turn, is dc-controlled by both Panabrite and color potentiometers, as well as by the color killer, which

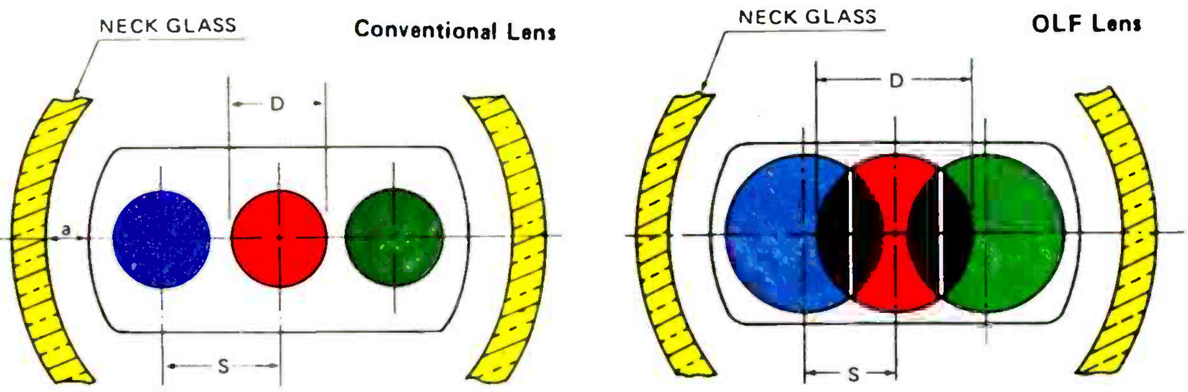

Fig. 1. In the overlapping field lens gun, the aperture lenses are partially merged without widening the normal three-beam separation. This gives a larger effective lens diameter and nearly circular cross-section.

shuts down extraneous signals when there is no incoming burst. During normal transmissions, color output from the color control advances through an RC network above *IC601* to the R-Y and B-Y demodulators.

The variable resistors (Sub. Bright, Sub. Color, Sub. Tint) above and below *IC601* are simply current-limiting rheostats from dc supplies, and are used to limit potentials of the customer controls bearing those names.

Tuners. Here we have another pleasant surprise. There are r-f amplifiers, oscillators, and mixers in both of the 82-channel u/v tuners, along with separate agc controls for each tuner. A 14-pin integrated circuit (designated "PLL" for phase-locked loop) has inputs from each tuner and a common output into the S-board tuner-controller of the main circuit board. At this point, signals are received for volume up/down, channel scan, and power on/off. Bandswitching and tuner-switching turn-on voltages are generated here, in addition to a separate isolated and fused power supply, an active low-pass filter, an optical isolating coupler for a dc amplifier, an IC comparator, and a microprocessor.

The microprocessor, of course, receives and issues commands for the channel, audio, and on/off functions. The comparator compares tuner inputs with frequency-synthesized and crystal-controlled voltages from the microprocessor and issues an aft voltage to the tuners whenever they drift above or below the broadcast video carrier. A red LED indicates channel numbers.

Also crystal-controlled, the front-panel transmitter has an 18-pin integrated circuit that responds to an infrared signal via dual diodes. The channel and audio selections are then superimposed as digital commands on the infrared carrier for virtually noise-immune transmissions to the receiver.

(continued on page 34)

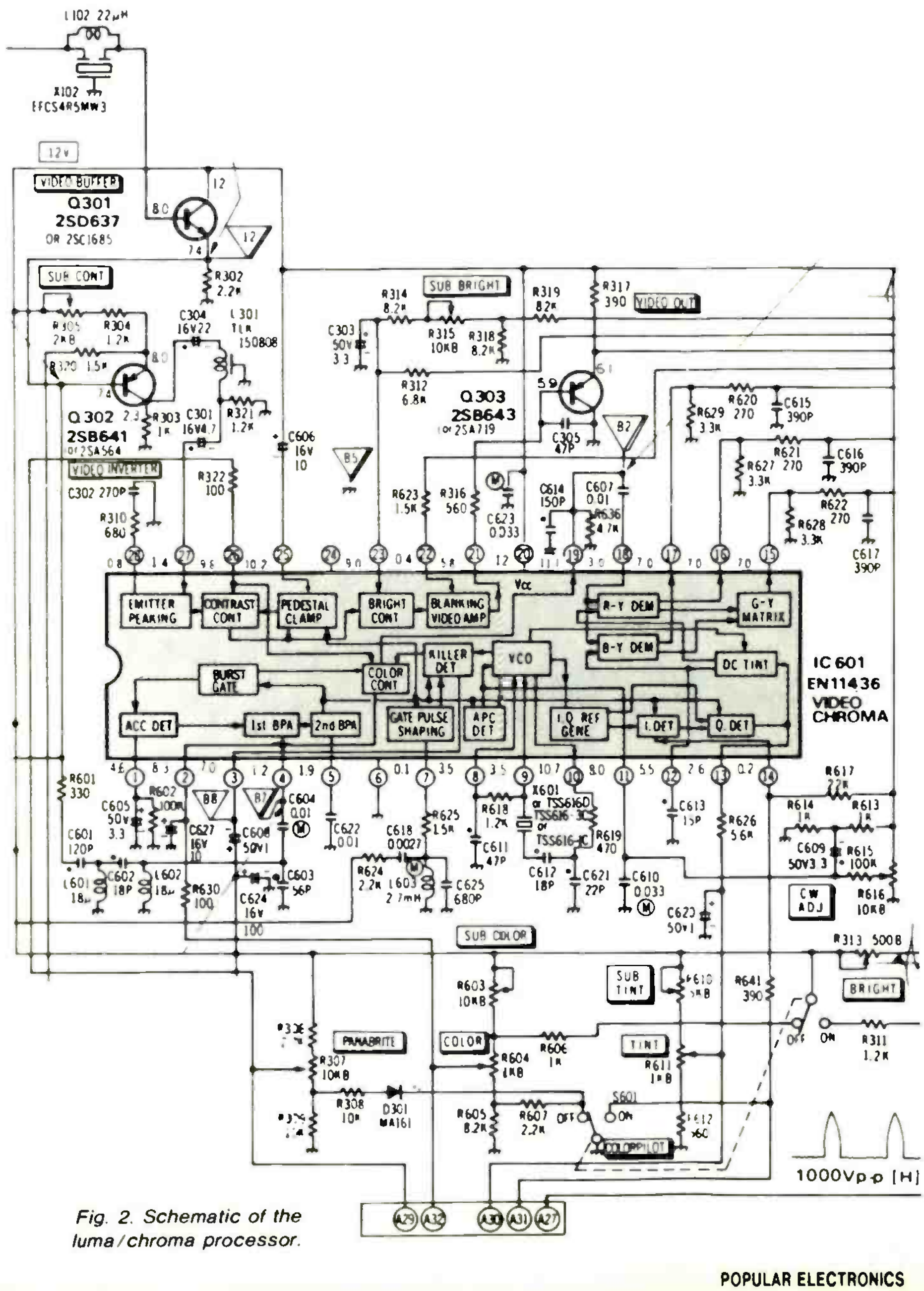

Fig. 2. Schematic of the luma/chroma processor.

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(Continued from page 32)

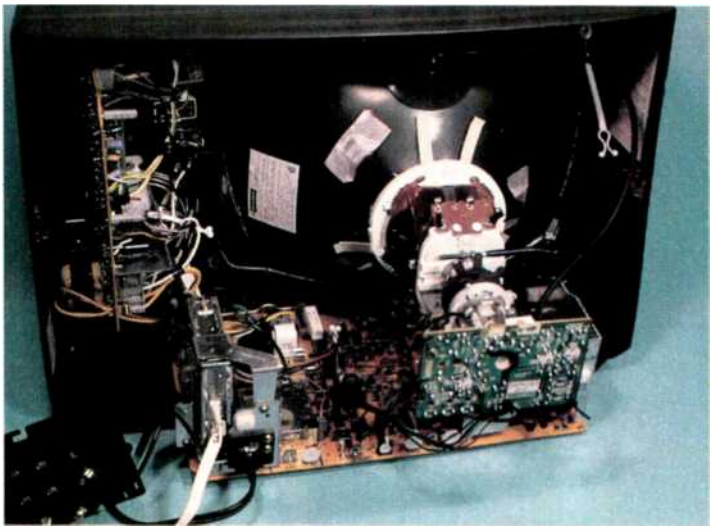
Comments. This 11-IC, 31-transistor, 13″ set is, by far, the best Panasonic has produced since its very expensive 19″ modular receiver of some years ago. Although its luminance bandpass is but 3 MHz (comparable to all other 13-inchers), and audio is somewhat restricted, the overall results are surprisingly good. With its new picture tube and well-designed electronics, this set will hold its own easily.

You'll like the dual-speed up/down remote control, the 75-ohm vhf input, −7-dBmV tuner sensitivity, the 98-to-100% high- and low-voltage regulation, the excellent 43-dB video signal-to-noise ratio, the 91.5% dc restoration, and the 99.8% solid convergence. With adequate surface-wave filter input, we could not record any interference on the usual 2, 4, or 5 vhf channels; and agc swing between saturation and cutoff measured a very respectable 64 dB.

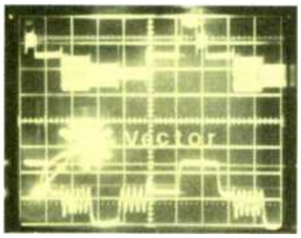
We recorded a 9,000°K CRT temperature, but this may be due to a hand adjustment at the factory. A typical production-line reading would probably be nearer 8,000°K, similar to a comparable Zenith receiver. We also were unable to turn the raster completely off with front-panel contrast brightness controls, possibly again due to the hurry-up setting of the limiting controls.

—*Stan Prentiss*

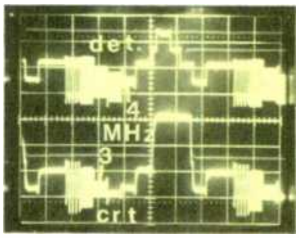
CIRCLE NO. 103 ON FREE INFORMATION CARD



The chassis of the Model CT-3031 holds eleven ICs and 31 transistors.



Swept chroma patterns at detector and CRT with vector.

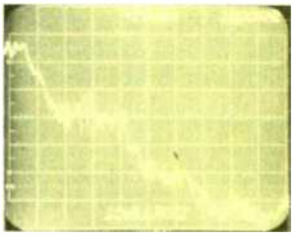


Multiburst at video detector and red cathode of CRT.

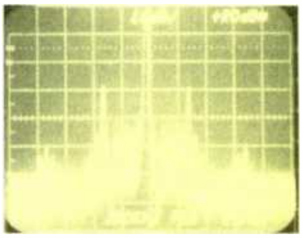
PANASONIC MODEL CT-3031 13″ COLOR TV RECEIVER LABORATORY DATA

Parameter	Measurement
Tuner/receiver sensitivity (before snow):	vhf (Ch. 3): −7 dBmV uhf (Ch. 20): −3 dBmV
Voltage regulation w/signal input (line varied from 105 to 130 V):	Low voltage: 12-V supply—100% 130-V supply—98.5% High voltage: 24-kV supply—97.8%
Luminance bandpass at video detector:	4 MHz
Luminance bandpass at CRT:	3 MHz
S/N at CRT:	43 dB
Convergence:	99.8%
Horizontal overscan:	20%
Audio response (−3 dB at speaker input):	80 Hz to 4 kHz
Pincushion/barreling/flagwaving:	None
Agc swing from saturation to cutoff:	64 dB
CRT color temperature	9000°K
Dc restoration:	91.5%
CB interference (Chs. 2,4,5 at 60 ft):	None
Power requirements (signal applied):	78 W (avg.)

Note: Instruments used in these measurements are: Tektronix 7L12 and 7L5 spectrum analyzers; Telequipment D66 and D67A oscilloscopes; Sadelco FS-3D VU f/s meter; Winegard DX-300 amplifier; Data Precision 245, 258, 1750 multimeters; B & K-Precision 1250 and 3020 NTSC & sweep/function generators; Sencore VA48 (modified), CG169 video & color bar generators and PR57 variable power supply; Tektronix C-5C, Minolta XD-11 cameras; and Gossen Luna-Pro light meter.



The 20-kHz swept audio shows dropping off at 8 kHz (2 kHz/div.)



Signal/noise at CRT measures a solid 43 dB.

Popular Electronics Tests

Xerox 820 Desktop Computer

Workstation system operates in an Ethernet environment

ALTHOUGH many view the Xerox 820 as just another personal computer, it is touted by its manufacturer as a low-cost, desktop workstation for use in an Ethernet-type environment. Moreover, the 820 is designed as an adjunct to the company's Star information system and, as such, it lacks some of the frills associated with more expensive personal computers.

Specifically, the 820 offers users an upgraded electronic typewriter that trades paper for a 12" black-and-white CRT display and employs disk storage. What the 820 doesn't offer are such things as game control ports, color, and sound generation. Instead, Xerox has opted to provide what it considers three key elements in system design:

- Ease of use. The system is fully menu-driven so the untrained operator can adapt to it more readily.
- Industry compatibility. It uses a Z-80, 2.5-MHz microprocessor, and Digital Research's CP/M operating system.
- The inclusion of multiple communication features: RS-232 and parallel port interconnects.

The basic system comes packaged with a stand-alone CRT that supports a 24-line by 80-character display (1,920 characters), a detached 96-character ASCII keyboard with function keys, and a 10-key numeric keypad. It also has dual 5.25", single-density disk drives with a total capacity of 90K bytes (approximately 40 pages of typed material per drive), 64K RAM memory and 4K of system ROM, and a demonstration diskette designed to assist familiarization with the system. The price for this basic system is $2,995. Adding the Model 630, 40-cps, daisy-wheel Diablo printer brings the price up to $5,895 minus software. Optional 8", single-side, single-density dual drives can store 250K characters (approximately 130 pages of typed material per drive).

To add the software, an extra $200 is needed for CP/M, and $500 for the WordStar word-processing package. Other software packages, such as Sorcim's SuperCalc and a Xerox 871 interactive communications emulator for 3270-mode access, will be available later with prices ranging from about $195 to $300.

Although Xerox plans to have MBASIC, CBASIC-2, COBOL-80, MSORT, and possibly dBase II available soon, they weren't ready at the time of this review.

Inside the System. We were unable to fully test the 820 under various heat and electrical conditions, but we did take a look inside the main housing. This is the case that encloses the CRT screen, a single-board computer, and interfaces. The CRT is manufactured by Clinton, which is the major CRT supplier for terminal manufacturers. It's a 10-MHz type, so sufficient bandwidth is provided for a crisp 1,920-character display.

It is interesting that Xerox employed standard off-the-shelf drivers with a flyback transformer for the CRT. No attempt was made to minimize the display board, thus cooling requirements are not strict.

(Continued on page 40)

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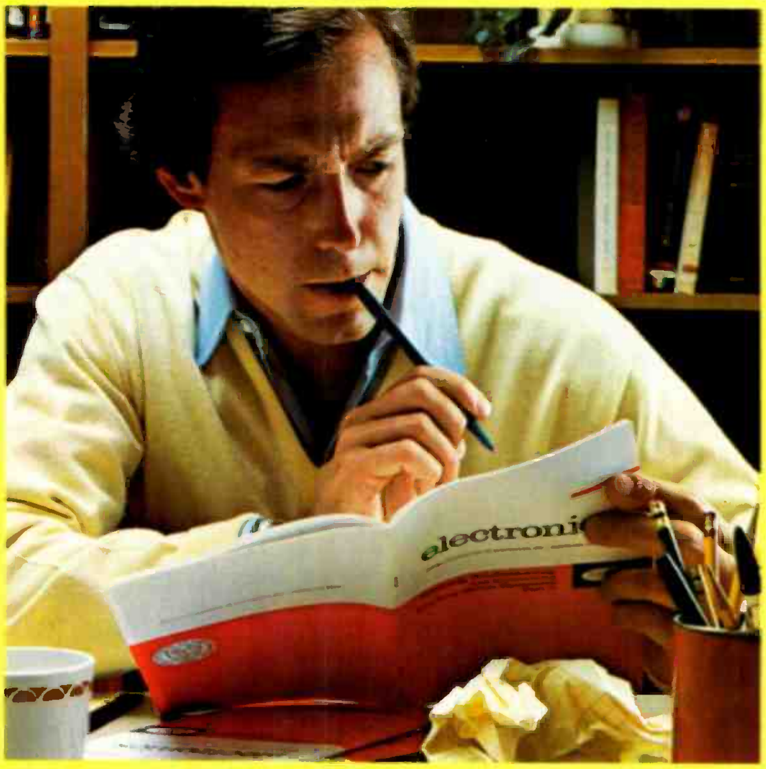

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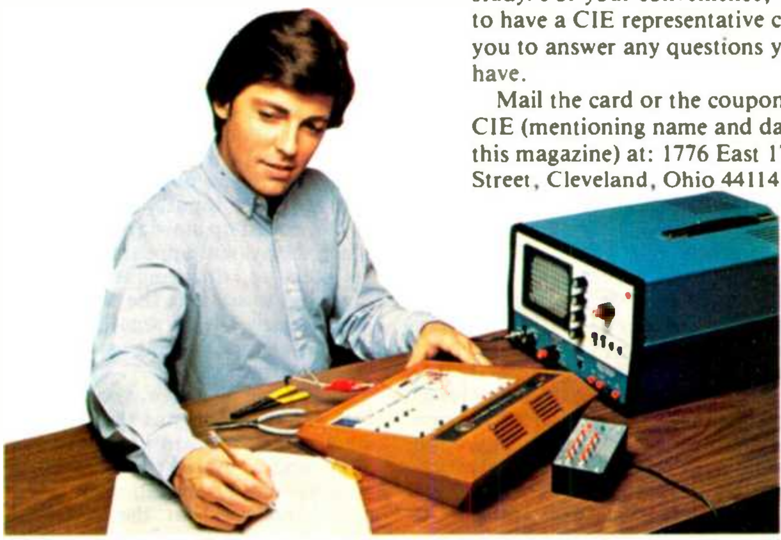

Pattern shown on oscilloscope screen is simulated.

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(Continued from page 35)

The power supply, located at the rear of the enclosure, is vertically mounted and surrounded by a cardboard shield. Although we couldn't be certain, it appeared to be a switching supply, rather than of linear design. This would improve overall heat characteristics of the system.

The main circuit board for the computer is mounted along the bottom and supports the CPU, memory, and interface electronics. Surprisingly, no shielding was evident for any of the active elements, and it appeared that the memory chips are directly below the deflection yoke of the CRT.

Located on the back panel are four DB-25-type connectors for the disk drives, the keyboard, the printer, and one marked "communication." These are RS-232 connectors and follow the standard layout. The keyboard and printer connections are 8-bit parallel. Interconnects are handled using RG-8U cable with full shielding and AMP connectors with screw lockdowns. In addition to the connectors, there is a system RESET switch.

The display/processor tips the scale at 30 lb and measures 13″x14″x15″. The keyboard assembly weighs 10 lb and measures 4″x10″x20″. Add 10 lb more for the 5.25″ disk assembly and 48 lb more if you choose the 8″ system.

Interestingly, although the 820 is designed to work with both 5.25″ and 8″ drives attached, on the system tested, only one or the other could be used, as no daisy-chaining of the drives was permissible.

Evaluation. The system we reviewed consisted of the display processor, keyboard, dual 5.25″ drives, and Model 630 printer.

When power was turned on, we were greeted with a message asking us to enter an *A* for boot, or *T* for typewriter. Tapping the *T* turns the 820 into a very expensive typewriter, with everything entered via the keyboard output to the printer (if attached). If the *A* is entered without having put in a diskette, the system generates an error message and stops. To continue requires system RESET or POWER OFF/ON.

For our evaluation, we used CP/M and the word-processing package, a special optimized version of MicroPro's WordStar. On booting, we were taken directly into the first menu screen of about 12 lines that guide us through the various attributes of the word-processing system.

When we booted the system and were put into the word processor, we noticed that the display features white characters on a black background with *no* highlighting. All the menus in WordStar were displayed with number selections, with no highlighting distinguishing the various attributes. We found this disconcerting since we feel highlighting is a prime feature for user-oriented systems, and is so used in other WordStar applications.

Another difficulty we encountered was that the Xerox version of WordStar is designed differently in that the menus and methods of choosing a feature are redefined from conventional WordStar. This can be a problem if you are familiar with WordStar since it means virtually relearning the commands. However, due to the depth of the menus and the amount of explanation (which, incidentally, is greatly amplified compared to conventional WordStar), with the use of the HELP key, relearning takes only a few minutes.

To test how well everything functioned in terms of speed, we entered a document consisting of four pages of text on a 50-column line (about 3,000 characters). We found that the arrowed keys used for moving the cursor did not function within the word processor. However, as usual, control keys are used to move around the document. The majority of the keys responded slowly, making it possible to type ahead of the system. Typing at 60 wpm, we found that characters were being dropped.

Saving and restoring the document to and from disk took almost a full minute. This time isn't unusual considering that 5.25″ disks are fairly slow in transfer. To find out how quickly the system responded, we entered the SPOOL mode to print the document and do further editing at the same time. Typically, the disk system will SPOOL out the document to the printer until interrupted by disk access requirements or by the processor when performing movement of text in memory. Usually no interrupt takes place until end-of-line is reached and a carriage return or line feed is inserted, with little or no degradation on the output or screen input.

We ended up slowing down our typing since the system appeared not to be able to keep up, dropping characters. This signaled to us that the keyboard buffer was apparently too small, thus allowing overflow and causing an interrupt in timing problem.

What we did like about the system was the use of menus throughout. Since no cooling fans are used, the system is quiet and we found that it ran fairly cool without extra ventilation.

We believe that the system we reviewed was not really representative of the product. This is primarily because the display/processor appeared to be a kludge to provide store owners with something to demonstrate. There were no indications that the system met FCC, RFI, or EMI requirements, and based on the internal layout, we're reasonably sure it wouldn't pass because no shielding was in evidence.

Furthermore, the keyboard was sloppy, with the keys slow in responding. We felt that, possibly, the debounce technique used took too much time, thus producing the lateness on entered characters. The latter can cause the operator to get ahead of the computer.

What we would have liked to see Xerox do is integrate the slimline floppies in the display cabinet, produce a slimline keyboard much like the IBM Personal Computer, and provide full-screen attributes of varying display intensities. In addition, we object to the necessity of buying the operating system separately. We felt that this should be an integral part of the system, and included in the basic price.

Documentation. The documentation that is currently available consists of an operator's manual for CP/M and instructions on how to connect everything. We thought we would see some great insight here, but Xerox is simply providing a reprint of Digital Research's CP/M manuals. We liked the section on the printer and disk drives, though, and felt that they showed what is probably coming.

In addition to the system manual, there is a user's manual for the word processor. This is a small, illustrated book that takes you through all the features of the word processor. The manual is well-written. Due to poor reproduction, key formats for showing you what to do are almost unreadable, but all the material is there.

Reportedly, manuals for BASIC, COBOL, SuperCalc, and other software products are in the making, and should reflect more attention to detail.

Conclusion. The Xerox 820 is a machine geared to the office environment and, therefore, should not be equated with systems designed for graphics or software development. Although the machine, as reviewed, doesn't rate highly with us—unless it is for use in an Ethernet or communications environment with access to a host computer—we expect the next generation to offer more features and to take care of the various problems we encountered.

According to sources close to Xerox, you can probably expect enhancements such as the 8086 16-bit microprocessor, a 5.25″ Winchester, and a raft of application software products in the near future. In addition, you will probably see the 8087 math processor and the 80130 communication processor incorporated by midyear.

As you read this, the 820 is being delivered with the Z-80, MBASIC, Sorcim's SuperCalc, and other systems software. Currently, many of the Computerland stores are gearing up to offer a host of CP/M-compatible software on the machine, and most-important—full services. The latter is a big plus in the machine's favor.

So we by no means put the 820 down for the count, but expect that it will not be a major entity in the desktop world until the new enhancements are implemented.—*Carl Warren*

Acknowledgements. *Special thanks to Ray Watt and Joe Resca of the Lawndale, CA Computerland, who made time and space available for this test.*

COMPUTER BITS

By Carl Warren

Exciting Episode Travels Well

SHOULD you be looking for a small computing system that fits on your desktop or can be packed up on a moment's notice, you might well consider the Episode from Epic Computer Corp. (9181 Cheseapeake Dr., San Diego, CA 92123. Tel 714-569-0440).

This exciting little machine uses a single-board Z-80A 4-MHz microprocessor with 64K bytes of RAM to create a standalone single-user workstation with built-in floppies, communication ports, and diagnostic (ROM-based) software. All you add is your favorite terminal and printer.

The compact unit takes up approximately the same desk space as a legal-sized tablet, weighs 15 lb and has a fold-up carrying handle. In addition, the Episode will work with literally any CRT and printer by virtue of a fully configured version of Digital Research's CP/M operating system.

The Episode is made easy to use by the manufacturer's unique software system called Supervyz. This software package allows the user to command the computer via a series of menus, thus precluding any knowledge of CP/M.

The console I/O is handled via an RS-232C port capable of 9600 baud (available on request). In addition, an auxiliary serial port can be configured so the Episode serves either as a computer or an intelligent terminal.

An integrated real-time clock provides the date and time and it is supported by battery backup. Further enhancing the system is a 16-bit interruptable timer, 8-position configuration sense switch, console discretionary reset, type-ahead feature (supported by interrupt-driven console input), low-voltage switching power supply, and a card cage for system expansion.

In addition, the Episode has a monitor program in ROM. When the system is first turned on, the monitor copies itself into programmable memory, initializes the I/O, signs on, performs a memory test, and then boots from the disk drive.

The monitor offers bootstrap functions to load the operating system, and the ability to display memory between two given addresses in hexadecimal with the ASCII equivalent to the right of each line. You can also go to a specific address and execute a program, query an input or output port, set the console output to a serial port, read a hex file, display, alter, or test memory.

The system's eight sense switches are used for sensing parity on the modem/printer port, the CP/M list-device assignment, and setting the density of the integrated floppy-disk drives.

The Episode comes with case, dual floppy drives, single-board computer, 2K ROM memory (expandable to 8K), 64K RAM memory, Supervyz, CP/M, dual programmable serial ports, and parallel printer port. It is priced at ($3445 with 1.5M bytes of disk storage, $2995 for 800K-byte disk drives, and $2550 for 400K-byte drives. Future options include an integrated modem, 5.25-in. Winchester disk, and multiple serial I/O. All options are slated for availability later this quarter. As of this writing, no pricing has been announced.

As indicated, Epic also supplies the Supervyz software package that makes Digital Research's CP/M and MP/M user friendly. The package accomplishes this with a series of menus that act as a preprocessor to CP/M or MP/M commands by employing the functions found in the O/S but handling them as command lines transparent to the user.

Users are greeted with a series of self-prompting, easily understood menus designed to interface directly to the installed applications. In addition, the powerful control system allows the user commands intrinsic to the O/S by specifying them as menu items.

For turnkey systems, Supervyz can come up when the system is first turned on, thus eliminating the necessity of the user's needing to know the proper boot procedures.

Besides supporting applications, Supervyz provides a time-of-day facility that interacts to the system's real-time clock. This utility is available by a simple menu entry. A computer-aided instruction technique, using tiny PILOT leads the user through the various formats required to establish a menu and all the desired help messages.

Because Supervyz uses a command line function for setting up commands to the O/S, multiple commands can be imbedded in one menu call. This feature makes it possible to perform batch-type tasks with a single entry.

Moreover, the package permits interfacing to a variety of terminals and printers and can be used to put the system in a typewriter mode. Since the Console Command Processor of CP/M or MP/M has been modified, all disks are logged in on entering the Supervyz program. This feature avoids irritating BDOS errors. Furthermore, once booted, there is no need to have a disk resident in the system, since Supervyz makes itself memory resident with full CP/M functionality.

The basic package delivered on an 8-in. IBM-compatible single-density diskette includes Supervys the interactive manager, Super CCP and extended console command processor, Menus Def and interactive menu builder, Help and interactive program tutor, and Install S, a configuration program.

Supervyz requires a Z-80- or 8080-compatible microprocessor, at least 40K bytes of RAM, CP/M 2.x or MP/M 1.1 or 2.0 operating systems, and at least 20K bytes of available disk space. There is no limit on the number of menus that can be nested, each menu can contain up to 10 functions with a description length of 32 characters and a command line length up to 64 characters with 4 parameter requests. Pricing is $99 for diskette and user manual.

Looking for a New Terminal? Then you'll want to contact Emulog/Phaser (48881 Kato Rd., Freemont, CA 94538. Tel. 415-490-1290) about the Alpha Star. This operator-oriented terminal includes sculptured matte finish key caps, palm comfort areas on the detached keyboard, green-phosphor tilting screen with a diffusing nonreflective bezel, and contrast and brightness controls on the front panel.

The 18-lb unit displays upper- and lower-case characters with true descenders in an 80-character by 24-line format. Cursor controls permit insert and deletion of lines or characters. In addition, the terminal employs ANSI defined control and escape sequences for reduced intensity, reverse video, and foreground/background generation for specialized data entry.

The terminal's logic board is located behind the main CRT housing for ease of access and to isolate it from high voltage. The logic board includes a programmable printer port, and an RS-232C or current-loop port.

The thin, detachable, Selectric-style keyboard sports a numeric keypad and three programmable function keys. Interfacing and display characteristics of the Alpha Star are easily changed via EPROM—either user created or customized by the manufacturer. This chameleon-like characteristic of the terminal makes it possible to emulate a number of others. Pricing for the terminal is $465.

For those interested in Lear Siegler products, there is the Model ADM 21 video-display terminal. This new terminal uses Z-80 microprocessor power to provide plenty of intelligence for applications that need a low-cost smart terminal for time sharing or data-entry chores. The microprocessor control furnishes a full editing capability, including screen-oriented features such as clear screen, erase line (or page), and character insert/delete. Furthermore, you can highlight data fields and text with reduced intensity, reverse video, blink, blank, and underline.

In addition, the terminal features a nonglare 12-in. CRT that displays 7 by 9 dot-matrix characters with lower-case descenders in 24 lines. The characters occupy a 9 by 11 dot character cell. Thus when you underline a character, the underline appears in the ninth line and doesn't interfere with descenders or reverse video on the next line.

The terminal accepts data and text via an 87-key board with auto-repeat. For special functions, you can use the numeric keypad, cursor-control, edit and function-mode keys along with line/page send keys. A self-test mode is included for quick diagnostics.

A combined I/O port handles both communications and a printer as two separate RS-232 ports. Communications over the port can take place at 10 distinct baud rates from 75 to 19.2K baud.

Available options include a 32-character answerback capability, current-loop communications, line graphics, and international character sets. Price: $695. (Lear Siegler Inc., Data Products Div., 714 N. Brookhurst St., Anaheim, CA 92803. Tel. 714-774-1010. Or your local computer store.)

Those who tinker with micro systems have probably run into situations where supposedly compatible RS-232 serial devices do not work correctly with a specific system. The difficulty is usually some incompatibility with the I/O lines.

Well, Mountain Computer Inc., (300 El Pueblo, Scotts Valley, CA 95066. Tel. 408-438-6650) has solved this problem with its RS-232C DB25 Pin Reconfiguration Adapter.

This classy little unit allows almost any serial I/O device to mate with a computer by re-routing the RS-232 signals, thus eliminating the task of fabricating special cables.

The PRA consists of a circuit board with slide matrix switches and a male DB25 connector on one end and a female connector on the other. In most applications, this configuration will match available cables. To achieve the proper interface, merely slide the switches to the proper position.

Although the $59.95 price tag may seem steep, the PRA is as important as your test-bench VOM.

Apple Temperature. To adapt your Apple for temperature data acquisition, Strawberry Tree Computers has introduced its Dual Thermometer system.

The Dual Thermometer interface for the Apple II microcomputer system is a combination of an interface card, two 10-foot cables with temperature probes, and sophisticated software to handle your temperature/data requirements. The temperature acquisition system can store temperature data and time on a disk at intervals you specify for later recall, or it can print the data immediately. In addition, an alarm can be set to intervals from once every 10 minutes to once a year.

The accompanying software permits tailoring the Apple display to your specific needs. Such information as time, temperature, maximum and minimum temperatures, and alarm information for the two probes can be displayed.

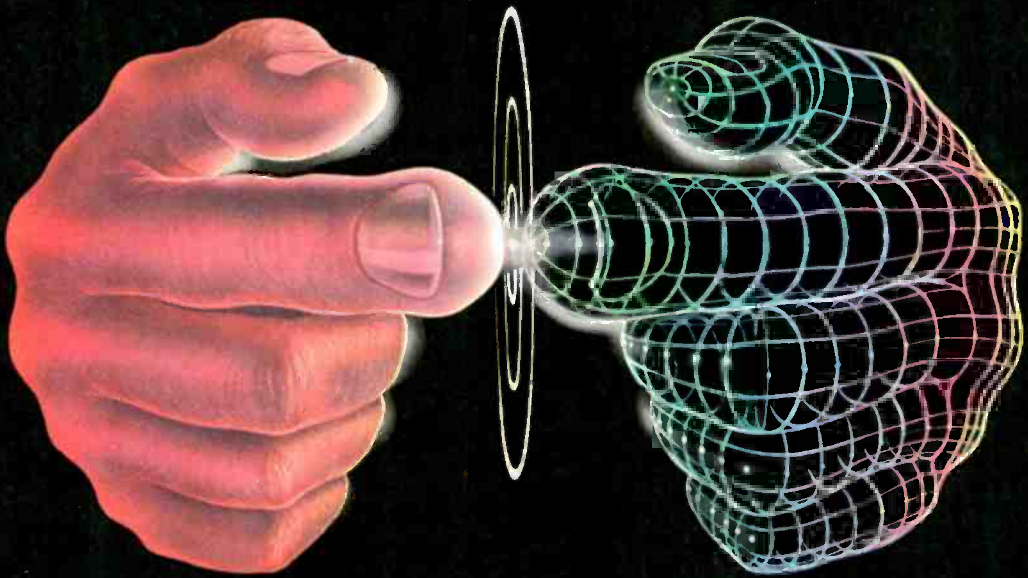
Moreover, the software will support up to seven Dual Thermometer cards with a total of 14 probes (two per interface), with the screen displaying data for each probe. The data can be displayed in Fahrenheit, Celcius, or Kelvin, along with a 12- or 24-hour clock.

The Dual Thermometer card plugs into any Apple II peripheral slot with 48K RAM, Applesoft BASIC, and at least one disk drive. The program is written in Applesoft BASIC for specialized applications.

Although the Dual Thermometer can be used for home temperature control applications, it offers accuracy, repeatability, range, and response time that make it ideal for industrial applications.

In addition, the Dual Thermometer's probe cables can be extended up to 500 feet using AWG #18 cable without sacrificing accuracy or response time.

Dual Thermometer is available for $260 including interface card, two 10-foot cables with probes, and disk software. (Strawberry Tree Computers, 949 Cascade Dr., Sunnyvale, CA 94087. Tel. 408-736-3083.) ◇



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The NEC PC-8000 Series is the best-selling microcomputer system in Japan, a country where productivity is something of a national pastime.

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These include general accounting, accounts receivable, inventory control, data base management, word processing, with dozens more on the way.

Hardware features 24K of ROM, 32K of low-overhead RAM, a Z80A equivalent chip, high resolution graphics in 8 colors, a 248 symbol character set including complete ASCII upper and lower case, graphics symbols, design elements, mixed text and graphics on the same screen, an 80-column character display, a set of user-definable keys, full 82-key keyboard with numeric pad, and a Centronics® compatible parallel interface, which is also perfectly compatible with the NEC PC-8023 high density dot matrix printer.

People are calling it the "end of the compromise" in microcomputers.

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NEW TELEPHONE DEVICES TAKE PAIN OUT OF DIALING

Options include memory bank, automatic redial, melody on hold, security dialing, amplified sound, and call time display

BY WALTER SALM

ONCE upon a time there was just one way to dial a phone—the tiresome rotary-dial twirling that made each outgoing call a chore—especially when you did a lot of calling or were trying to get a number that was often busy. With the advent of 10-digit direct distance dialing (now 11 digits in most parts of the country), the chore became even more burdensome.

Ma Bell came to the rescue a number of years ago with an automatic dialing phone that accepted a plastic punched card that did the chore for you. It was no faster, but it at least gave your fingers a rest. Naturally, this equipment called for an extra monthly rental charge, and you had to keep track of a stack of plastic cards with a lot of holes neatly punched in them.

Then along came Touch-Tone® and much of the benefit of those punched cards evaporated. However, whether you dialed a number or used pushbuttons, the need for an automatic dialer was there. This was especially true for users of the computer networks and computer-activated private toll numbers, since they require a minimum of 23 digits. The chances of a mistake on the last 2 or 3 digits are tremendous.

Privately owned dialers first emerged about a dozen years ago, but people weren't ready for them. They were expensive and difficult to program. Touch-Tone was really just as fast. Like many of today's dialers, these first of the new breed provided outpulse dialing—the electronic equivalent of a rotary dial. Manufacturers point out that this is necessary in many of today's dialers and pushbutton phones, presumably so that the instrument can be used on any telephone system anywhere. But that oh-so-slow 10 pulses per second can be a real

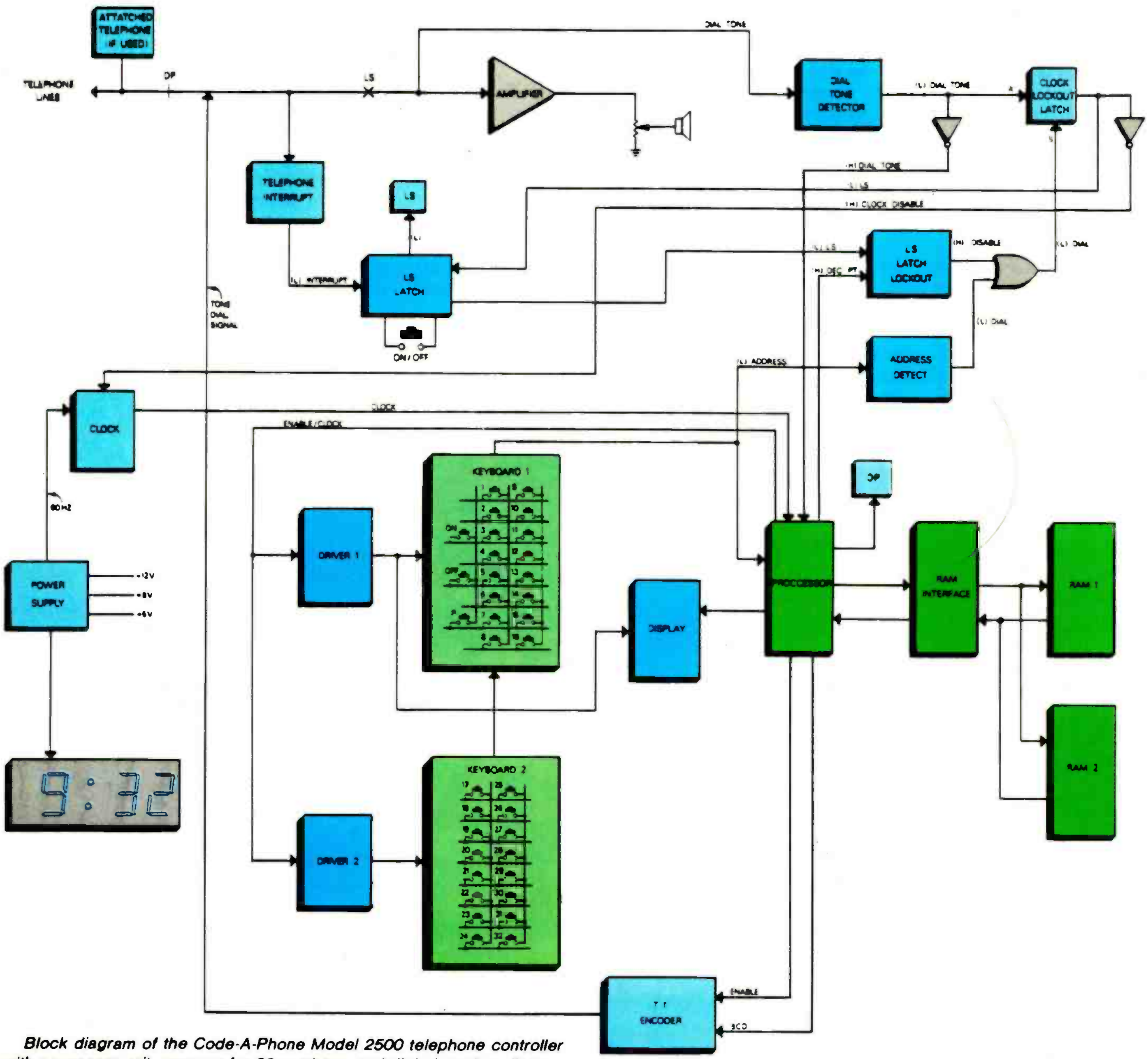
time-wasting annoyance, especially if the called line is busy.

But having Touch-Tone doesn't just improve operating speed and convenience; it's essential if you're going to use such private toll telephone services as MCI, SPRINT, ITT City-Call and Western Union. These systems universally use computers to process the calls, and the computers will only respond to tone-type signaling. Many customers of such systems carry a pocket-size digital beeper to hold over the telephone mouthpiece when they're traveling. It's a nuisance, but necessary. However, it shouldn't have to be so from your home or office.

High-Speed Technology. Today's automatic dialers are mind-blowing for their speed, accuracy and other features. They're so far removed from the dialers of a decade ago that they truly represent a totally new generation of communications equipment in concept and design. With most, a touch of a single button will access the dial tone, pause, dial the phone number quickly and accurately, and let you hear all this and the ringing tone on a built-in speaker, a must for "on-hook" dialing. You don't have to take the phone off the hook until your party actually answers.

Automatic redial is another must. While this feature is built into most of today's electronic phones, having it on the dialer means that any phone connected to the instrument has automatic redial. It's maddening to try to break through a persistent busy signal. Automatic redial makes it a lot easier, and most of today's dialers have this feature. In addition, many of them let you program an automatic redial sequence. Consequently, the instrument will keep trying that busy phone at 40-to-60-second intervals without any further attention from the user.

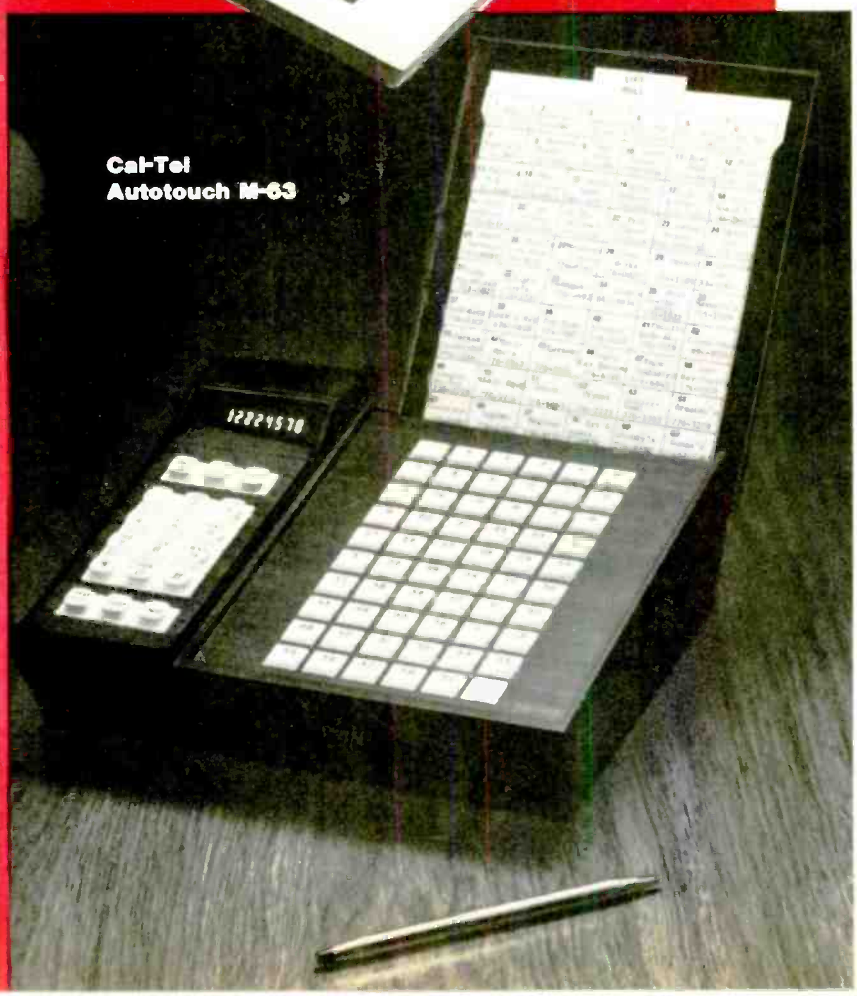
Compatible Dialing. If a dialer is "compatible" with both tone and rotary dial lines, it usually means that the



Block diagram of the Code-A-Phone Model 2500 telephone controller with processor unit, memory for 32 numbers, and dialed-number display.

Buscom Soft-Touch 80

Webcor ZIP 757

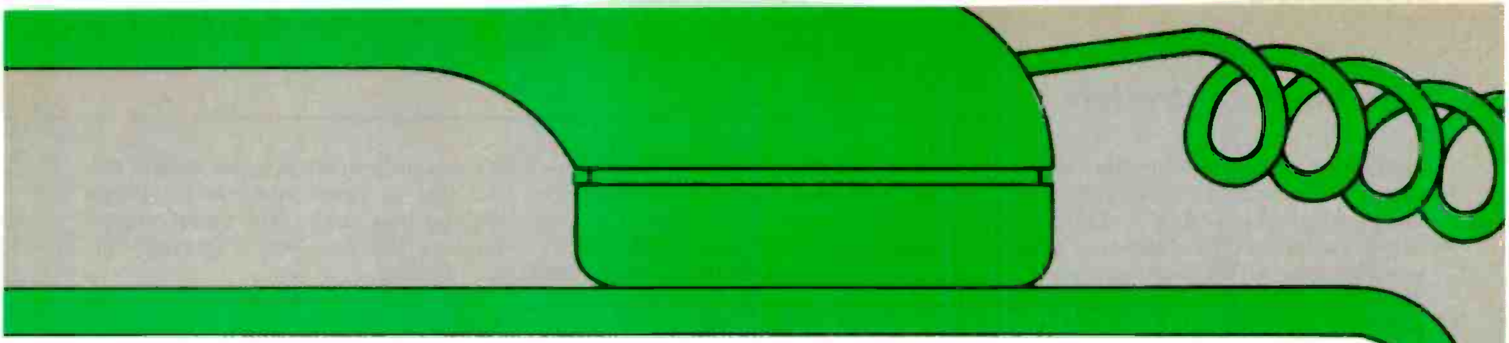


Cal-Tel Autotouch M-63

Cobra MT-240

Automatic Dialers

Manufacturer	Model	Suggested Retail	Phone Incl.	Memory Loc.	Digits	Output	Program Pauses	Digital Clock	Call Timer	On-Hook Dialing	Backup Batt.	MCI-SPRINT Compatible	Special Features
Buscom	Soft-Touch 20	$119.95	No	20	8	Tone	Yes	No	No	No	Yes	Yes	Screws on phone mouthpiece, hold control
	40	$139.95	No	40	8	Tone	Yes	No	No	No	Yes	Yes	''
	80	$159.95	No	80	8	Tone	Yes	No	No	No	Yes	Yes	''
	Porta-Touch 20	$129.95	No	20	8	Tone	Yes	No	No	No	Yes	Yes	Pocket size, acoustically couples to any phone
	80	$169.95	No	80	8	Tone	Yes	No	No	No	Yes	Yes	''
Cal-Tel	M43	$319.95	No	40	17	Pulse/Tone	Yes	Yes	Yes	Yes	Yes	Yes	(D) (P)
	M63	$369.95	No	60	17	Pulse/Tone	Yes	Yes	Yes	Yes	Yes	Yes	(D) (P)
	M20	$119.95	No	20	12	Pulse	No	No	No	No	No	No	
	M40	$169.95	No	40	12	Pulse	No	No	No	No	No	No	
	M60	$199.95	No	60	12	Pulse	No	No	No	No	No	No	
Cobra	AD 322	$59.95	No	32	16	Pulse	Yes	No	No	Yes	Yes	No	
	MT-240	$79.95	Yes	24	8	Pulse	Yes	No	No	No	Yes	No	
Code-A-Phone	960	$99.95	Yes	24	15	Pulse	Yes	No	No	No	Yes	No	
	940	$199.95	Yes	16	15	Pulse	Yes	No	No	Yes	Yes	No	
	Deluxe 2000/2500	$279.95	No	32	15	Pulse/Tone	Yes	Yes	No	Yes	Yes	Yes	
Dictograph	Phone Controller PC-30	$119.95	No	30	16	Pulse/Tone	Yes	Yes	Yes	Yes	Yes	Yes	Electronic lock, hold control
GTE	Access I	$129.95	Yes	9	20	Tone	No	No	No	No	No	Yes	
ITT	PC 1005	$300.00	Yes	24	21	Pulse	No	Yes	Yes	No	Yes	No	Calculator, Alarm
Otron	Computer Dialer CD-8050	$199.95	No	20	16	Pulse	No	Yes	Yes	Yes	Yes	No	Calculator
	Free Dialer FD-621	$119.95	No	32	14	Pulse/Tone	Yes	No	No	Yes	Yes	Yes	
	Memo Dialer MD-200	$79.95	No	20	14	Tone	Yes	No	No	No	Yes	Yes	
	DP-7903	$199.95	No	20	16	Pulse	No	Yes	Yes	Yes	Yes	No	Two-way speakerphone



At A Glance

Manufacturer	Model	Suggested Retail	Phone Incl.	Memory Loc.	Digits	Output	Program Pauses	Digital Clock	Call Timer	On-Hook Dialing	Backup Batt.	MCI-SPRINT Compatible	Special Features
Panasonic	1225	$139.95	No	32	16	Pulse/ Tone (B)	Yes	No	No	Yes	Yes	Yes	Can be bridged for 30 digits
	1235	$159.95	No	60	16	Pulse/ Tone (B)	Yes	No	No	Yes	Yes	Yes	"
Quasar	Future-Fone	$139.95	Yes	6	14	Pulse	Yes	No	No	Yes	Yes	No	Speakerphone (two-way)
Radio Shack	Duofone-10	$99.95	Yes	16	15	Pulse	Yes	No	No	No	Yes	No	
	Duofone-16	$129.95	Yes	16	15	Pulse	Yes	No	No	Yes	Yes	No	Two-way speakerphone
	Duofone-132	$99.95	No	32	15	Pulse	Yes	Yes	Yes	Yes	Yes	No	
	Duofone-100	$49.95	No	16	15	Pulse	Yes	No	No	Yes	Yes	No	
Teleconcepts	Gabbifon	$89.95	Yes	10	16	Pulse	Yes	No	No	No	No	No	
	Memory Dialer II	$249.95	Yes	64	16	Pulse/ Tone	Yes	Yes	Yes	Yes	No (not needed)	Yes	Two-way speaker-phone, business phone adapter converts to 5-line unit
Universal	Intelli-Phone Tel-1000	$199.95	Yes	12	7 to 11 (109 digits total)	Pulse	No	Yes	Yes	Yes	Yes	No	Alarm clock, hold control
	Gemini Tel-1011	$194.95	Yes	12	"	Pulse	No	Yes	Yes	Yes	Yes	No	Hold Control
U.S. Tron	DJ-11H	$89.95	Yes	11	16	Pulse*	No	No	No	No	No	Yes*	Mute, hold control, melody on hold + $10.00
	DJ-22H	$99.95	Yes	22	16	"	No	No	No	No	No	"	"
Webcor	ZIP 757	$150.00	Yes	16	16	Pulse-Tone	Yes	No	No	Yes	No	Yes	Hold control
Zoom	Demon Dialer 93	$150	No	93 or 73	7 10	Pulse	Yes	No	No	Yes	Yes	No	Detects dial tones** (A)
	93T	$180	No	93 or 73	7 10	Tone	Yes	No	No	Yes	Yes	Yes	"
	176	$200	No	176	10	Pulse	Yes	No	No	Yes	Yes	No	"
	176T	$230	No	176	10	Tone	Yes	No	No	Yes	Yes	Yes	"

Notes: *Tone and MCI-SPRINT compatibility optional. This option eliminates last-number-redial feature.
**Stores code names or numbers 2 to 4 characters or digits to call up stored phone numbers.
(A) One unit works all extension phones on circuit; also works with all lines on multiline key phones with appropriate adapter.
(B) Pulse/tone can be programmed to start pulse dialing (such as access number to MCI computer), then switch to tone dialing.
(D) Detects busy signal and redials number automatically.
(P) Programmable chained memory locations for automatically redialing MCI and SPRINT systems.

instrument provides outpulse only—slower than true tone dialing and totally useless with MCI, SPRINT, et al. Some of today's dialers offer a choice of either pulse or tone output models; some are available in tone-only models; and a few provide switch-selectable pulse or tone output. Some even offer switchable 10- or 20-pulse output for conventional or fast-pulse dialing. True tone output is still not commonplace among automatic dialers and almost always costs more.

On-hook dialing is a great convenience. Most dialers offer this by providing a built-in speaker so you can hear the dial tone, dialing and ringing signals. When the called party answers, you can then pick up your telephone handset. Dialers that are built into one-piece telephones obviously can't offer on-hook dialing; you have to take the handset off the wall or desk to activate it and to reach the touch buttons.

With the exception of the "Demon Dialer" and a couple of other instruments—which sense the presence of a dial tone—most dialers listed in the accompanying table have a built-in pause when the sequence starts. This pause allows time for the telephone circuit to connect with the central office and provide the dial tone. This is rarely a problem, except in those isolated cases where the telephone circuits are overloaded and there's an appreciable wait for the dial tone. In such cases, the dialer, not "knowing" that there's a dial-tone delay, will jump the gun and dial into a dead line. If there's an emergency, such as a flood, massive power outage, or other reason for the telephone company circuits to become overloaded, it might be a good idea to disconnect the dialer from your phone, in spite of the fact that manufacturers tout the instruments as being "perfect" for such emergencies. Perfect, they're not.

The most compact and unusual of the current crop is the "Soft-Touch" series from Buscom. This product was first born as a tone encoder for rotary-dial phones so they could be used with MCI, SPRINT, and others. This accessory screws onto the phone's handset, replacing the mouthpiece and microphone cartridges with a tiny 12-button pushbutton pad and microphone with sound slots between the buttons.

In its automatic dial version, the same type of minuscule design is used to offer up to an incredible 80 stored phone numbers, all with tone output and running on the telephone company's line power. A second product line from Buscom is a pocket-size portable dialer that travels with you. It acoustically couples to any phone transmitter. This device is the ultimate in portable convenience.

Possibly the most ambitious of the current crop is the Demon Dialer mentioned previously, which is a black box made by Zoom Electronics. It's not inexpensive, though, retailing for about $230 for the top-of-the-line unit. Unlike other dialers, once this unit is installed on a phone, it also operates with any extension phone on the line. All control functions and programming are done from the phone's rotary dial or tone dial pad. The dialer is one of few instrument readily available that senses the presence of a dial tone, both the telephone company's tone and the computer dial tone from a private toll network. It doesn't start dialing until it gets this go-ahead tone, which makes it a lot smarter than some people.

An obvious advantage with some models is the fact that the dialer is actually a complete telephone. This eliminates extra desk clutter, which is often a major objection to dialers. On the minus side, this approach limits the style of telephone you can own, which may shoot down the whole project if your wife or secretary have to use the system.

But using such a combination instrument automatically produces cost savings in telephone rentals and/or the purchase price of a telephone. In addition, installation and operation are often much simpler with a "smart" phone than with an add-on dialer. Unfortunately, most of those offered in combination packages have pulse output, making them useless for private toll network dialing, while many of them have severely limited storage capacity. A few models do have tone output.

What Is Needed? The ideal dialer should have some specific features to make it really useful. The most important is tone output for private network dialing and computer access. If this is switch-selectable, so much the better. Thus the dialer can pulse-access a toll network computer and then switch to tone for the rest of the operation.

Large memory capacity is also important. You may not think you need 25 or 30 memory locations until you actually start to program in those frequently called numbers.

Individual memory slot size is important, too. Any toll call today takes at least 11 digits in most parts of the United States. With a private network, the number of digits to be dialed reaches 24 or 25. Even with chained memory slots (autodial the access number, then when the computer answers, autodial the authorization code, area code and phone number), large-capacity memory slots are needed. Chaining three slots to get enough digits uses up a whole lot of memory, but it's often necessary, and it's certainly worth it. Most dialers permit you to chain numbers for longer digit strings, and their manufacturers promote this as a very important "extra" feature.

The ideal dialer should have an LED display to check phone number accuracy, both when programming and dialing. Once the display is there, adding a quartz clock chip is reasonably easy for the manufacturer, and this clock can also be used to time phone calls. Therefore, most dialers that have an LED digital display also feature a clock and stopwatch.

All memory chips are volatile, so some kind of battery backup is important to preserve those encoded phone numbers should the power go off. Some dialers will not only retain the memory with the battery, but provide operation during power failures. Such a unit is Dictograph's "Phone Controller," which continues to dial from memory with its little 9-volt transistor-radio battery. But the unit is rated for 12 volts dc, and the result is that during power outages the LED display won't light, and that little battery gets used up after just two hours. Of course, most power failures don't last that long anyway. Power-failure memory protection is important to check on all automatic dialers, for obvious reasons.

Installing the Dialer. Installation is a breeze on modular phones, and while it can be somewhat hairy on nonmodular types, it's not really difficult. Generally, most dialers require that you interrupt the telephone circuit in some way. With the modular instruments, this is easy: just unplug the modular cord that connects the phone to the wall and run it from the wall jack to the dialer (the jack will say "line" or something like that). A modular cable supplied with the dialer goes from the other jack that says "phone" to the telephone itself. There's also usually an ac line cord or a power pack converter to be plugged into the nearest ac outlet. Some dialers, including certain "smart" phones, operate on telephone company line power. Some of these provide no backup memory battery on the theory that the company's power to the phone system will never be interrupted.

Installing a dialer in a multi-line office telephone system can be a little more difficult. The dialer can be connected to only one line at a time. There are adapters available that do the job very nicely, but be careful. While many of the adapters have instructions that state they can be used with phone-answering machines and dialers, they won't work with dialers that require line interruption. Such adapters will operate

Radio Shack
Duofone-16

U. S. Tron
DJ-11H

Universal
Intelli-Phone
Tel-1000

Code-A-Phone
Memory Phone 940

only with dialers that are connected in *parallel* with the telephone—the same way an answering machine is. This is because they provide a *parallel* connection to the line. The arrangement is fine for answering machines, but these adapters do not break the circuit so that the dialer can operate on it. Such adapters are usually sandwich-type devices designed to fit between the two halves of the Amphenol-type connectors in the connecting cable.

Only one fully compatible accessory adapter is available right now, and that's Dictograph's "Universal 100." It's designed to work specifically with the company's Phone Controller, and is said to be fully automatic in operation. Like the others, it connects sandwich-style in the Amphenol connectors. Unlike the others, it is an *active* circuit and requires ac power (from the Phone Controller's power pack). It automatically finds the line in use on the key-type phone and operates on that line only (whichever line button is depressed at the moment). Key telephone lights and flashers operate normally. The manufacturer points out that it won't work automatically on some older types of office phones.

Probably the best way to wire in a dialer in an office situation is to call Ma Bell and ask for an RJ-35X jack. This is a six-conductor modular jack that will access all the circuits automatically in the key telephone. A special modular

Zoom
Demon Dialer

jumper goes from this jack to the dialer. The installation of this jack may cost as much as a "smart" adapter, but in the long run it may be the only method that will keep the phone company away.

During the next year, traditional suppliers of telephones and dialers will be introducing an ever-expanding line of products, and most of them will include the features listed for the "ideal" instrument. Many of them will continue the trend toward "smart" phones that combine a compact telephone with automatic dialing function. Ultimately, these smart phones will possibly become the most popular types of autodial instruments. And they'll get smaller and smarter as manufacturers evolve new and better LSI chip designs and automatic functions. ◇

BUILD A LOW-COST
STEREO COMPONENT SWITCHBOX

BY BILL ARRINGTON AND LARRY SANDERS

Avoid the headaches of constant rewiring when you want to change component arrangement

IF YOU'RE an audio enthusiast, you probably delight in adding external equipment to your component system. However, you'll want to avoid the trauma of rewiring the system each time a new configuration is needed. A low-cost solution to this problem, the "Stereo Switchbox" is presented here.

This device provides a simple way to deal with the interconnection problem that arises when your system contains a number of "extras" such as a second tape deck and one or more signal processors (equalizer, noise-reduction unit, dynamic-range enhancer, tick-and-pop reducer, etc.).

The switchbox allows complete flexibility for connecting the output of any device to the input of one or more other devices. For example, if you have two tape decks, there is often a need to copy from tape 1 to tape 2, or from tape 2 to 1. Or perhaps, you would like to record from disc or tuner to tape 1 or tape 2, or both. Now, add a signal processor to the system and you may spend more time behind your stereo with the cables than enjoying the music.

The switchbox is a set of switches arranged in a matrix pattern. Once it is connected to your system you can easily rearrange the inputs and outputs of external equipment with a flip of a few switches. In short, the switchbox provides you with complete versatility as well as simple operation.

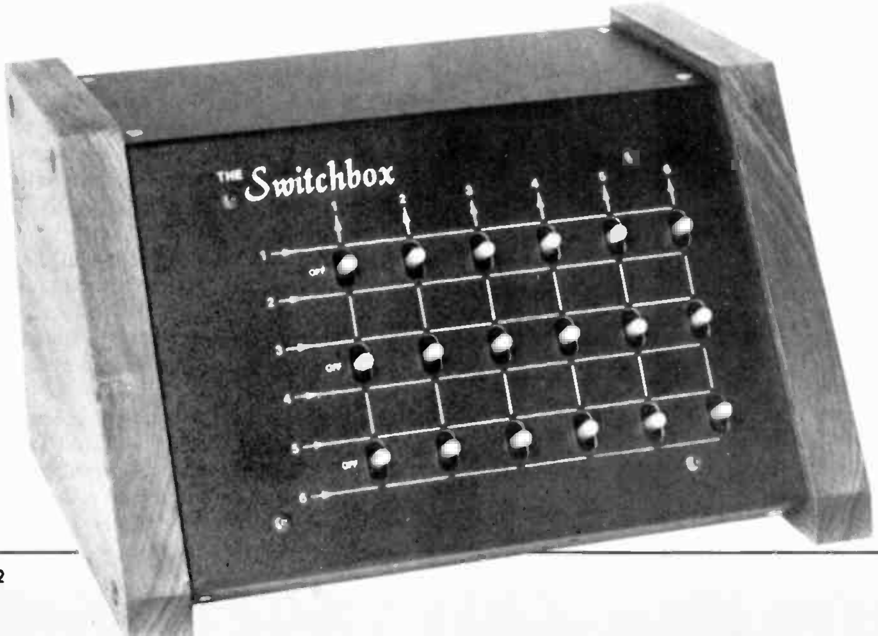
Circuit Operation. To see what a switch matrix can do for you, let's look at what it is and how it works. Figure 1 is the schematic diagram of a matrix switcher with X inputs and Y outputs. Notice that each input and output is actually a stereo left and right pair and each of the input pairs can be connected to any output pair by flipping a double-pole, single-throw (dpst) switch. For simplicity, the switch matrix can be represented symbolically as a rectangular pattern of signal paths with dots indicating the locations where switches have been closed to make a connection.

In Fig. 2, such a representation is used to show a phono preamp feeding a signal processor by the connection, labeled A, at input 5 and output 4. We will abbreviate this as 5,4. Then, the processed signal feeds both tape recorders through the connections at B(4,1) and C(4,2). For equalized playback, tape 2 feeds the equalizer with the connection at D(2,3) and the output of the equalizer drives the power amplifier via the connection at E(3,5). If we wish to hear the output of tape 1, simply switch off the connection at D(2,3) and complete the connection at F(1,3). Simultaneously, the tuner can be serving another room through connection G(6,6). Thus, once your system is connected to the switchbox there is no need to move the cables again. A few flips of the appropriate switches are all that is required to reconnect the system to any desired configuration.

The Design. In choosing a specific design for your switchbox there are some details to be decided. For example, how many inputs and outputs are needed? The larger the matrix, the greater the cost for switches and connectors. Since the cost of switches is proportional to the product of the number of rows and columns, it makes sense to choose a reasonable size. Except for ambitiously large systems, six rows and six columns are usually sufficient.

A standard 6×6 matrix requires 36 switches. Since good switches are expensive, the switches are the most costly item of the project. However, it wouldn't pay to use less than high-quality switches (an intermittent contact would be intolerable). It is recommended that the switches have silver- or gold-plated contacts that engage with a wiping action.

To save money on switches, don't



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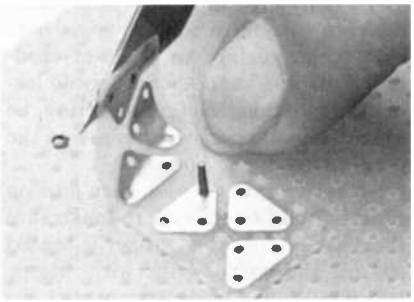

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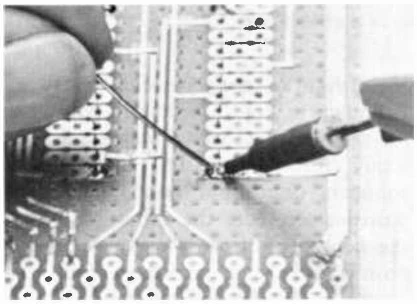

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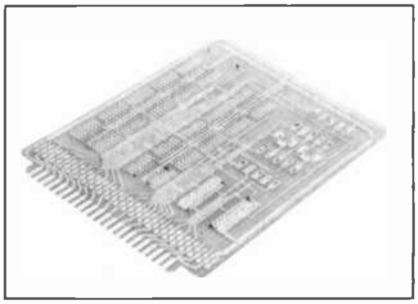

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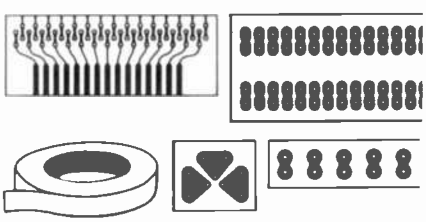

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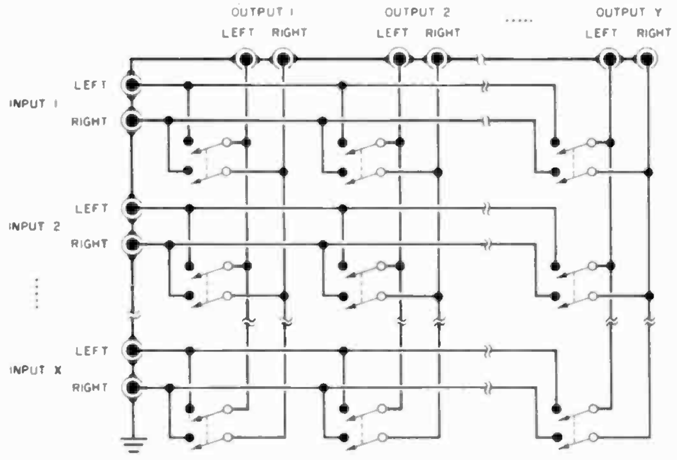


Fig. 1. Schematic diagram of a matrix switcher with X inputs and Y outputs. Each input and each output is a stereo pair.

sacrifice quality, rather look for a way to use fewer switches. First, consider that the total flexibility of a full matrix is not really needed or even useful. With a matrix that is fully populated with switches, a single output can be connected to more than one input; and, conversely, multiple outputs can be connected to a single input. However, summing multiple outputs to a single input is a job for a mixing console, not a switchbox. If a mixer is what you want, then an active circuit with controls to set the relative level of the various channels would be more appropriate. Since a switchbox is required and not a studio mixing console, a satisfactory design need not allow for channels to be mixed. This relaxation of requirements allows the use of half as many switches because, as shown in Fig. 3, a double-pole, triple-throw (dp3t) switch can serve two input stereo pairs. The up position connects one input pair, the down position connects the other pair and the center position is used as an off position in case neither input is wanted. This in no way reduces the usefulness of the switchbox, and it saves half the cost of switches and the time to mount them on the printed circuit board. (A 6×6 matrix needs only 18 dp3t switches.)

Construction. The printed circuit board layout is simple if a double-sided board is used. Certainly double-sided boards are more expensive, but the sheer number of jumpers that would be required for a single-sided design makes the choice very easy: use double-sided boards and save the hassle of loading 36 jumpers. Full-size foil patterns are shown in Figures 4 and 5.

If you make your own pc board, it is absolutely essential that it have plated-through holes to provide connections from the top to the bottom of the board. This is necessary because there is no room to get a soldering iron to the pads under the switches. To assemble the parts on the board, simply insert the switches from the component side of the board as shown in the top side loading diagram of Fig. 6. With all of the handles in the center position, turn the loaded pc board over onto a flat surface (a piece of cardboard may be handy here to avoid losing the switches). Before soldering, be absolutely sure the switches are on the proper side of the board.

Solder two diagonal corner pins on each switch first. Check to make sure that each switch is properly seated against the board. Otherwise, the pc board will not fit properly behind the front panel assembly. If any of the switches are improperly seated, reheat the two soldered legs while pushing the switch firmly into place. When you are sure that all the switches are properly installed, solder the rest of the pins.

The phono connectors are inserted into the board from the bottom at the locations shown in Fig. 7, and soldered on the top side. The board

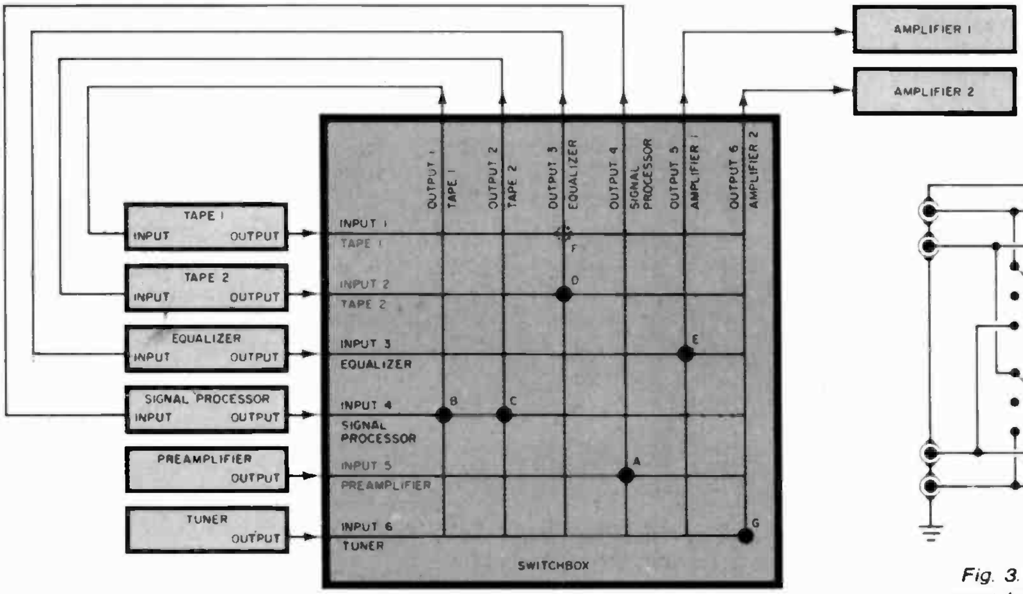


Fig. 2. Inputs and outputs of external equipment are shown with a simplified representation of the matrix.

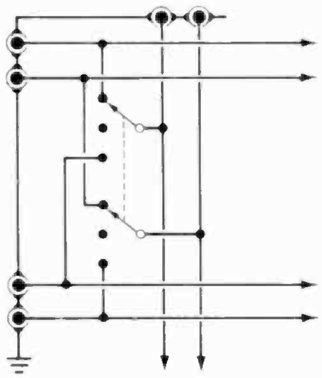
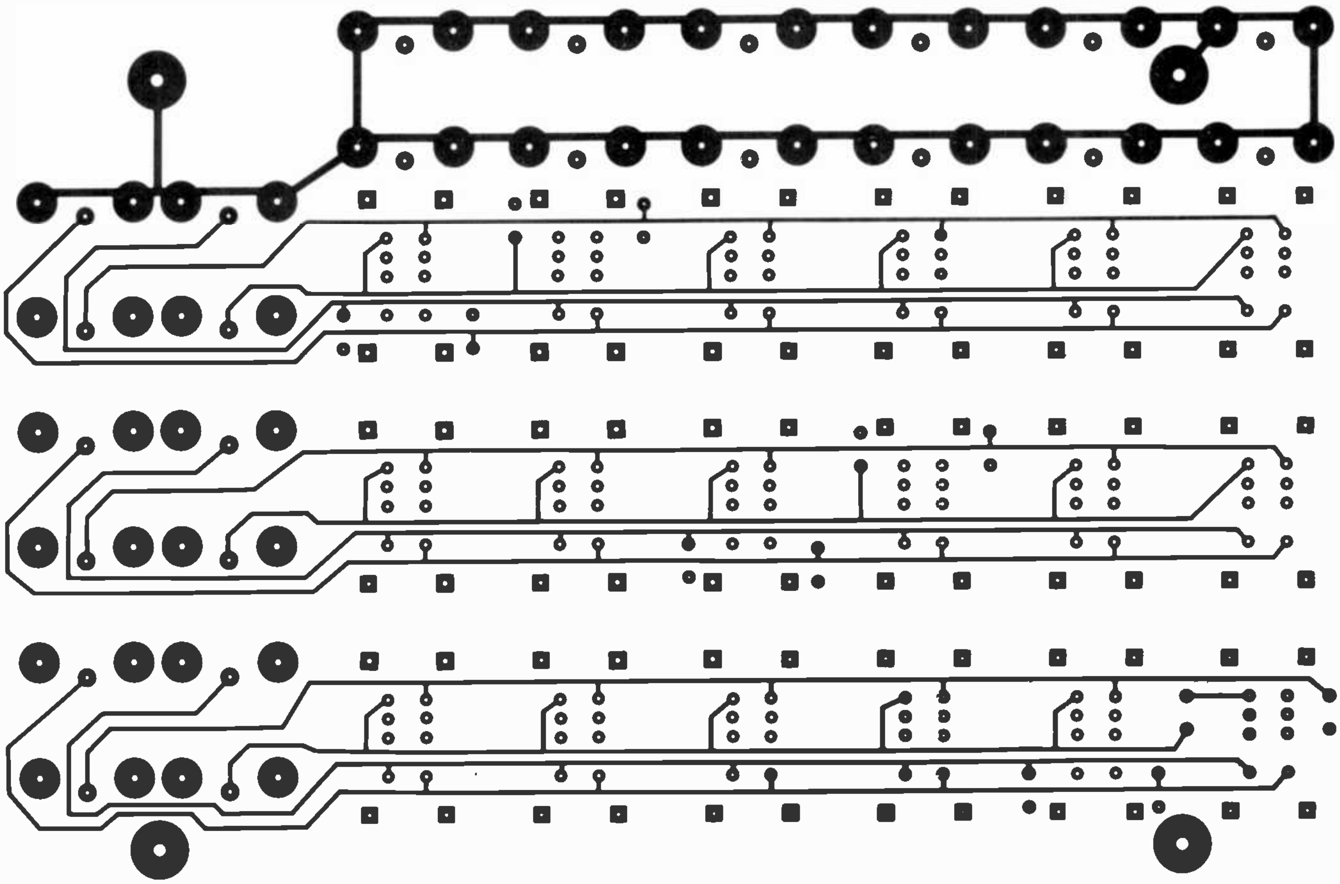
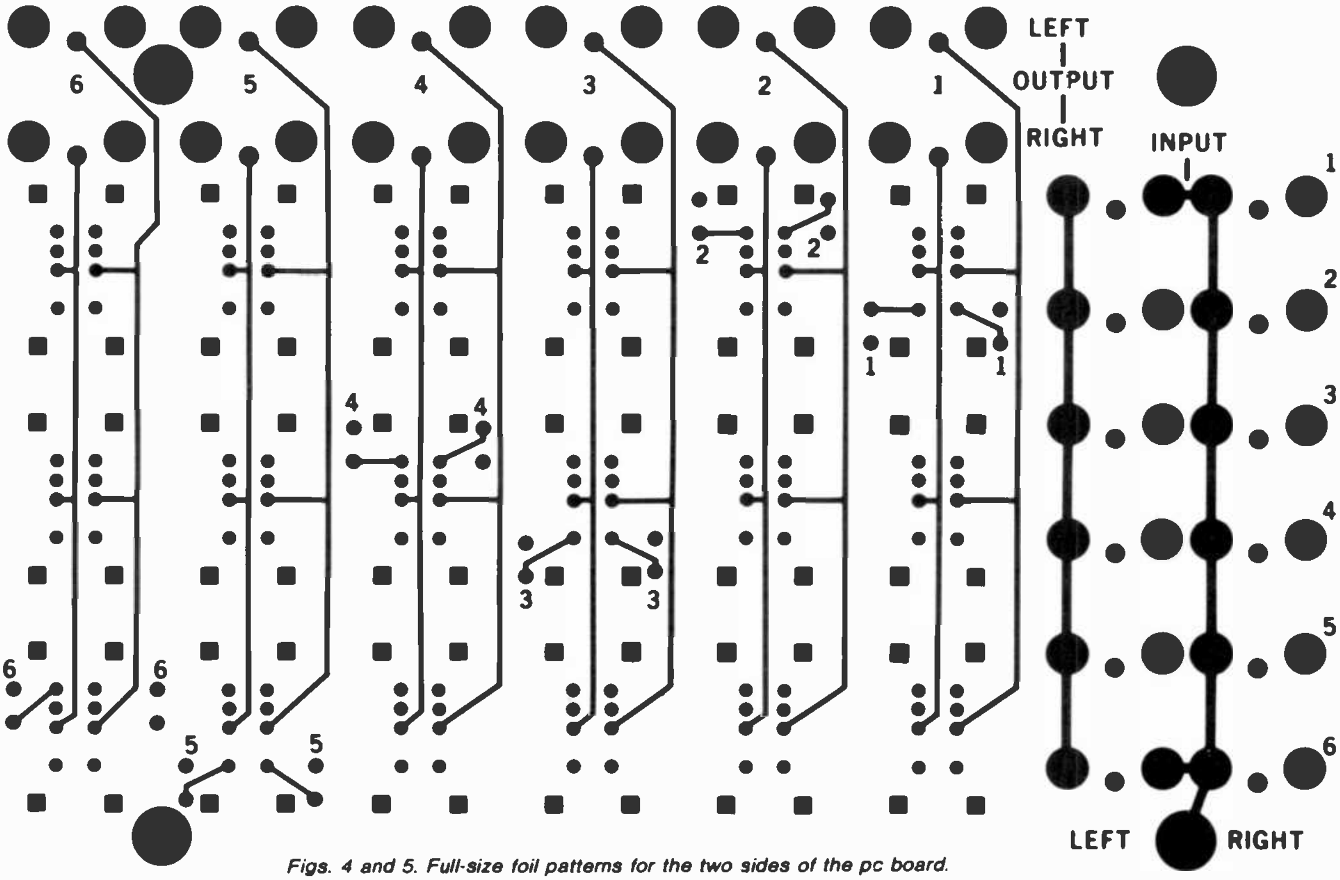


Fig. 3. A dp3t switch can serve two input stereo pairs.





Figs. 4 and 5. Full-size foil patterns for the two sides of the pc board.

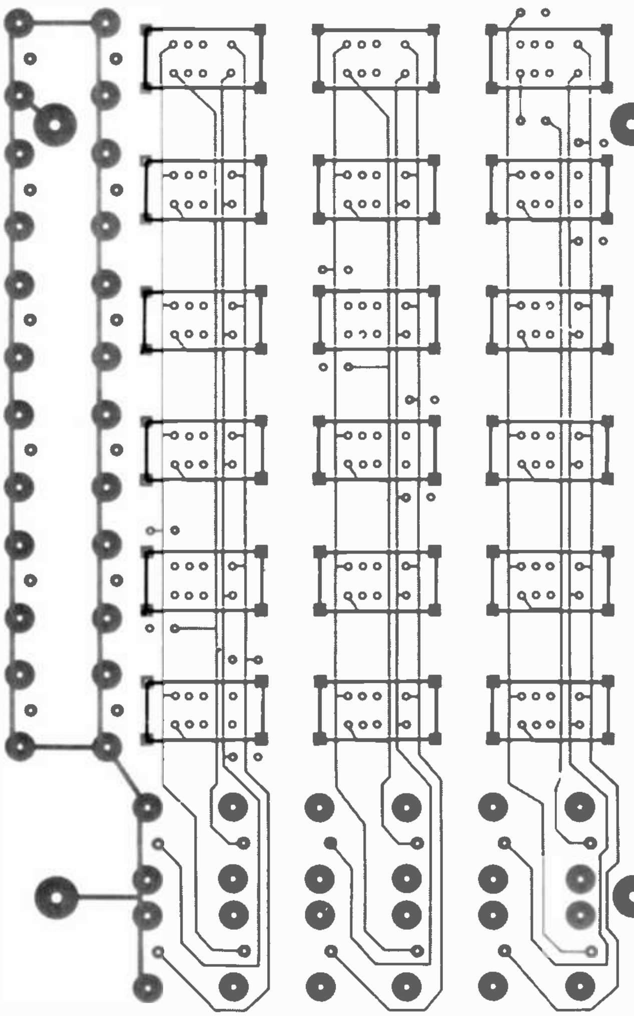


Fig. 6 Top side loading diagram shows switches inserted from the component side of the pc board.

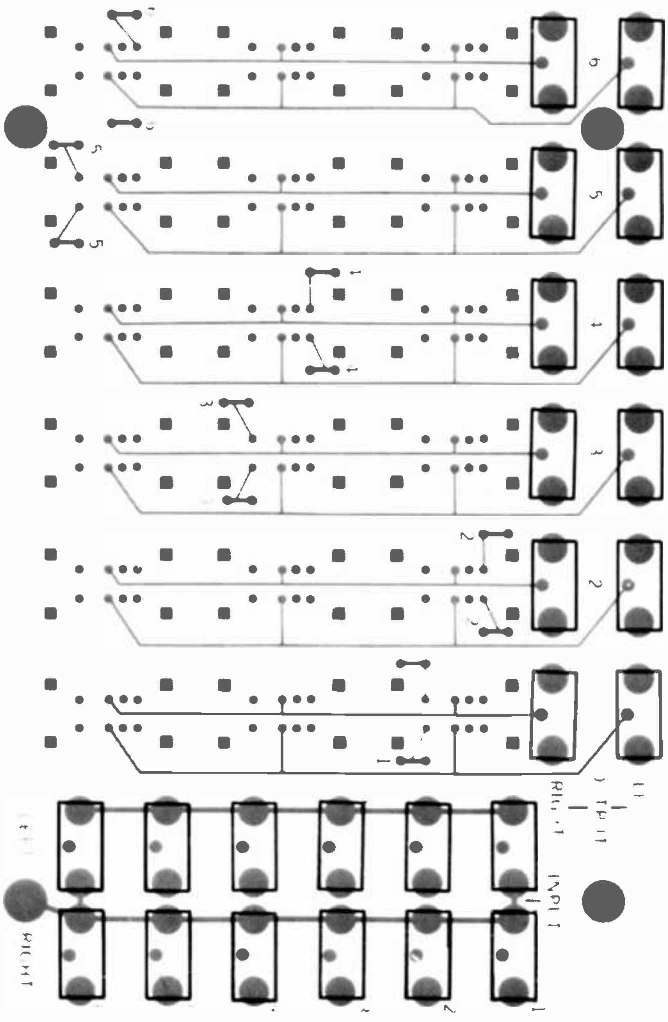


Fig. 7. Phono connectors are inserted into the board from the bottom at the locations shown above.

attaches to the front panel with four ⅝-inch standoffs that are pressed into the sheet-metal front panel. The circuit board is attached to the standoffs with ¼-inch, 6-32 screws. The front panel and switchboard assembly are now attached to the wooden end panels with three ¾-inch, 6-32 screws on each side, with the screw heads resting in countersunk recesses.

At this point the box is complete. Notice, however, that not all the holes in the pc board are filled. These holes are for some optional jumpers. But first let's try it out and get back to the jumpers in a moment.

Use. As a suggestion to get started, hook up your system as shown in Fig. 8. It is recommended that you either label each channel on the front panel or use a card patterned after Fig. 8 to remind you which components are connected to each switchbox channel. This is so you can keep track of which components are being hooked together. If you don't have all the equipment shown, don't worry, just adapt the general plan to what you have. Notice that in Fig. 8, the tape loop output from the receiver is connected to row 1 of the switchbox (labeled input 1 on the front panel and on the pc board). The tape loop input of the receiver is connected to vertical column 1, labeled output 1. In a similar manner the equalizer output is hooked to input 2, and the equalizer input is hooked to output 2.

There is a difference in how we wish to treat these two devices. It will do no harm to connect the receiver's tape loop input and output together (this is what happens inside the receiver when the tape monitor switch is disengaged). But it makes little sense to hook the output of the equalizer to its own input; in fact to do so will probably start a fierce speaker-blowing oscillation as the audio signals run around in circles through the equalizer. It is also not a recommended practice to connect the tape deck output to its input. If it is a two-head deck, or a three-head deck with the monitor switch in the source position, the results are much the same as with the equalizer. If the monitor switch is in the tape position, an echo is the result. The echo will grow or decay depending on how the gains are set. Therefore, with a receiver it is acceptable to connect between the tape monitor output and input. Also, in situations like that shown in Fig. 2 where a tuner and power amplifier use the corresponding input and output, it is necessary to be able to make this connection. But for *most* components, a connection to itself may be hazardous to the health of your amplifier, speakers and ears.

This brings us to **Rule Number 1** : *Do not connect an output to the input of the same device* without at the very least stopping to think about what you are doing. To avoid the need to stop and think each time a switch is thrown, connections on the diagonal of the matrix, points (1,1), (2,2), etc., are omitted from the pc board. If both the input and the output of a device are always assigned to the same input and output number on the switchbox, for example the tape machines in Fig. 8, then rule 1 may be safely ignored. For occasions when a connection is needed, holes are provided on the pc board so that adding a pair of jumpers will enable diagonal connections. If you want to protect against forgetfulness or a child playing with all the pretty switches, leave the jumpers out. For those places where you need to connect a row to the corresponding column, add the two jumpers for the row and column you intend to use. The jumper locations are numbered on the pc board and shown in Fig. 7.

Another word of caution is appropriate here. **Rule Number 2**: *Do not engage two switches in the same column at the same time*. Even with jumpers installed only in the right places (or not at all), it is possible to have a feedback problem. In Fig. 8, a switching arrangement is shown where two devices try to feed the same input at A (2,3) and B (4,3), while tape 2 feeds another input at C (4,2). This enables a feedback path to occur even though there are no diagonal connections. The result is the same as if a phantom connection existed at D (2,2). To avoid this, remember to turn any switch in a column off before another switch in the same column is engaged.

Now that your switchbox is properly installed in your system, complete system flexibility is available at your fingertips. If you need to reconfigure your system, just flip the appropriate switches and your system is reconfigured. For example, if your system is normally set up with the equalizer before the power amplifier for speaker

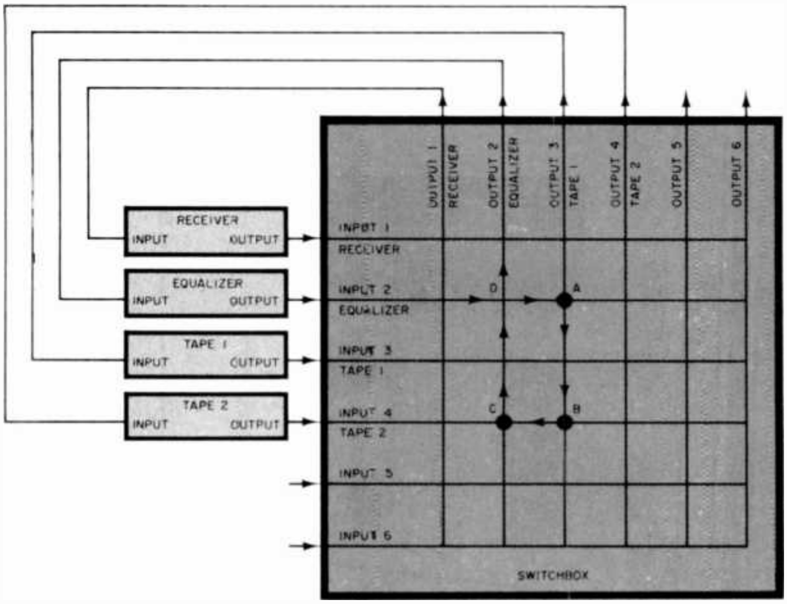
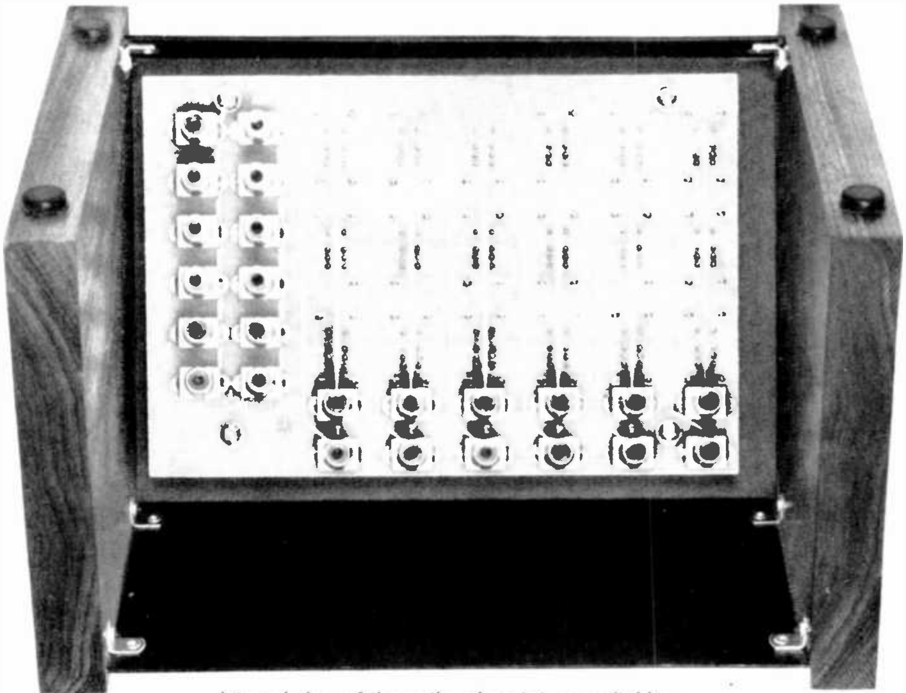


Fig. 8. Typical system hookup of four components. However, the switching arrangement would create undesirable feedback.

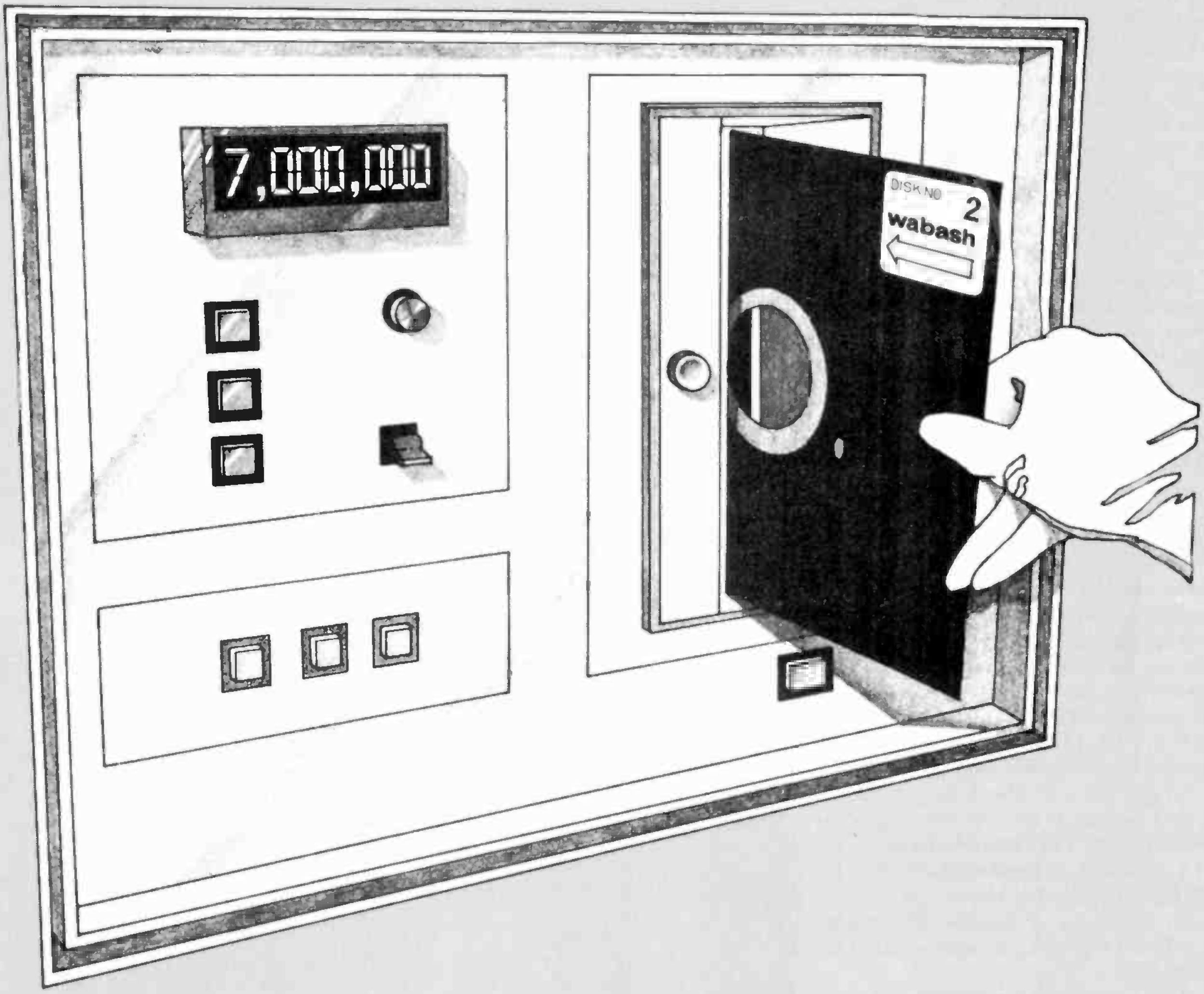


Internal view of the authors' prototype switchbox.

and/or room equalization, it is now easy to place it into any other signal path in the system. This is extremely useful when a tape needs equalization. Or what about the tapes that were made before you bought your new signal processor? Just switch it into the tape playback path. If you want to monitor another component while recording a tape or record, just follow the example of Fig. 2. And if you are one that sets up your own bias and equalization on your tape deck, simply find an unused input and inject the signal through your switchbox. These are just a few of the 279,935 useful combinations available (there are 387,420,489 possible combinations but most are not useful because they include feeding two sources into one input). The flexibility of a switchbox in your system is only limited by your own imagination. Now that you have quit fiddling around behind your system, you can start enjoying the music. ◇

KIT AVAILABILITY

The following are available from Sound Technics, 2115 Derby Hill Dr., Loveland, CO 80537: Complete kit of parts including 18 dp3t switches (UID part #MG-023-12-6-P-2W), 24 pc-mount RCA phono jacks, pc board, epoxy-finished front panel, unfinished walnut end panels, feet, and screws, for $95.00. Also available separately is a pc board for $24.50 (not separately available after 9/30/82); six-foot stereo-connector cables with dual-phono connectors on each end at $2.50 each or six for $13.00. Add $3.00 for shipping and handling. Colorado residents, add 3% sales tax.



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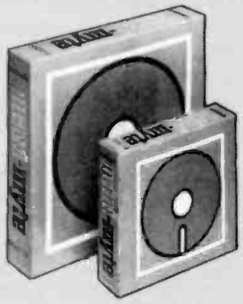

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CIRCLE NO. 57 ON FREE INFORMATION CARD

ONE-CHIP R-F MODULATOR FOR CRISP COLOR SIGNALS

Low-cost, easy-to-build circuit enables games and computers to produce excellent color on TV receivers

BY MARTY BERGAN AND BEN SCOTT

CONVERTING a baseband video signal from a computer, video game, VCR, CCTV camera, etc., into an r-f signal suitable for use by a conventional TV receiver is the job of an r-f modulator. These usually consist of a low-band (channel 2 through 6) oscillator driving a modulator and antenna matching network for connection to the TV receiver antenna input connector.

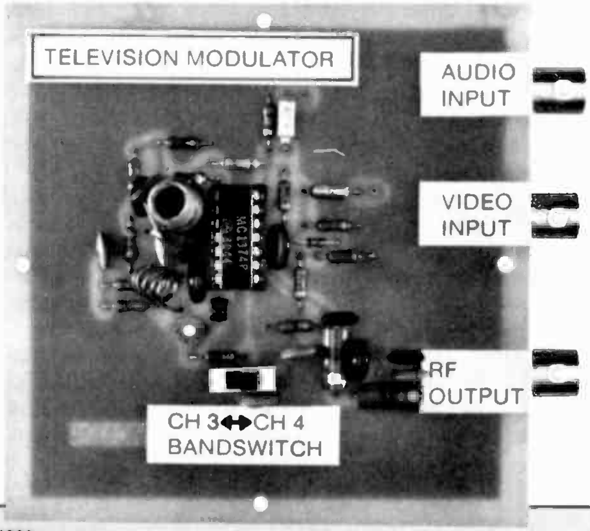
Unfortunately, most r-f modulators do not have the bandwidth to transmit a clean, crisp image to the color-TV receiver which is already somewhat limited in bandwidth. The result is usually just a passable color display.

The recently introduced MC1374 TV Modulator Circuit, shown in block diagram form in Fig. 1, has a performance that exceeds the accuracy of most TV receiver systems. Nonlinearity is less than 2%, differential phase distortion is under 2 degrees, and differential gain distortion is less than 7%. (A schematic of the circuit is shown in Fig. 2.) Driven from a 75-ohm source, there is no rolloff at 30 MHz. Unlike most r-f modulators, the MC1374 has separate inputs for video and audio, thus greatly reducing the possibility of crosstalk and unwanted mixing products.

Video Section. The AM video system is a basic multiplier combined with a balanced oscillator capable of operation to over 100 MHz. Since the signal inputs are not internally dc biased, the user can bias the device for the required video dc level and polarity. This, plus the separation of the inputs, keeps the video and intercarrier sound sources from interfering with each other. Chip temperature and voltage stability are excellent with respect to output frequency, thus no supply regulation is required.

The r-f output is directly proportional to the voltage difference between pins 1 and 11. Consequently, short leads are required to these pins. A long lead might introduce carrier shift, a result of output r-f being picked up on the lead. If the video source impedance is low, pin 11 can be shunted to ground via a low-value (47 pF) capacitor to reduce the possibility of oscillator feedback. Reasonable layout care will yield carrier rejection ratios of 36 to 40 dB below sync tip level carrier.

Resistor R_G, connected between pins 12 and 13, is for gain adjustment, and is selected so that only about half the dynamic range will be used at sync tip level to avoid modulator saturation. For example, the FM oscilla-



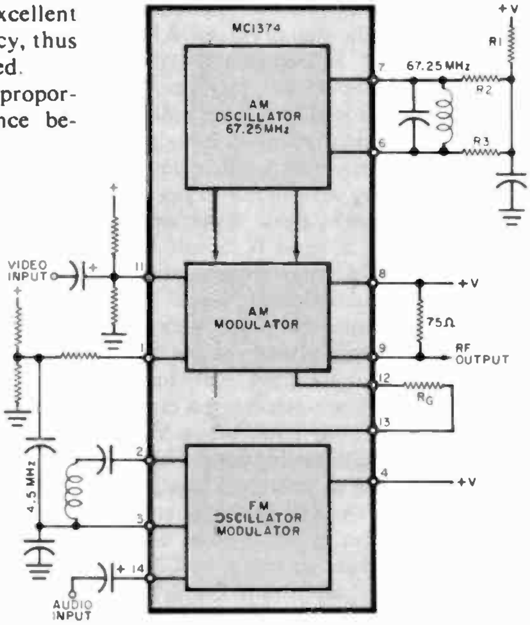


Fig. 1. Block diagram of the internal arrangement of the MC1374 Modulator IC.

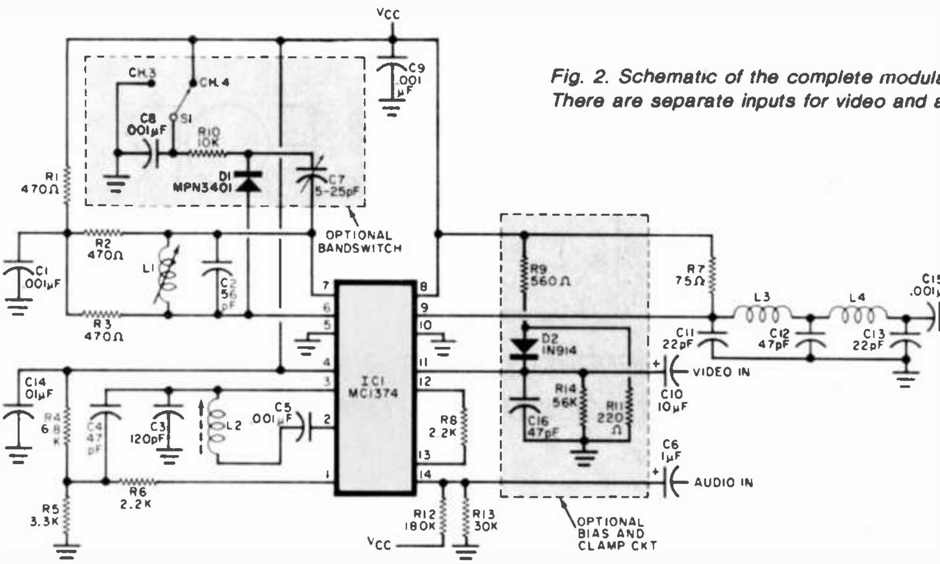


Fig. 2. Schematic of the complete modulator circuit. There are separate inputs for video and audio.

PARTS LIST

C1,C5,C8,C9,C15—0.001-µF, 50-V disc ceramic capacitor
C2—56-pF, 5% silver mica capacitor
C3—120-pF, 5% silver mica capacitor
D4.C12,C16—47-pF, 10% disc ceramic capacitor
C6—1-µF, 15-V electrolytic
C7—5-25-pF ceramic trimmer capacitor
C10—10-µF, 15-V electrolytic
C11,C13—22-pF, 10% disc ceramic capacitor
C14—0.01-µF, 50-V, disc ceramic capacitor
D1—MPN3401 (Motorola)
D2—1N914
IC1—MC1374 (Motorola)
L1—Inductor (4 turns #22 enamelled copper, 1/4" diam., close wound, air core)
L2—Inductor (45 turns #36 enamelled copper, 3/16" diam. ferrite core, close wound, with C5 on form)
L3,L4—0.22-µH rfc (Airco 4411-2M or similar)
The following are 1/4-W, 5% fixed resistors:
R1,R2,R3—470 Ω
R4—6.8 kΩ
R5—3.3 kΩ
R6,R8—2.2 kΩ
R7—75 Ω
R9—560 Ω
R10—10 kΩ
R11—220 Ω
R12—180 kΩ
R13—30 kΩ
R14—56 kΩ
S1—Spdt switch
Misc.—14-pin socket, mounting hardware, suitable enclosure, 12-volt power supply.
Note—The following are available from Circuit Specialists, 730 S. Perry Lane, Tempe, AZ 85281 (Tel: 602-966-0764): printed-circuit board at $4.95; IC MC1374 at $3.50; diode MPN3401 at $0.70.

tor/modulator (on the same chip), can deliver about 500 mV peak-to-peak of 4.5-MHz signal to the AM video modulator. In accordance with broadcast practices of picture-to-sound ratios, this implies a peak video of about 1 volt maximum. At low signal levels, noise becomes another limitation. In keeping with standard practices, the minimum peak (sync tip) video should be at least 0.25 volt to assure that background noise is over 60 dB below standard white level.

There is a definite "window" within which the video signal and the pin 11 voltage must be contained. Resistors *R1*, *R2*, and *R3* are selected to bias pins 6 and 7 at about 1 volt below V_{cc} to permit the oscillator to swing without clipping, and to provide a circuit Q of about 20. The voltage on pins 1 and 11 must always be at least 1.5 volts below the bias on pins 6 and 7.

Conservatively, input pins 1 and 11 should never go below 2.25 V above ground; but, in fact, no distortions are evident down to 1.6 V on either input. Operation in this region is necessary when using a 5-V power supply, but should be avoided when a higher supply voltage is available.

A biasing divider to pin 1 and another to pin 11 can be chosen to establish nominal conditions for a static picture, so that a test pattern signal can be ac coupled to the input. The relative polarity and exact difference between these dc levels is critical to the establishment of standard levels. A positive-going (sync) video signal requires a dc bias on pin 11 that is approximately the average value of the video with respect to pin 1 bias. A negative-going video signal requires that pin 11 be biased below pin 1 by the same amount. If V_{cc} changes, divided voltages will change proportionately, as will the difference between them. This is unacceptable because it changes modulation depth. Similar difficulties occur if the video input signal changes in average value, as for a full white or full black scene.

In many cases, the video source itself is dc referenced, and can be made to provide both pin 1 and pin 11 reference levels. If not, the two divider voltages must be regulated, and the signal sync tip clamped to the pin 11 bias by diode *D2*. The divider impedance should be kept low to minimize the time constant of clamping corrections as video content changes.

The output frequency can be selected from channel 3 or 4 by a dc control circuit. Selection is accomplished by changing the *C* of the tank circuit with a switching diode, *D1*. When the diode is forward biased, it effectively parallels *C7* with *C2* thereby lowering the frequency of the oscillator (Ch. 3 selected). When *D1* is reverse biased, its impedance is very high, eliminating *C7* from functioning in the circuit and raising the frequency (Ch. 4 selected). To align this circuit, first select Ch. 4 (*C7* switched out) and tune *L1* to 67.25 MHz (Ch. 4). Then switch to Ch. 3 and adjust *C7* to obtain 61.25 MHz (Ch. 3).

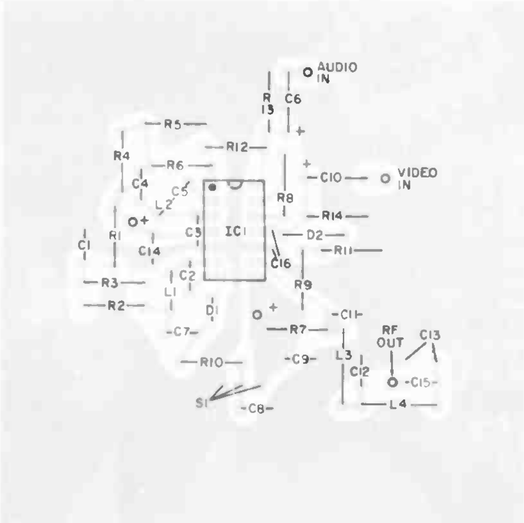
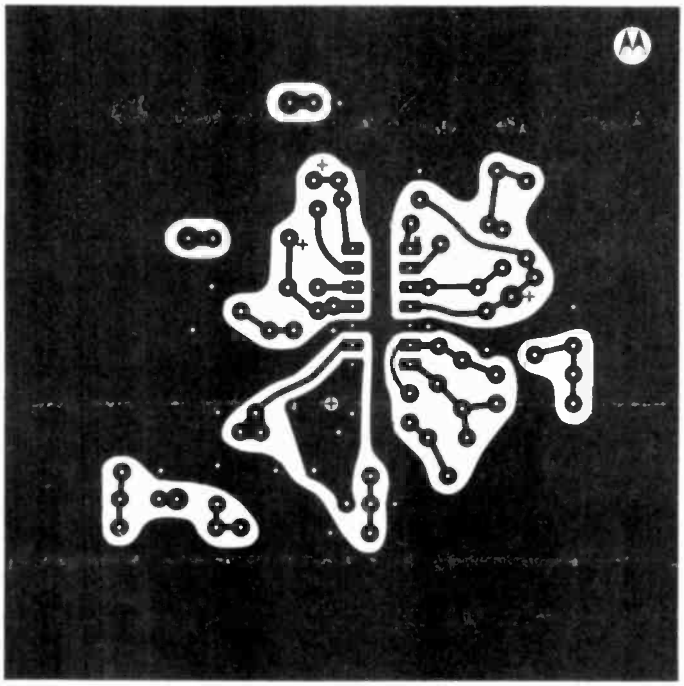


Fig. 3. Exact-size guide for a printed-circuit board is shown below. The component layout diagram is at right. Use any regulated 12-volt power supply.



FM Sound Section. The FM system was designed specifically for the TV intercarrier function at 4.5 MHz, and will operate from 1.4 to 14 MHz. Performance of this system compares favorably to many laboratory generators and exceeds the distortion performance of varactor modulators by several times. For example, at 4.5 MHz, a deviation of ±25 kHz can be achieved with 0.6% distortion.

The oscillator center frequency is approximately the resonance of inductor *L2* and the effective capacitance *C3* from pin 3 to ground. Include approximately 6 pF (internal) when making frequency calculations. For overall oscillator stability, it is best to keep X_L in the range of 300 to 1,000 ohms.

One added convenience in the FM section is the separate "oscillator B+" (pin 4), which permits disabling the sound system during alignment of the AM section. Usually this pin is hard-wired to the V_{cc} source without decoupling.

Standard practice is to provide preemphasis of higher audio frequencies at the transmitter and a matching deemphasis in the TV receiver audio amplifier. This is to counteract the fact that less energy is usually present in the higher audio frequencies, and also fewer modulation sidebands are within the deviation window. Both factors degrade signal-to-noise ratio. Pre-emphasis of 75 μs is standard. For cases where preemphasis is not provided, a suitable network can be made from a parallel-connected 0.0012-μF capacitor and 56,000-ohm resistor between *C6* and pin 14.

Modulators of this type, when operated at vhf, introduce substantial second harmonics in the r-f output. At 67 MHz, the second harmonic is only 6 to 8 dB below the maximum fundamental. This poses no real impairment of performance as it would be ignored by the TV receiver's selectivity, but it would not meet FCC requirements. To compensate, a simple double-pi filter is used at the chip output.

The schematic of Fig. 2 includes a simple and almost lossless second-harmonic r-f filter formed by *L3*, *L4* and their associated capacitors. Gain resistor *R8* was selected for an intended video input of approximately 1 volt peak at the sync tip, and biasing is arranged for negative-going sync. This produces a signal at the output filter of about 12 mV rms, about 12 dB greater than FCC rules permit. Therefore it must be padded down for commercial applications.

The intercarrier sound signal is coupled to the AM modulator by *C4*. The input impedance at pin 1 is very high so the intercarrier level is determined by the source impedance at pin 3 (about 2000 ohms). This drives into the bias circuit impedance of *R4* and *R5* (about 2200 ohms) through *C4*. This provides an intercarrier level of nearly 500 mV peak-to-peak, correct for the 1-volt peak video level selected. The audio input for a full ±25 kHz FM is about 0.2 volt peak-to-peak. If the preemphasis circuit previously discussed is used, the audio input will have to be increased approximately 10 times.

Construction. The modulator can be assembled on a pc board such as that shown in Fig. 3. If you elect to create your own layout, keep all leads as short as possible. The completed board can be mounted in any selected enclosure.

The circuit can be powered from any regulated 12-volt source having good filtering and bypassing. With a typical 12-volt regulated source, measured r-f carrier deviation was less than 10 kHz between 0° and 50°C for any video input level. ◇

DECIMAL MULTIPLICATION FOR THE ZX-80

A program to expand the range of your microcomputer

BY LOYD REDMAN

ALTHOUGH the Sinclair ZX-80 performs only integer arithmetic, it can be made (via software) to perform decimal multiplication. Pages 35 and 36 of the ZX-80 operating manual show a program that multiplies two integers and displays the product. All you need to add to this program are instructions telling the computer where to place the decimal point in the product. Make sure neither the multiplier nor the multiplicand contains more than five digits. Remember, the ZX-80 will not perform a multiplication if the product is larger than 32,767 due to internal arithmetic limitations.

```
10   PRINT "ENTER NUMBER OF DECIMAL PLACES IN PRODUCT"
20   INPUT D
30   PRINT "D="; D
40   PRINT " "
50   PRINT "ENTER M"
60   INPUT M
70   PRINT "M="; M
80   PRINT " "
90   PRINT "ENTER N"
100  INPUT N
110  PRINT "N="; N
120  PRINT " "
130  IF D=1 THEN LET B=10
140  IF D=2 THEN LET B=100
150  IF D=3 THEN LET B=1000
160  IF D=4 THEN LET B=10000
170  LET P=M*N
180  LET Q=P/B
190  LET R=P-Q*B
200  IF D=2 AND R<10 THEN GO TO 400
210  IF D=2 AND R>9 THEN GO TO 300
220  IF D=3 AND R<10 THEN GO TO 500
230  IF D=3 AND R<100 AND R>9 THEN GO TO 400
240  IF D=3 AND R>99 THEN GO TO 300
250  IF D=4 AND R<10 THEN GO TO 600
260  IF D=4 AND R<100 AND R>9 THEN GO TO 500
270  IF D=4 AND R<1000 AND R>99 THEN GO TO 400
280  IF D=4 AND R>999 THEN GO TO 300
300  PRINT M;"X";N;"(";D;"DECIMAL PLACES)=";Q;".";R
310  STOP
400  PRINT M;"X";N;"(";D;"DECIMAL PLACES)=";Q;".Ø";R
410  STOP
500  PRINT M;"X";N;"(";D;"DECIMAL PLACES)=";Q;".ØØ";R
510  STOP
600  PRINT M;"X";N;"(";D;"DECIMAL PLACES)=";Q;".ØØØ";R
```

The program shown here multiplies two integers, then determines the location of the decimal point in the product (no more than four decimal places).

Lines 10 to 120 enter and display the multiplier and multiplicand (without decimal points) and the number of decimal places in the product. Lines 130 to 190 find the value of the integer (whole-number) portion of the product. Lines 200 to 280 instruct the ZX-80 to examine the portion of the product to the right of the decimal point to determine the proper format for displaying the complete answer. The routines at lines 300, 400, 500, and 600 show the format used when printing the product. ◇

BUILD THE TIME-ON RECORDER

Tells you at a glance how long an appliance or TV receiver has been operating

BY DANIEL M. FLYNN

WITH the cost of electricity constantly rising, you might want to check how many hours an appliance or the TV set has been on during the day. An ideal way to do this is with the Time-On Recorder described in this article. Unlike many mechanical timers, which you have to stop and start yourself, this recorder is triggered on and off by the appliance itself.

The recorder is a relatively simple device to build. It has a single clock chip which performs all timing functions. This chip, an *MM5309*, has a 24-hour LED display format. The chip times only when an appliance plugged into the recorder is turned on. A circuit in the recorder senses that the appliance is on and "enables" the clock chip. The recorder displays a continuously changing time until the appliance is shut off. At this point, the clock chip is disabled but it holds the time count. The displayed time remains unchanged until the appliance is turned on again, at which point the clock continues timing. This is how the recorder displays the cumulative "time on" of the appliance for the entire day.

Circuit Operation. To use the Time-On Recorder, an appliance must be plugged into socket *SO1* of the recorder and the recorder plugged into an ac outlet. When the appliance is in use, its current flows through fuse *F1* and the triac (Fig. 1). Fuse *F1* protects the triac and also disconnects the circuit from the line in the event the primary of *T2* becomes shorted. The triac is held on constantly by resistor *R1* as long as current is flowing through the device. The drop across the triac is approximately 2 volts, which remains relatively constant despite changing current. Most of this voltage is across *R2*, but a portion excites the 8-ohm winding of *T1*. The 1000-ohm, center-tapped secondary of *T1* produces an ac voltage that is rectified by *D1* and *D2*, filtered by *C1*, and applied through current limiter *R3* to the base of *Q5* an npn transistor. Fuse *F2* protects *T1* in the event the triac should open while a load current is flowing. If this happened, the entire current would be forced to flow through *T1* causing a great deal of damage.

When there is no load, *Q6* receives no base current and is off. Under this condition, pin 19 of the clock chip is brought up nearly equal to V_{SS} through resistors *R4* and *R5*. Pin 19 of the clock chip is the 50/60-Hz input. (See Fig. 2 for the pin-out configuration of the clock chip.) When it is held at V_{SS} the clock's time will not change. If a load is present and drawing current, transistor *Q6* receives a base current which forces it on. With *Q6* on, pin 19 of the clock chip is grounded. This condition allows the

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Box 953, Elizabeth, N.J. 07207

clocking pulses produced from the 60-Hz line to pass through diode *D3*. These pulses cause the clock's time to advance. As soon as the load is turned off, *Q6* turns off, and the clock stops timing.

The clock chip, an *MM5309*, has multiplexed, 7-segment outputs which are used to directly drive a five-digit numeric, monolithic display. The digit-enable outputs of the clock chip are used to drive pnp transistors *Q1* through *Q5*. These transistors in turn drive the individual digits. Tens of hours and minutes and units of hours, minutes, and seconds are displayed. Units of seconds are displayed so the user can verify, at a glance, if the circuit is timing. Components *R7* and *C4*, connected to pin 26 of the clock chip, provide an RC network for the internal multiplex oscillator. Together, *R7* and *C4* determine the rate at which the display is multiplexed.

The dc supply voltage is provided by *IC2*, a full-wave bridge rectifier, and capacitor C2. The latter not only filters the voltage from *IC2* but, more importantly, it raises the average dc voltage from 11 volts to 17 volts, which is a functional voltage level for the *MM5309*. The *MM5309* does not require a voltage regulator.

Switch *S1* is connected to pin 16 of the clock chip and is used to reset the clock to all zeros. Normally pin 16 is tied high internally allowing the clock to time. Depressing *S1* shorts pin 16 to ground performing the reset function. Switch *S2* is optional and can be replaced with a jumper wire if the builder prefers to see units of seconds displayed all the time. (I found displaying units of seconds confusing without also displaying tens of seconds when trying to interpret the display.) Switch *S2* is depressed by the user to see if the clock is timing and then released.

Pin 14 of the *MM5309* is tied low so the timer will time correctly with a 60-Hz clock signal on pin 19. Pin 27, the 4/6 digit select, is tied low to enable the units and tens of seconds outputs (pins 21 and 20) along with the minutes and hour outputs. Lastly, pin 13, the 12/24 hour select, is left disconnected (the pin is pulled high internally) so the timer will time to 24 hours before recycling.

Construction. Building of the time-on recorder is not complicated. A printed-circuit board such as the one shown in Fig. 3 greatly simplifies wiring. However, the circuit is simple enough that it can be hard-wired on perfboard if desired. The mounting of all components except *F1*, *R1*, *SO1*, the triac, and the switches on the board helps reduce the amount of off-board wiring. Figure 4 shows component placement for the pc board. Take care in inserting ICs in case the leads must be bent to match holes.

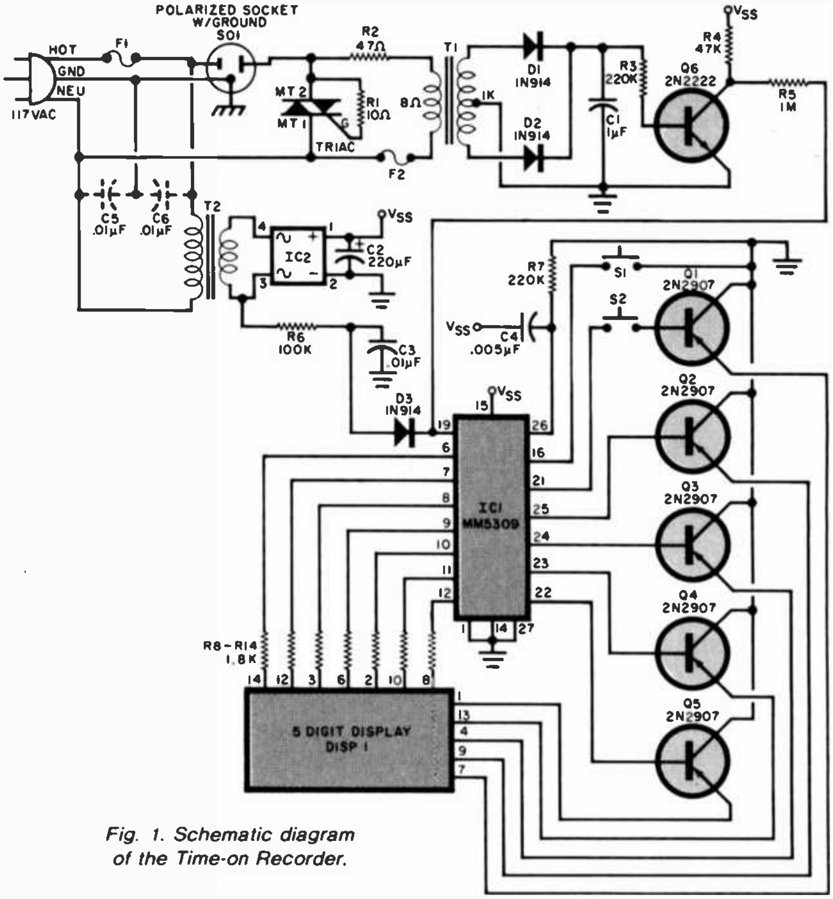


Fig. 1. Schematic diagram of the Time-on Recorder.

PARTS LIST

C1—1-μF, nonpolarized electrolytic
C2—220-μF, 35-V electrolytic
C3—0.01-μF, 50-V, ceramic-disc capacitor
C4—0.005-μF, 50-V, ceramic-disc capacitor
C5, C6—0.01-μF, 400-V, ceramic-disc capacitor
D1,D2,D3—1N914 signal diode
DISP1—5-digit, 7-segment, common-cathode display (H-P 5082-7415 or equivalent)
F1—6¼-A, 3AG, slow-blow fuse
F2—¼-A, 3AG, fast-acting fuse
IC1—MM5309 PMOS clock chip (see note)
IC2—Full-wave bridge rectifier (Radio Shack 276-1161 or equiv.)
Q1 through Q5—2N2907 pnp transistor
Q6—2N2222 npn transistor
R1—10-Ω, ½-W, 10% tolerance carbon-composition resistor
R2—47-Ω, ½-W, 10% tolerance carbon-composition resistor
The following resistors are ¼-W, 5% tolerance carbon-composition resistors:
R3, R7—220 kΩ
R4—47 kΩ
R5—1 MΩ
R6—100 kΩ
R8 through R14—1.8 kΩ
SO1—Polarized ac socket with ground
S1, S2—Normally open, momentary-contact, pushbutton switch
T1—Miniature audio-output transformer (Radio Shack 273-1380 or equiv.)
T2—12.6-V, 300-mA transformer
Triac—400-V, 6-A (Radio Shack 276-1000 or equivalent)
Misc.—Suitable enclosure, circuit board, standoffs, line cord, strain relief, IC sockets (one 28-pin, one right-angle 14-pin), panel-mounted fuse holder, pc-mounted fuse holder, mounting hardware, terminal strip, solder, etc.
Note—The MM5309 clock chip is available from Jameco Electronics, 1355 Shoreway Rd., Belmont, CA 94002.

The line cord coming into the unit should be three-conductor and of 16- or 18-gauge wire. The line cord should be properly relieved for strain at the point of entry to the cabinet. Care must be taken when connecting the internal 115-V wiring. On a polarized, grounded, electrical socket, one side of the outlet is smaller than the other. This side is the "hot" side. The larger of the two blade holes is the neutral. The hot side of the line should be brought in and taken to the end tab of the panel-mounted fuse holder of *F1*. The side tab of the fuse holder is connected to the gold-colored terminal screw of *SO1*, the ac socket. The silver-colored terminal is connected to

Pin Connections
MM5309

Pin	Function	
1	V_{DD}	
2	$\overline{\text{BCD 8}}$	BCD Outputs
3	$\overline{\text{BCD 4}}$	
4	$\overline{\text{BCD 2}}$	
5	$\overline{\text{BCD 1}}$	
6	A	7-segment Outputs
7	B	
8	C	
9	D	
10	E	
11	F	
12	G	
13	12/24-hour select	
14	50/60-Hz select	
15	V_{SS}	
16	Reset	
17	Slow set	
18	Fast set	
19	50/60-Hz input	
20	S10	Digit enable outputs
21	S1	
22	H10	
23	H1	
24	M10	
25	M1	
26	MUX timing	
27	4/6-digit select	
28	Output enable	

Five-digit numeric display

Pin	Function
1	Cathode 1
2	Anode E
3	Anode C
4	Cathode 3
5	Anode DP
6	Anode D
7	Cathode 5
8	Anode G
9	Cathode 4
10	Anode F
11	N/C
12	Anode B
13	Cathode 2
14	Anode A

Fig. 2. Pin connections of the two integrated circuits.

the triac's *MT2* terminal. Then, as shown in the schematic, the triac's *MT1* terminal is connected to the neutral. The ground wire of the line should be electrically fastened to the metal chassis enclosure (if one is used) and to the grounding screw of *SO1*. All of the wiring just mentioned should be 16- or 18-gauge stranded wire. (Solid wire of this gauge is difficult to work with in the chassis box.) Other ac wiring is not as critical size-wise (24 gauge will work fine), but care should be taken to follow the schematic closely.

The time-on recorder pictured in Fig. 5 was assembled in a 3½ x 9 x 6", 20-gauge, aluminum cabinet such as Radio Shack's part number 270-261. Whichever cabinet is chosen, it should be of easily machinable material since square holes are required for the outlet and the display. If the display is mounted on the board, it should be located at a side and mounted with a 14-pin right angle socket. This way the board can be mounted flat and positioned on standoffs so the display appears in the cabinet front.

The triac must be heat sinked. The metal chassis itself functions well as a heat sink if the triac is mounted with a nylon bolt on a mylar spacer. The triac can be connected to a terminal strip for all the connections to it. Also recommended is that the clock chip be mounted in a socket, with the chip placed in the socket only after all wiring is complete.

Using the Time-On Recorder. To use the recorder, plug it in and reset the clock so the display shows all zeros. Then plug an appliance into the recorder's socket. Turn the appliance

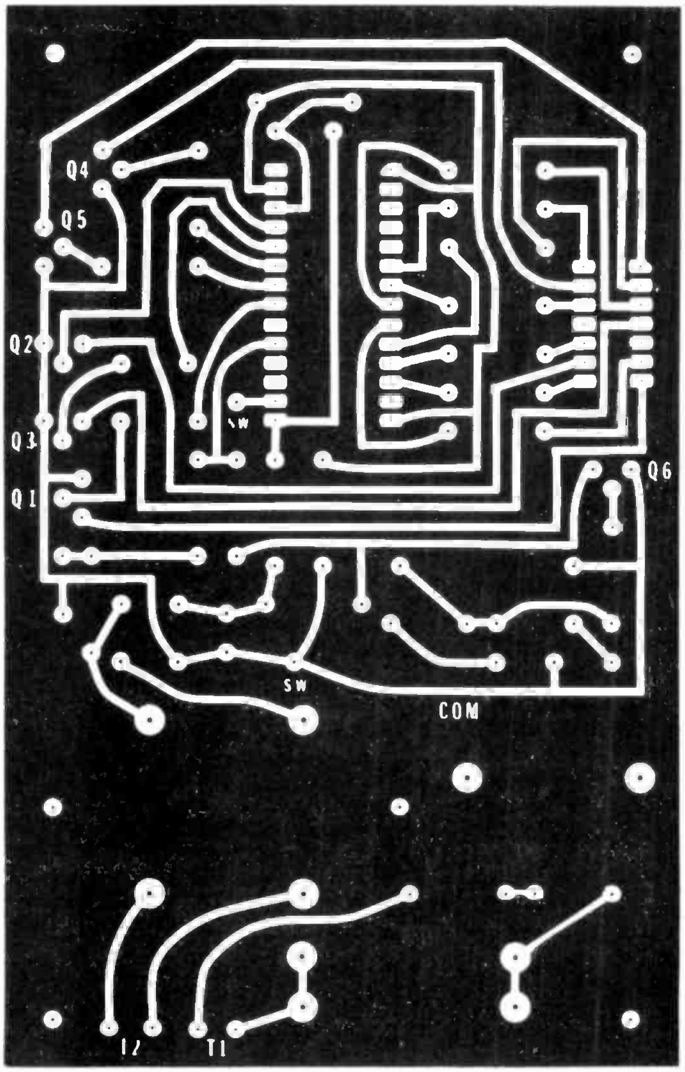


Fig. 3. Exact-size foil pattern for a printed-circuit board for the project.

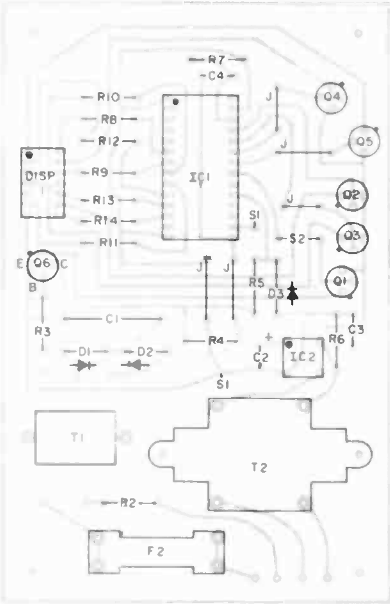


Fig. 4. Component layout for the board shown in Fig. 3.

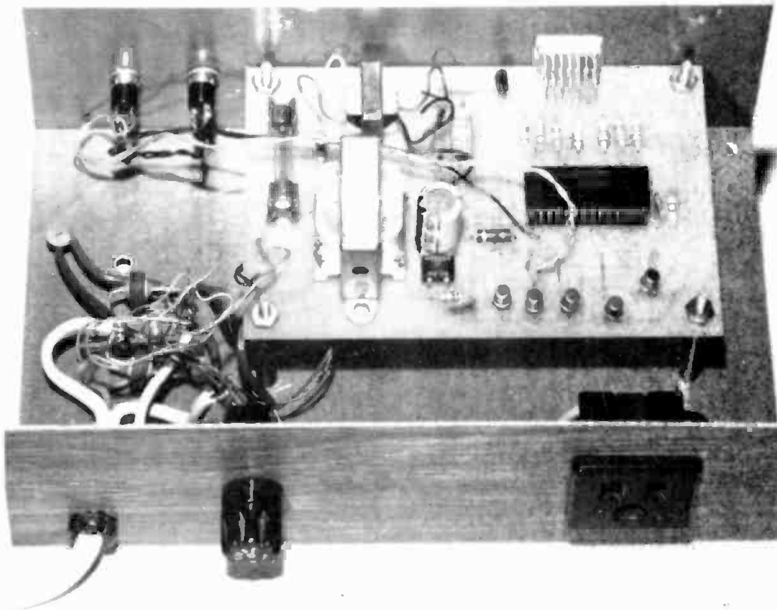


Photo of the internal arrangement of the author's prototype.

on and verify that the recorder starts timing. To find the cumulative time-on for a period longer than a day, note the recorder's display daily and then reset the recorder. At the end of the time period, add the results for each day. (The maximum display is 24 hours before the clock resets itself to zero.)

Please note that the recorder's maximum load is 720 watts (i.e., a load requiring no more than 6 amperes).

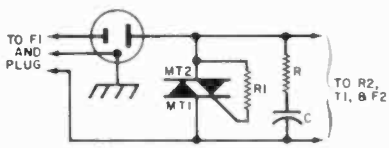


Fig. 5. An RC shunt on the triac improves operation with inductive loads.

Some loads, such as a dehumidifier may be rated at 5 A but when first turned on will draw in excess of 6 A. This will cause fuse *F1* to blow. In this case, the time-on recorder cannot be used. Also, if the ac line has noise spikes on it (from appliances such as a dehumidifier) the recorder may be accidentally reset and lose its count. To remedy this add capacitors *C5* and *C6* as shown in the schematic. These components may also be needed if the load is a fan. These capacitors short

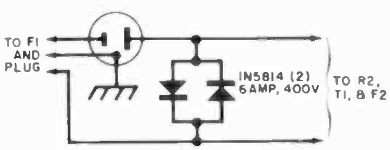


Fig. 6. Two diodes can be used to replace the triac if desired.

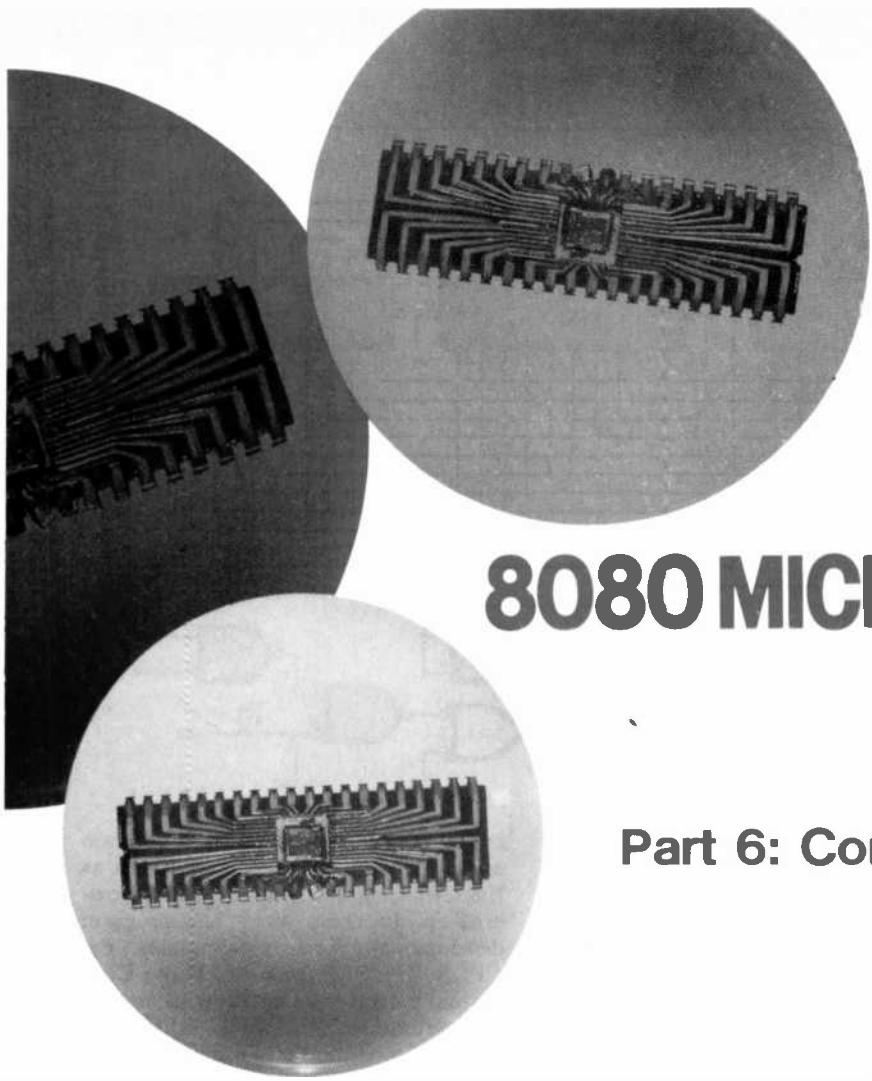
the noise spikes on the ac line to ground. Note also that there is a minimum load requirement to start the recorder timing. A load as small as 10 watts will activate the recorder, while a load of 7½ watts will not.

Although the recorder can be used to tell you how much television the family is watching or the like, it can also tell you how much the television is costing you to use. To find the cost, take the total time in hours, multiply it by the power rating of the load in kilowatts and then multiply by the cost of a kilowatt-hour in your area.

Going Further. The circuit shown in Fig. 1 uses a triac to produce the signal that enables the clock chip. The triac was selected because of its easy availability. It does, however, restrict the types of loads that can be timed. That is, the triac will prevent large inductive loads such as fans and other motors from starting.

If you want to avoid this, the circuit can be changed. Shunting the triac with a series RC circuit as in Fig. 5 would eliminate the problem mentioned with inductive loads. This solution, however, requires two additional components and creates the problem of finding the values of the two components. Therefore, the circuit shown in Fig. 6 is preferable. If the diodes are available, use the circuit to replace the part of the original circuit which uses the triac. No other change in the circuit is necessary.

If one of the diodes in Fig. 6 fails, fuse *F2* will blow to protect *T1*. In this case, the bad diode and *F2* will have to be replaced before the circuit will operate. This type of circuit failure should be kept in mind if *F2* blows but there are no wiring errors present. ◇



BY RANDY CARLSTROM

DESIGNING WITH THE 8080 MICROPROCESSOR

Part 6: Conclusion—Programming the CPU Module's ROM

HAVING designed and built the interface for receiving Morse code, into the CPU, it is now necessary to program the CPU program memory.

There are several types of read-only memory (ROM), each of which has its unique way of being programmed. One type is the *mask programmable* ROM in which the desired binary state of each memory cell (bit) is programmed by selectively including or excluding a small conducting jumper in the cell during manufacture. This type of ROM programming is permanent and the bit pattern cannot be altered once programmed. A change of even one bit requires that a new custom mask be made, which is a relatively expensive process (about $1,000). This type of ROM is generally used only in high-volume production applications where the desired bit pattern has already been proven and the probability of pattern changes or updates is very unlikely.

A second type of ROM is the *Programmable Read-Only Memory* (PROM). This device is similar to the mask programmable ROM, but has the advantage of being *field programmable*—that is, the customer can program it himself. This is done by selectively "blowing" fusible links (made of polycrystalline silicon or nichrome) in each memory cell with a relatively high-current pulse to obtain the desired bit pattern. Needless to say, the PROM must be discarded and a new one programmed if any bit changes are to be made which would otherwise require the repair of a blown fuse link. The PROM shares the same disadvantage of the mask programmable ROM—it is not reprogrammable.

The last type of ROM we will examine is the *Erasable and Programmable Read-Only Memory* (EPROM). As its name suggests, the EPROM can be programmed by the user. However, rather than "blowing" fusible links as in the PROM, a small electric charge is selectively deposited in each memory cell. The EPROM has the property that when its chip surface it exposed to ultraviolet light, any charges deposited in the memory cells are removed, which completely "erases" the memory. This unique property of the EPROM gives it the added feature of being reprogrammable. The EPROM chip is covered by a transparent quartz lid (rather than the conventional opaque metal or plastic cover) which allows it to be exposed to ultraviolet light. The erasing process (exposure to UV light) normally takes from 20 to 30 minutes, and will set all of the EPROM's memory cells to a logic 1. Programming a cell to a logic 0 is done electrically by depositing a small electric charge in that cell. However, the only way a programmed cell can be changed from the 0 state to the 1 state is by erasing the *entire* device.

The EPROM is generally used in prototype systems, where bit pattern changes are likely to be made. Because of the distinct advantages the EPROM offers, it is this type which is used for the CPU module's program memory.

Program Development Board Design. In a 2K EPROM, there are over 16,000 memory bits to be programmed (depending on the length of the user's program), and there are strict timing requirements that must be adhered to when programming. To solve these problems the Program Development Board (PDB) was designed. Its objectives are:

(1) To provide a "program-development memory area" where 8080 programs can be conveniently stored and edited. This memory area should exist in the same address space as the CPU's EPROM, and the CPU must be able to execute any program stored in this area. In this way a new program can be loaded, tested, and debugged before it is copied ("burned") into an EPROM.

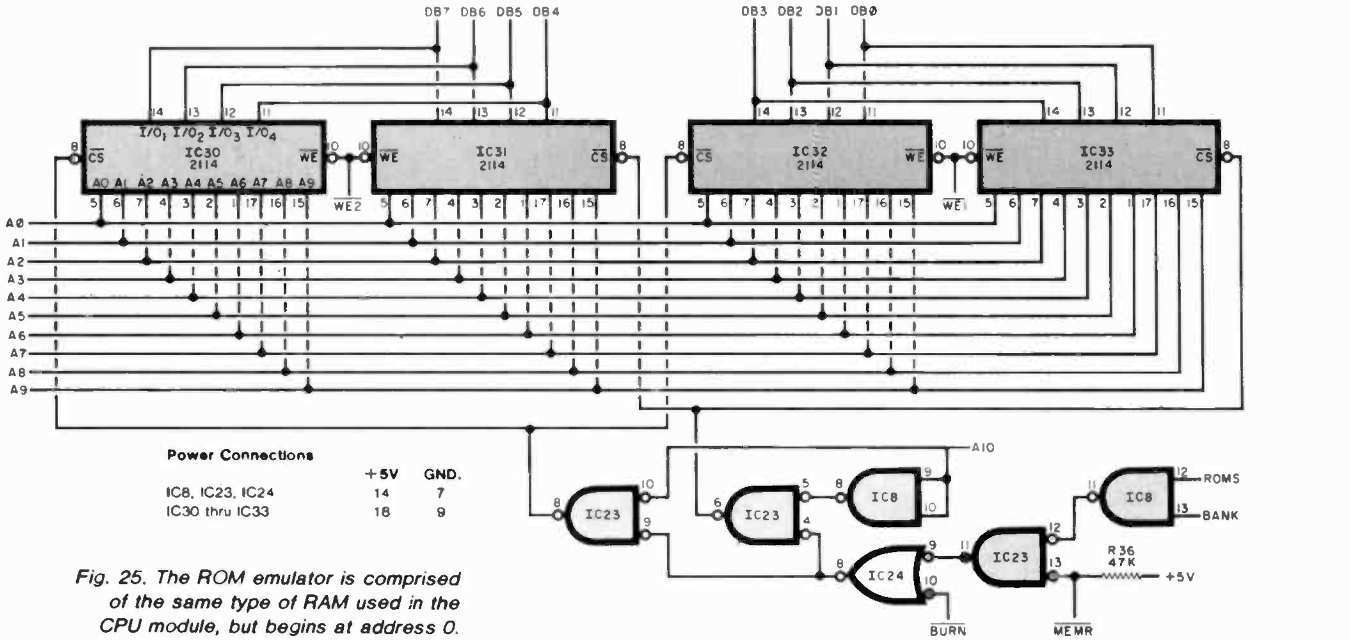


Fig. 25. The ROM emulator is comprised of the same type of RAM used in the CPU module, but begins at address 0.

(2) To monitor the status of the Address, Data, and Control busses at all times.

(3) To single-step the CPU one instruction at a time, thereby enabling the programmer to observe the results of each program instruction as it is executed. This provides an instructional tool as well as an aid in debugging new programs.

(4) To single-step and monitor the execution of a program already contained in the CPU's EPROM.

(5) To provide a fast and efficient means of burning a newly developed program into an EPROM.

To satisfy design objective 1, a 2K-byte ROM emulator and a 20-key keypad were incorporated into the PDB design. The ROM emulator (Fig. 25) is comprised of the same type of RAM used in the CPU module, but begins at memory address 0. Although the CPU cannot write data into this memory area, it can read program instructions and data previously stored there. This provides built-in protection to prevent a bad program from completely wiping itself out. It is only possible to begin program execution at memory location 0, just as the CPU module does when first powered-up. In these ways, the program development memory simulates the CPU's EPROM from which the CPU normally obtains its instructions, even if a programmed EPROM is installed in the CPU module. This ensures that programs which run successfully in this memory area will also run properly when they are transferred to the CPU's EPROM. Program instructions and data are loaded into the program devel-

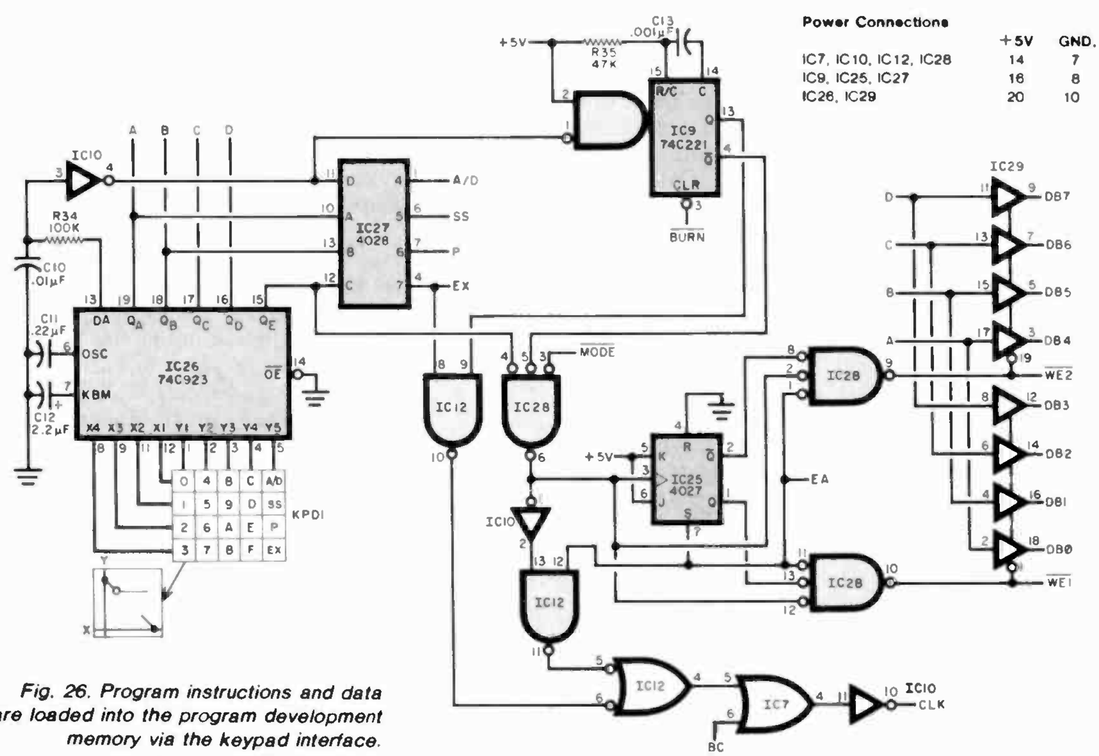


Fig. 26. Program instructions and data are loaded into the program development memory via the keypad interface.

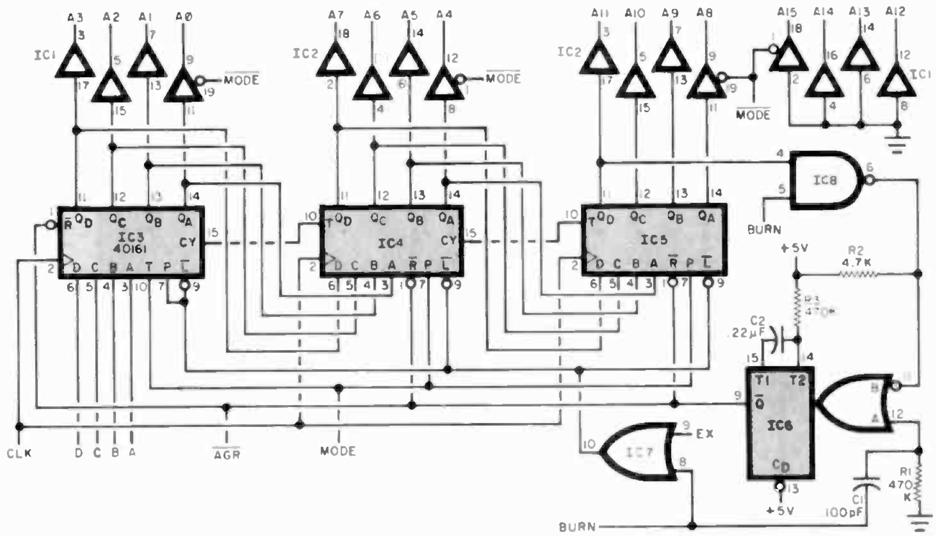


Fig. 27. The contents of any memory location in the program development or scratchpad memory can be examined using the address generator.

Power Connections

	+5V	GND.
IC1, IC2	20	10
IC3, IC4, IC5, IC6	16	8
IC7, IC8	14	7

PARTS LIST

C1—100-pF disc ceramic capacitor
C2,C9,C11—0.22-μF disc ceramic capacitor
C3,C8,C10—0.01-μF disc ceramic capacitor
C4—0.47-μF Mylar capacitor
C5,C13—0.001-μF disc ceramic capacitor
C6—47-pF disc ceramic capacitor
C7—0.33-μF, 50-V capacitor
C12—2.2-μF, 10-V tantalum capacitor
DIS1 through DIS6—Common-cathode, 7-segment LED display (H.P. 5082-7740, T.I. TIL313, or equivalent)
LED1 through LED7—Red light-emitting diode
IC1,IC2,IC29—MM74C244 octal noninverting tri-state buffer
IC3,IC4,IC5—CD40161BC or MM74C161 binary counter
IC6—CD4528BC dual monostable multivibrator
IC7—CD4071BC quad 2-input OR gate
IC8—74LS00 quad 2-input NAND gate
IC9—MM74C221 dual monostable multivibrator
IC10—CD40106BC or MM74C14 hex Schmitt trigger inverter
IC11—CD4013BC dual D flip-flop
IC12—CD4011BC quad 2-input NAND gate
IC13—CD4081BC quad 2-input AND gate
IC14—LM340LA-12 positive 12-volt regulator
IC15,IC16,IC17,IC18,IC19,IC20—MC14495 BCD-to-seven-segment decoder/driver
IC21—74LS74A dual D flip-flop
IC22—7417 or 7407 hex buffer with open-collecter outputs
IC23—74LS32 quad 2-input OR gate
IC24—74LS08 quad 2-input NOR gate
IC25—CD4027BC dual J-K flip-flop
IC26—MM74C923 20-key encoder
IC27—CD4028BC BCD-to-decimal decoder
IC28—CD4075BC triple 3-input OR gate
IC30 through IC33—2114L 1024x4 RAM
J1,J2,J3—16-pin DIP plug
P1,P2,P3—16-pin DIP plug
Q1,Q2,Q7—2N3904 or equivalent transistor
Q3—2N2907, PN2907, or equivalent transistor
Q4,Q5,Q6—2N2222, PN2222, or equivalent transistor
The following, unless otherwise specified, are ¼-watt, 10% fixed carbon-composition resistors:
R1,R3,R29—470 kΩ
R2,R8,R28,R33—4.7 kΩ
R4—330 kΩ
R5—50-kΩ pc-mount potentiometer
R6—82 kΩ
R7,R34—100 kΩ
R9—10 kΩ
R10,R13,R20,R27,R31,R32,R35,R36—47 kΩ
R11—22 kΩ
R12—1 kΩ
R14—1.2 kΩ
R15—560 Ω
R16—1-kΩ pc-mount potentiometer
R17,R18,R19,R21 through R26—330 Ω
R30—1 MΩ
S1 through S4—DIP switch
Misc.—0.01-μF or 0.1-μF disc ceramic bypass capacitors distributed near ICs; 4x5 X-Y matrix keypad or 20 spst NO momentary-contact pushbutton switches; IC sockets; perf or printed-circuit board; wire or solder, etc.

opment memory via the keypad (Fig. 26). It is also possible to examine the contents of any memory location in the program development or scratchpad memory via the keypad (Fig. 27).

A four-digit hexadecimal display monitoring the CPU's Address Bus, a two-digit hexadecimal display monitoring the Data Bus, and four LED's monitoring four of the five Control Bus lines satisfy design objective 2 (Fig. 28).

Through the use of a special key of the keypad it is possible to single-step the CPU in one of two selectable modes (Fig. 29). The first of these modes causes the CPU to execute one instruction with each depression of this key. The second mode causes one 8080 machine cycle to be executed with each depression of the key. The states of the CPU busses are always displayed in these modes to aid in monitoring an executing program's progress.

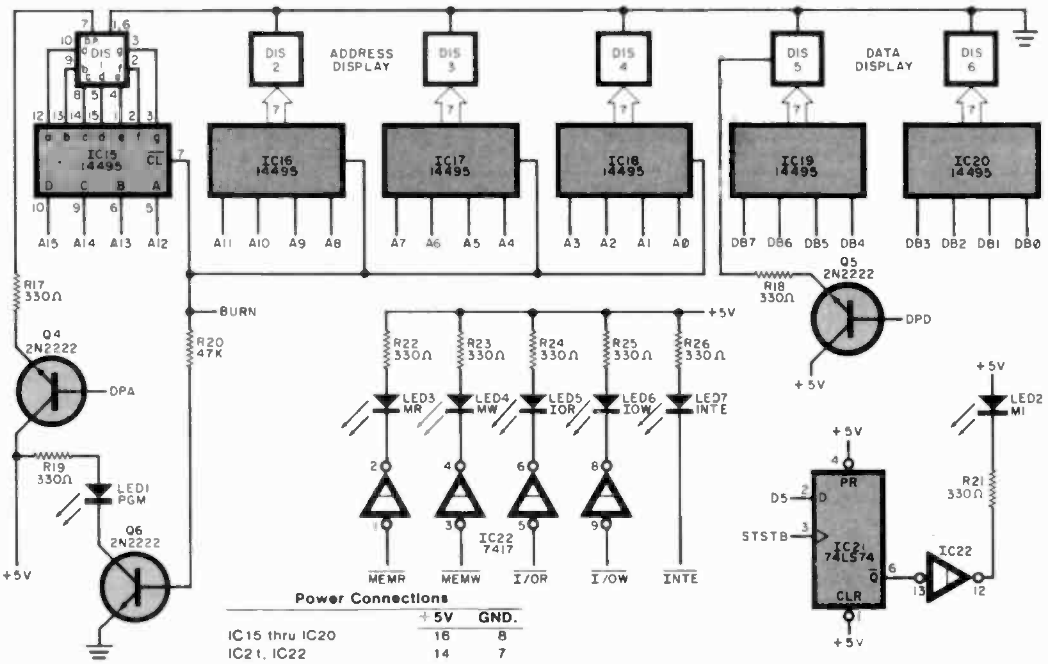
To satisfy design objective 4, the PDB allows the programmer to select the "memory bank" the CPU will use to obtain its program instructions from; the program development memory or an installed CPU EPROM. The CPU scratchpad RAM area beginning at memory location 800_{16} is always accessible to a running program, regardless of the memory bank selected.

When the programmer is satisfied with the operation of his new program, the depression of a single key of the keypad will burn the entire contents of the program development memory into an erased EPROM installed in the CPU module in less than two minutes (Fig. 30). After a successful burn, the programmer can separate the CPU module and interface(s) from the PDB (Fig. 31) and connect the CPU module directly to the interface(s). The programming of the CPU module in this particular application is now complete, and so are the design objectives of the PDB.

Functions. There are two primary modes of operation of the PDB—edit and execute. The edit mode allows program instructions and data to be loaded, examined, and altered in the program development memory. The PDB enters the execute mode whenever the CPU is single-stepped or run. Here are the PDB functions:

0 through F (numeric): Used to enter hexadecimal memory addresses and load program instructions and data into the program development memory area. The destinations of the numbers entered with these keys are governed by the A/D key.

A/D (Enter Address/Load Data): Places the PDB in the edit mode and also determines where subsequent nu-



Power Connections

	+5V	GND.
IC15 thru IC20	16	8
IC21, IC22	14	7

Fig. 28. The display logic drives a four-digit address display, two-digit data display, and four of the five LEDs on the control lines.

meric entries will be sent. Each key depression alternately lights a decimal point in the display corresponding to the destination of subsequent numeric entries (address or data). Actuating this key while a program is running will momentarily reset the CPU, restarting the running program.

SS (Single-Step): Places the PDB in the execute mode and allows the CPU to execute one instruction or one machine cycle (as selected by the instruction cycle switch) each time the key is actuated. A program can be restarted in the single-step mode at memory location 0 by depressing the A/D key followed by the SS key.

P (Program): Depressing this key will burn the contents of the program development memory into an erased EPROM installed in the CPU module. The keypad is disabled until the burn cycle has ended.

EX (Examine): Operates only when the PDB is in the edit mode. It allows the contents of the next sequential memory location (as displayed on the Address display) to be viewed on the Data display.

BANK: Determines which memory bank the CPU will use to obtain its instructions and data when single-stepped or run. Closing the switch will select the EPROM installed in the CPU module; otherwise the PDB's program development memory is selected.

INSTRUCTION CYCLE: Operates in conjunction with the SS key. Closing the switch causes the SS key to operate in the instruction-cycle mode; otherwise it operates in the machine-cycle mode.

SLOW: Also operates in conjunction with the SS key. Closing this switch

Power Connections

	+5V	GND.
IC8, IC10, IC11, IC13,	14	7
IC21, IC22, IC24, IC25	16	8

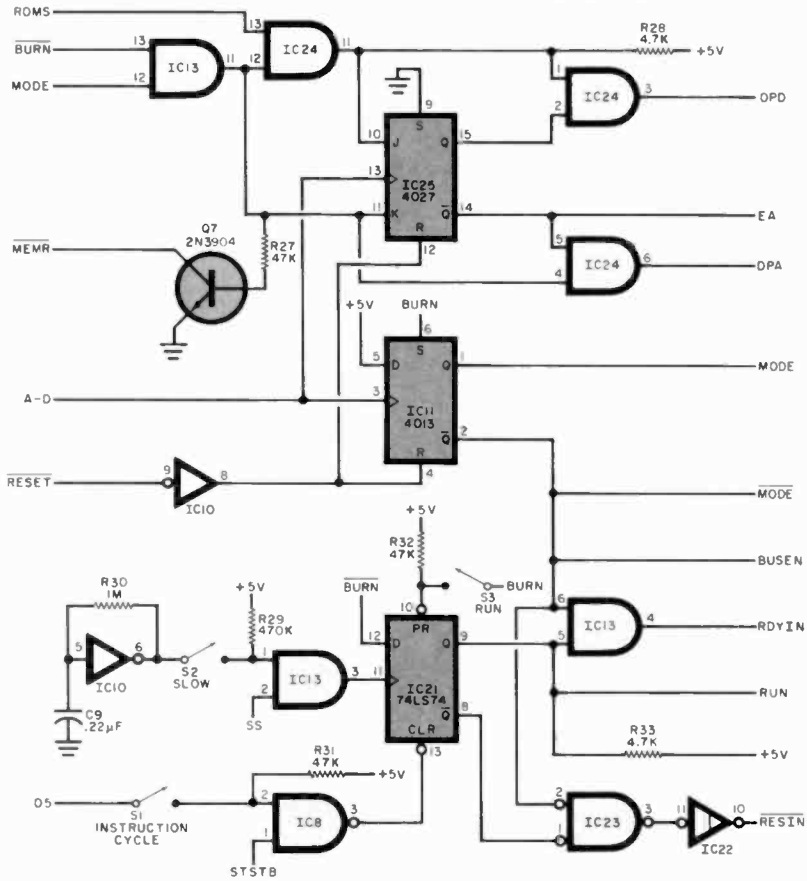


Fig. 29. The CPU can be single-stepped in one of the two selectable modes.

allows execution of instruction or machine cycles at a rate of approximately two cycles per second for the duration of the SS key's depression.

RUN: Places the PDB in the execute mode and allows the CPU to exit the Wait state, so that the program contained in the selected memory bank is executed at full speed (approximately 500,000 machine cycles per second). All keypad functions except A/D are disabled.

ADDRESS DISPLAY: A dual-function display of either the contents of the CPU Address Bus (execute mode) or the address of the addressed location of the program development and scratchpad memory areas (edit mode).

DATA DISPLAY: A dual-function display of either the contents of the CPU Data Bus (execute mode) or that of the addressed location of the program development and scratchpad memory areas (edit mode).

M1: Indicates the CPU is in machine-cycle one of an instruction cycle.

PGM: Indicates the PDB is in the process of burning an EPROM.

INTE: Indicates the CPU signal $\overline{\text{INTE}}$ is active.

The following LED's display the status of the control bus signals:

MR: Indicates the CPU signal $\overline{\text{MEMR}}$ is active.

MW: Indicates the CPU signal $\overline{\text{MEMW}}$ is active.

IOR: Indicates the CPU signal $\overline{\text{I/O R}}$ is active.

IOW: Indicates the CPU signal $\overline{\text{I/O W}}$ is active.

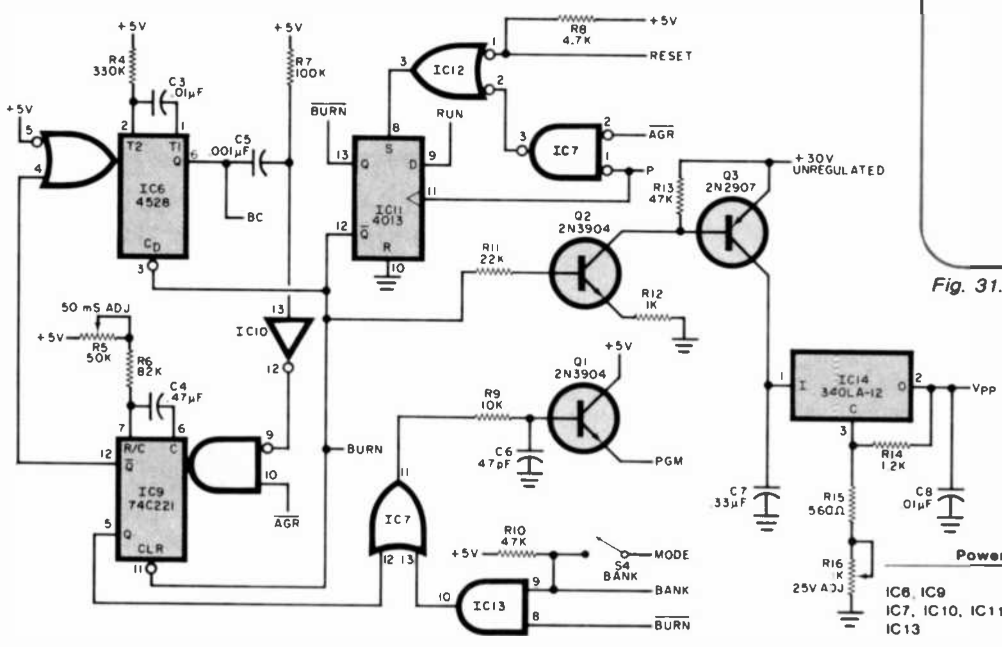
Power Supplies and Adjustments. The PDB can be powered from the CPU module's supplies (*J2*), but an unregulated +30-volt supply is also required for programming an EPROM. The latter supply must be between +28 and +40 volts for the on-board 25-volt regulator to operate properly. Three (preferrably four) fresh 9-volt transistor radio batteries connected in series will give satisfactory operation if you don't want to build a separate ac-powered supply.

Two adjustments must be made on the PDB to ensure proper programming of EPROMs. First remove any EPROM that may be installed in the CPU module and attach the CPU module to the PDB. Apply power to the CPU module and depress the Program key on the PDB. (The unregulated 30-volt supply must be connected to the PDB for this adjustment.) Adjust *R16* on the PDB for +25 volts at pin 13 of *J3* (V_{pp}). (This voltage must lie in the range of +24 to +26 volts or damage to the EPROM could result.)

The second adjustment can be performed with the 30-volt supply disconnected. Depress the Program key while monitoring pin 11 of *J2* (PGM) with an oscilloscope. A low-frequency rectangular waveform should appear. Adjust *R5* so that the positive portions of this waveform are 50 ms ±5 ms in duration. These are the programming pulses to the EPROM which, in conjunction with the 25-volt programming supply, burns each memory location of the EPROM. There are 2048 program pulses during a complete burn cycle (corresponding to

From CPU Module Pin No.	Function	To Interface Pin No.
J1		P1
1	A8	1
2	A9	2
3	A10	3
4	A11	4
5	A12	5
6	A13	6
7	A14	7
8	A15	8
9	A7	9
10	A6	10
11	A5	11
12	A4	12
13	A3	13
14	A2	14
15	A1	15
18	A0	16
J2		P2
1	DB0	1
2	DB1	2
3	DB2	3
4	DB3	4
5	DB4	5
6	DB5	8
7	DB6	7
8	DB7	8
9	$\overline{\text{I/O R}}$	9
10	$\overline{\text{I/O W}}$	10
11	PGM	11
12	GND	12
13	GND	13
14	+12	14
15	+5	15
16	+5	16
J3		P3
1	$\overline{\text{INT}}$	1
2	$\overline{\text{ROMS}}$	2
3	$\overline{\text{INTE}}$	3
4	$\overline{\text{STSTB}}$	4
5	$\overline{\text{RESET}}$	5
6	$\overline{\text{BUSEN}}$	6
7	$\overline{\text{MEMR}}$	7
8	$\overline{\text{MEMW}}$	8
9	INTA	9
10	$\overline{\phi 2\ \text{TTL}}$	10
11	$\overline{\text{RESIN}}$	11
12	RDYIN	12
13	Vpp	13
14	D5	14
15	SPARE	15
16	SPARE	16

Fig. 31. Connections between CPU module and interface from the PDB.



Power Connections

	+5V	GND.
IC6, IC9	16	8
IC7, IC10, IC11, IC12, IC13	14	7

Fig. 30. Schematic of the EPROM programmer.

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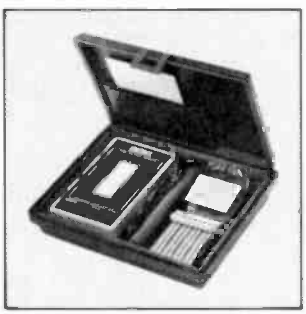

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the 2048 memory locations of the EPROM). The adjustment of *R5* can be made with an EPROM installed if the unregulated 30-volt supply is left disconnected. The EPROM will not be programmed without this supply. (If an oscilloscope is not available, *R5* may be adjusted by setting it to the point such that the time interval between the initial actuation of the Program key and the PGM LED extinguishes is 108 seconds).

Using the PDB. Operation of the PDB is fairly simple once its functions are understood. As an illustration of its use we will load and run the program shown in Table II of last month's installment of this series. This program tests the Morse interface.

Before the program is loaded, the CPU module and Morse interface should be connected to the PDB (*P1, P2, P3* of the CPU module connect to *J1, J2, J3* of the PDB; *P1, P2, P3* of the PDB connect to *J1, J2, J3* of the interface). Set the PDB Run, Instruction Cycle, and Bank switches to off and apply power to the CPU module. The RUN LED of the CPU module should be off, indicating that the CPU is in a Wait state. The PDB should display address 0000 and the contents of this location, which is indeterminant now. The MI and MR LEDs should be lit, indicating that the CPU is in an "instruction fetch" cycle.

To begin loading the program at the first memory address, depress the A/D key twice (the decimal point in the Data display should then light), which places the PDB in the Load Data mode. Subsequent numeric entries will now be deposited in the addressed memory location as an instruction (or data) and displayed in the Data display. Load the first part of the program by entering each instruction machine code with the numeric keys of the keypad. After each byte is deposited in its memory location, depress the Examine key to increment the address to the next sequential memory location (i.e., 3-1-EX, F-F-EX, and so on). After the byte at memory location 0008 has been loaded, it will be necessary to alter the normal sequential loading sequence by entering the subroutine's starting address (A/D, 0-1-0-0) and then continue by loading the subroutine instructions (A/D, 3-E-EX, 4-1-EX, and so on). After the subroutine's RET instruction has been loaded, the program will be ready to be executed.

Begin single-stepping the program by pressing the SS key. The first time this key is depressed the CPU will be reset and the PDB will go into the Execute mode (neither decimal point lit). Fur-

TABLE III
TESTING THE MORSE INTERFACE AND MACHINE CYCLE ILLUSTRATIONS

SS Key Depression Number	Address Display	Data Display	(LEDs ON)	Activity or Action
1	0000	31	M1,MR	The first instruction's op code (31) is being fetched (read) from memory. This is the first machine cycle of the instruction.
2	0001	FF	MR	The first instruction's first operand is being read from memory.
3	0002	0B	MR	The second operand of the first instruction is being read
4	0003	CD	M1,MR	The three bytes of the first instruction were "put together" inside the CPU and executed. The first machine cycle of the Call instruction is entered (fetches the op code).
5	0004	00	MR	First operand is read from memory
6	0005	01	MR	Second operand is read from memory
7	0BFE	00	MW	The CPU is writing the high-order byte of the PC (00) into memory location SP-1 (0BFE)
8	0BFD	06	MW	The CPU is writing the low-order byte of the PC (06) in memory location SP-2 (0BFD). The stack now holds the return address.
9	0100	3E	M1,MR	The second-half of the previous instruction was executed (jump to memory address 0100) The CPU is now in machine cycle one of the first instruction of the subroutine
10	0101	41	MR	The MVI A, 41H instruction's operand is read from memory.
11	0102	F6	M1,MR	The previous instruction was executed; fetching op code of ORI 80H instruction of subroutine.
12	0103	80	MR	Read operand from memory.
13	0104	D3	M1,MR	ORI 80H instruction was executed (accumulator contains $C1_{16}$), enter machine cycle one of output instruction is entered.
14	0105	FC	MR	Read operand (port address) from memory
15	FCFC	C1	IOW	The CPU is writing the contents of the accumulator to port FC (Morse interface) A dc voltmeter would read approximately 4 volts at pin 4 of *IC3* of the interface at this time, which latches the contents of the Data Bus in *IC1* (Fig. 23). The letter "A" should appear at the output device if connected
16	0106	DB	M1,MR	Fetch op code of Input instruction
17	0107	FC	MR	Read port address from memory
18	FCFC	FF/FE	IOR	The CPU is reading port FC A dc voltmeter would read near 0 volt at pin 10 of *IC3* of the interface, which enables the tri-state buffers (*IC4*) Adjust *R1* of the interface, observing the LSB of the Data Bus It should follow the detector, *LED1*.
19	0108	C9	M1,MR	The CPU stored the data placed on the Data Bus from the input interface in the accumulator The last instruction of the subroutine is now being fetched
20	0BFD	06	MR	The CPU is reading the data stored at the memory location specified by the SP (0BFD). This byte will soon be moved into the low-order byte of the PC
21	0BFE	00	MR	The CPU is reading the data stored at memory location SP+1. This byte will go into the high-order byte of the PC The CPU now holds the return address
22	0006	C3	M1,MR	The second-half of the previous instruction was executed (jump to memory address 0006) The CPU is fetching the Jump instruction's op code.
23	0007	03	MR	Read low-order bits of Jump address
24	0008	00	MR	Read hi-order bits of Jump address
25	0003	CD	M1,MR	And we're back to start again'

ther actuations of the SS key will allow the CPU to execute one machine cycle each time the key is depressed. (*Machine cycles* are small units of processing activity which comprise each instruction cycle. Every instruction cycle consists of one to five machine cycles, depending on the type of instruction involved. A machine cycle is required each time an instruction requires the CPU to access memory or an I/O port). Table III follows the program's execution one machine cycle at a time using the PDB displays to monitor the CPU's activities (refer to the program listing and the individual instruction descriptions as necessary). Remember that the Address and Data displays are monitoring the CPU's Address and Data busses, respectively.

After single-stepping through the program once, examine memory locations 0BFD and 0BFE, noting their contents. This is where the CALL instruction stored its return address. One may load different codes at memory location 0101 to view the different characters that can be displayed on the Morse interface display (Fig. 24). Note also how the PDB single-step mode can be used to troubleshoot an interface.

To burn this program into an EPROM for permanent storage, an erased EPROM must be installed at *IC5* in the CPU module and the unregulated 30-volt supply connected to the PDB. Pressing the Program key will then completely program the EPROM in a little less than two minutes.

After programming an EPROM it is wise to verify its contents by selecting it for a "test run" by the CPU (Bank and Run switches closed). The content of the program development memory is left intact after a burn cycle, making it possible to repeat the burn if necessary. If an EPROM won't verify properly after it is programmed (the program contained in it will not run properly), it is possible that it was not fully erased to start with. Re-erase and try again, or try another EPROM.

Once it has been determined that an EPROM contains valid information, a small piece of electrical tape or other opaque material should be placed over its transparent window to keep out ambient light. Sunlight and some types of artificial light can cause the EPROM's data to slowly decay and eventually become erased.

This series of articles has laid a foundation for one to design an interface and write his own machine-language programs for the popular 8080 family of microprocessors. What is built on this foundation is solely up to one's imagination and ingenuity. ◇

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Popular Electronics Tests

Two Albia Instrument Modules

USING the ubiquitous digital multimeter as the central section of a test instrument system is a fine way to reduce costs. One need only add the proper external circuits to get a brand new measurement facility, reading off the numbers on your existing DMM. The same holds true for an oscilloscope. Here are two add-on modules that can be used in just that way with your DMM. From Albia Electronics, the Low-Ohm Meter and Scope Multiplexer will truly expand the utility of your existing instruments at low cost.

THE Albia DM-10 Low-Ohm Meter, is designed to work with a conventional 3½-digit voltmeter to make resistance measurements between 10 milliohms and 20 ohms in three ranges. Accuracy is ±3% of the reading, ±1 digit, plus the voltmeter error. The battery powered unit is 6¼"W x 2"H x 3¾"D and it weighs one pound. Suggested retail price is $63.

General Description. The ZERO CAL and three-position RANGE controls, along with the PUSH TO MEASURE pushbutton, and the DVM and RX binding posts are mounted on the top cover. Before operation, a 9-volt battery must be installed.

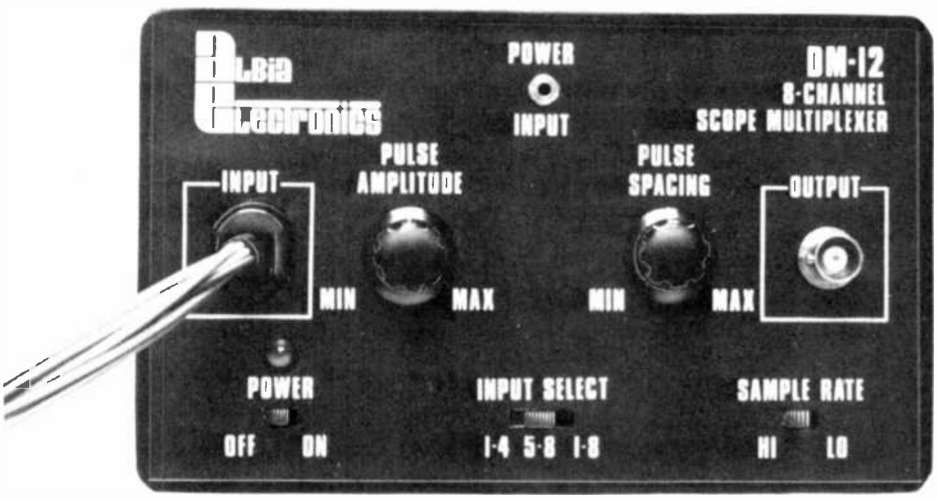
The RANGE switch selects from 0.2-, 2.0- or 20-ohm ranges while the ZERO CAL allows zeroing the DMM readout either at the RX binding posts, or at the end of the cables used to make the measurement. A pair of binding post test clips are provided for measuring physical resistors.

Comments. At first it would appear that a requirement to measure very low resistances would be a rarity. Actually, it is a long-standing requirement, but we never did anything about it since our resistance-measuring instruments never really gave us a good indication at these very low values. Now, with the DM-10 we can check the slender foil patterns on a pc board (or interconnecting wiring) to make sure that they really are almost zero resistance instead of an appreciable part of an ohm, which could cause circuit interaction. It also allows us to check the relatively low resistance of vehicle and boat grounding systems to make sure that they are within their prescribed limits. On the bench, we can now make sure that the low-resistance winding of a coil, transformer, or relay is not a short circuit, as a standard meter will indicate, but does have some resistance. Since we do have a decent DMM, it is the 0.2- and 2-ohm ranges of the DM-10 that get the most use.

True, we do not use the DM-10 very often, but when we do, it has been a lifesaver in removing low-resistance doubt.

DM-10 Low-Ohm Meter

THE second Albia module, DM-12 8-Channel Scope Multiplexer was designed to enable a digital-circuit designer or troubleshooter to use a conventional single-trace scope to observe the timing between eight time-related digital signals as an aid to troubleshooting. The instrument can also be used by an instructor to display the operation of a digital circuit. The device is 3¾"D x 2"H x 6¾"W and it weighs one pound. Suggested retail price is $63.



DM-12 8-Channel Scope Multiplexer

General Description. All controls, selector switches, power, and input/output connections are made via the top cover. Power is applied from a wall-mounted dc source, cable-connected to the POWER INPUT jack. Dc-coupled signal connections to the eight external circuits are made via color-coded 24-inch long lengths of insulated lead, terminated with insulated alligator clips. A separate signal ground lead is also provided. Connection to the scope is made via a BNC connector labeled OUTPUT.

The PULSE AMPLITUDE control determines the height of the signal being displayed, while the CHANNEL SPACING control, as its name implies, sets the spacing between the selected number of traces. The INPUT SELECT switch enables the user to select all eight traces for display, or just the upper or lower four. In the event that the signal being displayed is harmonically related to the internal chopping rate, thus producing a blurred display, a SAMPLE RATE switch has been included to change the sample (chop) rate to clear the observed display.

The input threshold for all channels is TTL with 2.4 volts a logic 1, 0.7 volt a logic 0, and with 5.5 volts the maximum signal input. Input circuit loading is one low-power Schottky TTL load, minimum pulse width is 150-ns, and the maximum input frequency is 3 MHz.

Comments. We connected the DM-12 to one channel of our dual-trace scope, and several of the eight input connectors to a digital circuit we had operating on the bench. When the DM-12 is powered up, and the INPUT SELECT switch is set to the 1-8 position, all eight traces are displayed, including the signals being monitored. The scope was externally synchonized from the slowest digital waveform under observation. The scope vertical input and the DM-12 CHANNEL SPACING were adjusted for a full-screen display. The PULSE AMPLITUDE control was adjusted to set the displayed digital signals to the desired height.

Using the DM-12, it is easy to observe the timing of up to eight digital signals; and, if desired, the INPUT SELECT switch can be operated to examine either the top or bottom four sets of waveforms. We found that clean trace activity occurred at a signal amplitude of about 1.5 volts. Overloading, which causes all the traces to blur, occurred at about 4 volts input. There was a faint "ghosting" visible when the signal amplitude reached about 1.75 volts, but this was not bad enough to disturb the observation. The DM-12 cannot be used for analog signal observation, as any signal reaching threshold is automatically squared off. There was some vertical nonlinearity in the channel spacing as its control was varied, but this occurred only at the extremes of this control.

If you do any digital troubleshooting, there is no question that the DM-12 is superior to a simple LED-type logic probe. The mere presence of a signal at a given point does not necessarily mean that a circuit will function properly. It is the *combination* of the signal and its timing with respect to other signals in the circuit that makes the circuit operate properly. It is in this coverage that the DM-12 is superior to a logic probe.

After using the DM-12 for a while, we made some slight mechanical changes to assist in its use. We removed the relatively cumbersome insulated alligator clips from the signal input leads, and replaced them with plastic-covered mini-clip connectors. This made attachment to IC leads, and other tight points on a crowded pc board much easier. We then used IC clamp-on connectors to ease lead connections to an IC. Other than this modification, the tester is exactly as it came from the factory.

If you are doing any practical digital work, take a look at the DM-12. You'll discover how easy it is to check out a digital circuit when you can watch the complete operation at one time.

—*Les Solomon*

CIRCLE NO. 104 ON FREE INFORMATION CARD

COMPUTER SOURCES

By Leslie Solomon
Senior Technical Editor

Hardware

Hand-Held Computer. The Panasonic Hand-Held Computer (HHC), measuring $8\frac{5}{16}''$ by $1\frac{3}{16}''$ by $3\frac{3}{4}''$ with a 159 by 8-dot, 26-character line LCD display looks like an advanced calculator—but it isn't. Instead, the HHC contains a 6502 CPU, up to 4K of internal RAM, and a 48K operating system in ROM. It is equipped with a 65-key board with a 2-key rollover and redefinition of all keys, an internal real-time clock accurate to $\frac{1}{256}$ second, and a 44-pin bus connector for external peripherals. A warning beeper signals loose connections.

With the appropriate ROM modules plugged in, BASIC or other high-level languages can be used. The operating system, called Snap, is derived from Forth. The internal memory can be expanded externally using bus-connecting modules with up to six 8K RAM modules attached at the same time. Special circuitry keeps the RAM up, even when the system is turned off, and the CPU is shut down when not actually being used. Power is from an internal set of NiCad cells. The 2K version (RL-H1000) is $500, the 4K (RL-H1400) is $600, with the AC Adapter/Charger (RD-9498) at $58.

Among the peripherals are a thermal printer at 15 characters per line, an RS-232 I/O port that allows communication with other devices (RL-P3001 at $254), an acoustic modem (RL-P4001 at $285), a video/r-f adapter that connects to a baseband video monitor or a TV receiver antenna and allows display of 16 lines of 32 characters, or up to 48 by 64 picture element graphics in 8 colors and black (RL-P2001 at $349), and an I/O Adapter for multiperipherals (RL-P6001 at $158). A 4K RAM (RL-P9001) is $221, with an 8K RAM

The Panasonic Hand-Held Computer is $8\frac{5}{16}$ inches wide.

block (RL-P9002) at $330. An attache case and various cables are available.

Initially, 8K Microsoft BASIC, 16K Level II BASIC, and the Snap operating system are provided in plug-in ROM. However, a number of application programs are available including a word processor. When the upcoming disk system is plugged in, an internal (to the

disk) Z-80 CPU allows the system to work with CP/M, thus opening the door to a wide range of software.

The 14-ounce HHC can be disconnected from the system at any time and used as a stand-alone portable computer. When the complete system is packaged within its attache case, it will be known as The Link. The system is of the "mix and match" variety, with any arrangement of peripherals attached.

TRS-80/16 Telephones. The Communications Multiplexer allows a TRS-80 Model II to respond to 16 telephone lines at once. This enables use as a host computer in private Videotex information retrieval networks, allowing communications with a number of Videotex-type text terminals simultaneously for easy access to virtually any data base. The 8-line version is $6000, and the 16-line version is $8000. **Address:** Radio Shack Special Marketing, 1600 One Tandy Center, Ft. Worth, TX 76102.

Apple Lower Case. The Lower Case Generator produces the full 96 ASCII characters with true descenders. Installation requires no soldering. Apples prior to revision 7 use the Form 1, while revision 7 and newer use Form 2. $49.95. **Address**: Great Lakes Digital Resources, Box 32133, Detroit, MI 48232 (Tel: 313-538-7963).

Talking Board. The Electric Mouth, designed for the Apple II, TRS-80 Level II, S100 bus, and ELF II uses the National Semiconductor Digitalker chip containing 143 commonly used words/phrases/phonemes/numbers that can be mixed-and-matched to produce a considerable vocal library. Each board is expandable as more speech chips are made available. Programming is in machine language or BASIC and is extremely simple. S100/ELF II is $99.95;

Apple/TRS-80 is $119.95; VOX II (second word set) is $39.95. **Address:** Netronics R&D Ltd., 333 Litchfield Rd., New Milford, CT 06776 (Tel: 800-243-7428. Connecticut number is 203-354-9375).

SS-50 Disks. The MFD disk system for the AIM-65, KIM, and SYM computers are available in 40- and 80-track versions in both conventional and flippy versions, and 1-,2-, and 3-drive units. It includes a disk controller card, DOS, cable, and manual. Two controllers are available, one for the AIM-65 and one for System 50. The firm also makes an adapter (M-65-50) to interface these computers to the Percom System-50 (SS-50) motherboard. **Address:** Percom Data Co., 211 N. Kirby, Garland, TX 75042 (Tel: 214-272-3421).

Software

Text Formatter. WORD-C1 is a text processing program that accepts lines of text interspersed with lines of format control information and formats the text into a document. It also merges a text file with elements of a data file or mailing list, allows the date to be automatically inserted, has user-specified constants such as name and address, will send control characters to the printer, is compatible with text files prepared by the CP/M ED, and the system configuration can be set by on-line commands. $85. Requires CP/M 2.2, and 60K RAM. **Address:** Micro Architect Inc., 96 Dothan St., Arlington, MA 02174.

Xerox 820 Software. An extensive selection of software for this machine is now available. Of special interest are Microspell, a spelling corrector; Postmaster, a flexible mail management and form letter program; Plink II, a linkage editor; and languages such as CBASIC, C Compiler, and advanced data management systems. **Address**: Lifeboat Associates, 1651 3rd Ave., New York, NY 10028 (Tel: 212-860-0300).

Circuit Analysis. The Electronics AC and DC Circuit Analysis Programs computes solutions to ac and dc circuits with resistors, capacitors, inductors, current sources, voltage sources, and controlled sources. The ac program has step function and oscilloscope-like graphics. For TRS-80 Model I, 16K Level. $17.94. **Address**. Computer Heroes, 1961 Dunn Rd., East Liverpool, OH 43920 (Tel: 216-385-4570).

CP/M Utility. The DMM-1 Utility software diskette features the XDIR that displays directory file names in alphabetic order and shows file size. A disk usage summary is provided. It also reports the number of available file names and space. The EXTRACT program lists a portion of a file with two label names, STRIP will remove the hex code from a PRN file and turn it into an ASM file, SORT will create a symbol table from an assembly done with ASM so that it can be listed with SID. CONVERT changes all uncommented lowercase characters to upper case, while STATUS provides information on the current operating system such as memory available, TPA size, top of memory address, I/O assignments, etc. Single density 5¼" or 8" diskettes. $35 plus $1.50 shipping/handling. **Address**: Elliam Associates, 24000 Bessemer St., Woodland Hills, CA 93167 (Tel: 213-348-4278).

H8 BASEX. The BASEX compiler for the Heath H-8 system runs 10 times faster than similar BASIC programs and overhead is only 2K bytes for the execution routines. It includes a custom console driver, and commands to save and load on tape. The cassette is 1200 baud. Manual and cassette is $33. Manual alone is $8. It is also available for the TRS-80 Level II, Sorcerer, SOL, Poly 88, and Meca Alpha systems. It also comes on 5" North Star and 8" single-density CP/M. **Address**: Interactive Microware Inc., Box 771, State College, PA 16801 (Tel: 814-238-8294).

6800/6809 Utilities. Super Sleuth operates with 6800/6809 systems and disassembles programs in a form suitable for changes and reassembly. Object and source code are provided. $149 for 5" and $150 for 8" diskette. Debug-68 and Debug-69 provide software emulation for the 6800 or 6809. A wide range of options are available to permit fast debugging of any assembly language program. In object code only. $149 for 5", $150 for 8". **Address**: Smoke Signal broadcasting, 31336 Via Colinas, Westlake Village, CA 91362 (Tel: 213-889-9340).

Model III SuperScript. This software enables the TRS-80 Model III to use SuperScript which features Directory and Kill files without losing text; pause while printing and insert text from the keyboard; serial drivers using the ETX/ACK protocol for 1200 baud communications; drivers for the NEC5510, NEC5530, Daisy Wheel II, Lineprinter IV (Centronics 737), Epson MX80, and Diablo printers; custom serial/parallel drivers; and depending on the printer, superscript, subscript, underline, boldface, select 10/12 pitch, and slash zeroes. You can also enter a number of special characters (brackets, braces, carets, etc.). Works with TRS-80 Model I or III, 32K, one or more disk drives, lowercase modification, and Model I Scripsit. $50 plus $2 postage and handling. **Address**: Acorn Software Products, Inc., 634 North Carolina Ave., S.E., Washington, DC 20003 (Tel: 202-544-4259). ◇

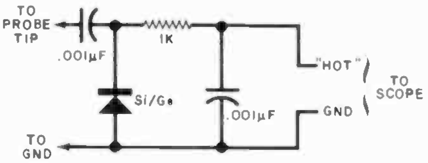
HOBBY SCENE

By Leslie Solomon
Senior Technical Editor

Scope Demodulator

Q. *My oscilloscope will not respond at the frequency of my transmitter. Can you show me a simple probe that will allow me to see the modulation of the rig? I want to see when I start clipping, or if I am not modulating high enough.—Charles Pen, Mendicino, CA*

A. Although commercial demodulator probes are inexpensive, this circuit will work, when closely coupled to the r-f

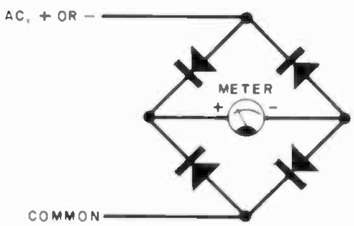


output of the transmitter. Do not make a direct connection to the transmitter antenna, but use the probe tip as a short antenna.

Universal DC Meter

Q. *I have an old, but good, analog multimeter that I use for servicing appliances. Sometimes I measure ac and sometimes dc, but when measuring dc, I usually have to exchange the leads to avoid meter needle damage. I understand that I can use a bridge to enable the analog meter to measure ac and either polarity dc without changing the leads. Can you show me the circuit?—Alf Meek, Toledo, OH*

A. The circuit you requested is shown below. It will enable your analog meter to measure ac and dc of either polarity as you desire, without moving the leads.



Keep in mind that the silicon diodes used in the bridge have a small voltage drop, so do not make exacting measurements unless you also introduce the missing voltage.

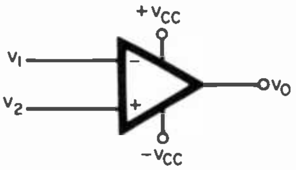
Have a problem or question in circuitry, components, parts availability, etc? Send it to the Hobby Scene Editor, POPULAR ELECTRONICS, One Park Ave., New York, N.Y. 10016. Though all letters can't be answered individually, those with wide interest will be published.

FUNDAMENTAL FACTS

By Walter Buchsbaum

Operational Amplifier Fundamentals

THE op amp is basically a high-gain amplifier with negative feedback. Reduced gain, increased bandwidth, improved stability and a variety of different amplifier functions are made possible by proper choice of the feedback element. Figure 1 shows the basic op amp connections and the gain (G_1,G_2) relationship of input and output voltages.



$V_o = G_1V_1 + G_2V_2$
Ideal: $G_1 = -G_2$

Fig. 1. These are the standard basic connections for an op amp.

Op Amp Parameters.

Open-Loop Gain. Usually stated at dc or as graph of gain versus frequency.

Input Impedance. Accurately stated as parallel RC network, it is often stated as resistance only.

Input Offset Voltage. The ratio of output error and theoretical gain at a fixed feedback resistance. Can often be reduced to zero by adjustment of a trimming potentiometer.

Common-Mode Rejection Ratio (CMRR). Measures op amp's rejection of signals common to both inputs. The ratio is expressed as V_c/V_o. (Fig. 2.)

Bias Current. The current from an infinite source impedance that will drive the output to zero.

Difference Current. The difference in bias current between the op amp's two input terminals.

Full Power Response. Sine-wave output at maximum frequency, unity gain and specified distortion into the rated output load.

Settling Time. Period from step voltage input until output reaches specified error range of its final value.

Slew Rate. The maximum rate of change of the output voltage in response to a step input, usually given as volts per microsecond.

Basic Op Amp Circuits. Five of the most elementary applications of op amps are shown in Fig. 3.

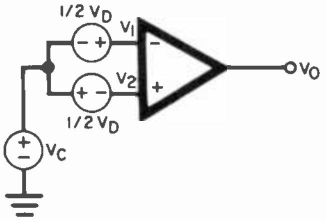
Inverting Op Amp. Provides an output directly related to the ratio of the input and feedback resistor. Output is inverse of input.

Noninverting Op Amp. Polarity of input and output are the same, but amplitude is not a simple resistance ratio.

Voltage Follower. Basically used for impedance transformation, with unity gain.

Summing Op Amp. Utilizes the high-impedance input to connect several signals together with very low current.

Integrator. Uses frequency dependent feedback elements. Although a single capacitor is shown, more complex RC networks can be used to provide specific characteristics. By cascading such op amps it is possible to implement various functions, including inductance effects and active filters.



Nonideal: $G_1 \neq -G_2$
Therefore $V_D = V_1 - V_2$ = Difference V
$V_C = \frac{1}{2}(V_1 + V_2)$ = Common-Mode V
G_D = Gain when $V_C = 0$
G_C = Gain when $V_D = 0$
$V_o = G_DV_D + G_CV_C$

Fig. 2. Illustrated here are the basic op amp input parameters.

Practical Op Amp Applications. The inverting op amp of Fig. 3A is used when we want a stable amplifier with fixed gain, such as that used to indicate remote temperature from a kiln described in the November 1981 issue of POPULAR ELECTRONICS.

A good example of the utilization of the voltage follower of Fig. 3C was illus-

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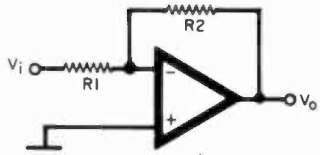
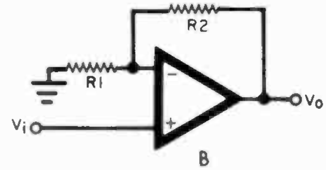
trated in the same issue on page 48, where a simple RC network at the input to the op amp resulted in a first-order active filter, used for bass boosting.



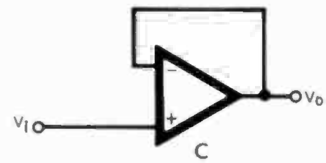
A

$V_o = (-R_2/R_1)V_i$



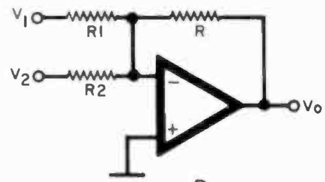
B

$V_o = [(R_1 + R_2)/R_1]V_i$



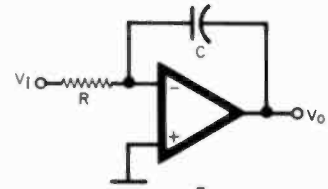
C

$V_o = V_i$



D

$V_o = -(RV_1/R_1 + RV_2/R_2)$



E

$V_o = -(1/RC)\int_0^t V_i dt$

Fig. 3. Op amp applications: (A) Inverting; (B) Noninverting; (C) Voltage follower; (D) Summing; (E) Integrator.

The voltage summing circuit of Fig. 3D can be used in audio mixing applications, as described in the December 1981 issue in "Experimenter's Corner." Here the two potentiometers of a joystick are the two series input resistors to the inverting op amp, mixing two audio signals.

Op amp integrator circuits are used in all types of analog-to-digital converters where they generate the ramp which converts voltage into an analogous time period. ◇

SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

The New Power FETs

JUST as CMOS integrated circuit technology is making major inroads into traditional TTL territory, a new generation of superior field-effect transistors (FETs) is beginning to replace conventional bipolar (pnp and npn) transistors in many applications. It's important to understand the operation of these new power FETs because they are turning up in many new power supplies and switching circuits. A FET may even solve some of your own circuit design problems.

The new power FETs are collectively known as VMOS devices, a name whose origin is somewhat confusing and requires an explanation. MOS, of course, means metal-oxide-semiconductor (or silicon) and refers to the mechanical structure of a FET having an insulated gate.

Thanks to the silicon dioxide film between the gate electrode and the device's silicon channel, MOS field-effect transistors or MOSFETs have a much higher input impedance than junction FETs and bipolar transistors. The vulnerability of the gate's thin insulating film to damage from static electricity is the chief drawback to MOSFET technology.

The V in VMOS originally referred to vertical-groove MOS technology, an integrated circuit structure pioneered several years ago by American Microsystems, Inc. In this process V-shaped grooves reduce the size of transistors and permit higher component packing densities than the conventional flat, two-dimensional approach. The V-grooves are etched into the silicon, and aluminum gate electrodes are deposited on their walls. A VMOS transistor therefore requires less chip area than a conventional MOS transistor having the same gate area.

Though the VMOS process was originally intended to provide integrated memory chips with high component densities, it was soon learned that the technology is well suited for power applications. This is because the VMOS geometry gives faster switching speeds and much lower channel resistance than conventional MOSFETs.

These advantages are related to the stacked arrangement of the source, gate and drain and not the presence of the V-groove. In conventional MOSFETs, the current flow is lateral (across the silicon) while in VMOS structures, the flow is vertical (through the silicon). The vertical configuration provides a much shorter current path, hence switching speed is much faster. The vertical arrangement also simplifies heat sinking since the bottom of the chip doubles as the device's drain.

The advantages provided by the vertical geometry of the VMOS structure soon led to the development of vertical-structure MOS transistors without a V-groove. These transistors were also dubbed VMOS devices, hence the confusion over the name VMOS.

Now that the nomenclature is behind us, let's compare the various MOS and VMOS structures more closely. Then we'll look at a few VMOS circuits.

Comparing VMOS Structures. Figure 1 shows the construction of a standard MOSFET transistor. Note how the source-to-drain current flows laterally through the transistor. The length of the channel region between the source and drain is responsible for the relatively high *on* resistance of this structure. The fact that all the contact electrodes are on one side of the chip imposes design constraints and restricts maximum power capability due to the difficulty of extracting heat generated in the chip.

Figure 2 shows the construction of a basic VMOS transistor. As in a standard MOS transistor, current flows through the p-type channel region when a voltage is placed on the insulated gate electrode. The silicon dioxide layer between the metal gate electrode and the p-type region acts as the insulator.

The V-groove can introduce both mechanical and electrical stresses which

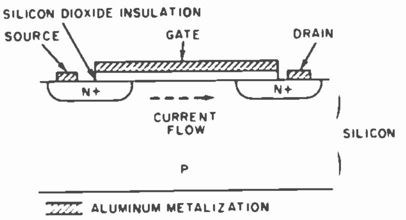


Fig. 1. Geometry of a conventional MOSFET.

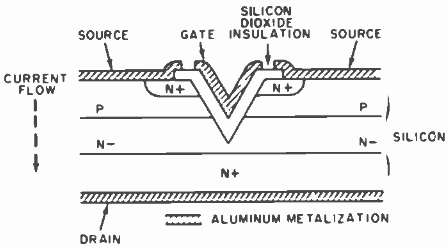


Fig. 2. Geometry of the VMOSFET.

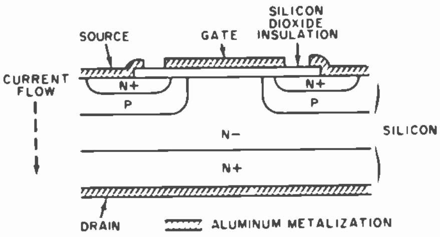


Fig. 3. Geometry of the DMOSFET.

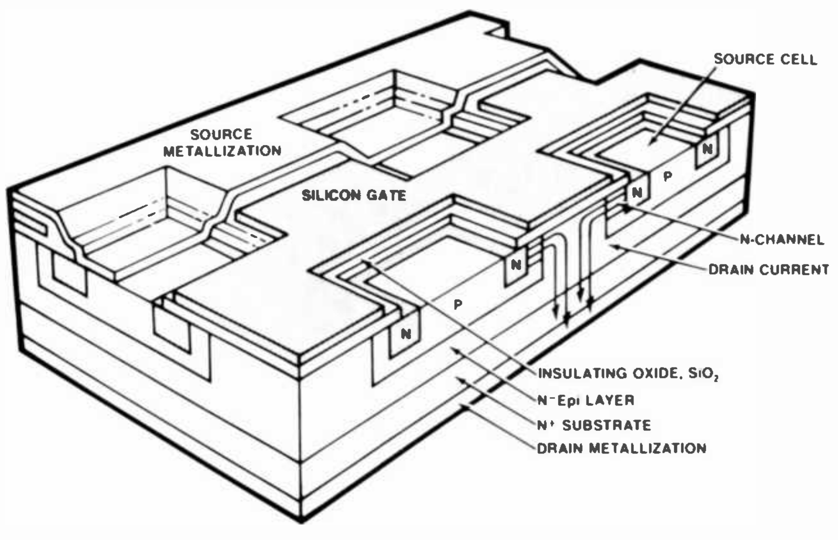


Fig. 4. A detailed pictorial view of Motorola's TMOSFET transistor cell structure.

limit the power handling capability of VMOS transistors. An alternative is to eliminate the V-groove as we observed earlier and utilize the structure shown in Fig. 3. The latter is sometimes called DMOS after *double-diffused* MOS. In both DMOS and VMOS, the current flows vertically through the transistor from source to drain.

To achieve high power capability, many VMOS or DMOS cell patterns are formed on a single chip. International Rectifier has introduced a series of DMOS transistors having hexagonal cells which it calls the HEXFET. Motorola DMOS transistors have square cells and are called TMOS devices. Siemens also makes a series of square-celled DMOS transistors which it has designated SIPMOS. Many other variations of the VMOS/DMOS structure have been introduced by other companies, but all rely upon vertical current conduction through the transistor.

Figure 4 is a pictorial view of Motorola's TMOS power MOSFET. Note the arrows denoting the direction of current flow which give rise to the TMOS label. The four cells shown in the figure are replicated many times across the surface of the chip to provide hundreds of parallel DMOS cells. The actual cell count may exceed 100,000 per square inch!

Figure 5 is a microphotograph of the surface of a TMOS transistor chip revealing a pattern of hundreds of individual DMOS cells. The large size of the chip explains its high power capability. The square regions on either side of the chip are the gate and source contacts. The chip's substrate is the drain. The chip is shown on a header in Fig. 6.

Advantages and Disadvantages of VMOS/DMOS. It is important to understand the relative advantages and disadvantages of the new generation of vertical-current MOS transistors. Here are some of the advantages:

1. Their high input impedance and

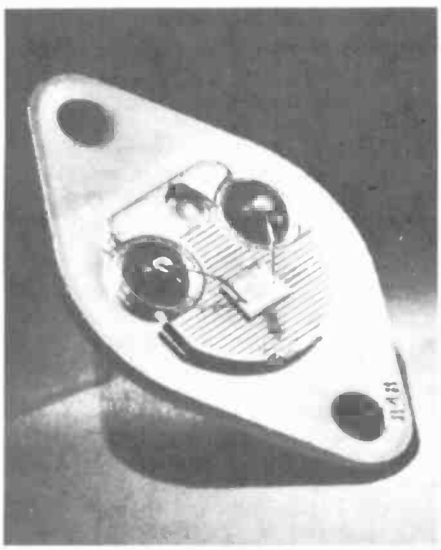


Fig. 6. The TMOS chip atop the metal header. (Motorola)

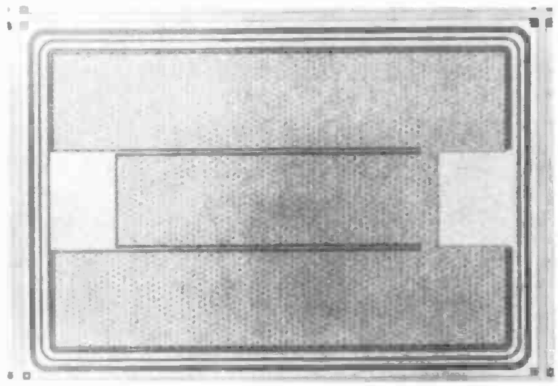


Fig. 5. A photomicrograph of Motorola's TMOS transistor chip.

low voltage drive requirements make VMOS/DMOS transistors easy to drive and interface.

2. The *"on"* resistance can be as little as a few tenths of an ohm.

3. Nanosecond switching speeds are possible.

4. Since drain current decreases as chip temperature rises, they are more thermally stable than bipolar transistors.

5. They can be connected in parallel without special design procedures or constraints.

6. Up to hundreds of volts and tens of amperes may be safely switched.

7. They may be operated as both switches and linear amplifiers.

VMOS/DMOS transistors have two principal drawbacks:

1. They require special handling due to their susceptibility to electrostatic discharge.

2. They require more processing steps than other power transistors and, therefore, are more expensive.

Some Simple Circuits. Figure 7 shows an ultra-simple lamp dimmer designed around a Siliconix VN67 VMOS transistor. *R2* controls the voltage on the gate of the VN67. This permits the VMOS FET to be operated over a range of full off to full on, thus providing a linear light dimmer controlled by a single potentiometer. For best results, V_{DD} should be from 6 to 12 volts.

The circuit in Fig. 7 works well, but is inefficient because the VMOS transistor

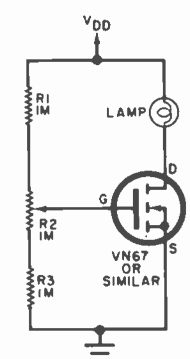


Fig. 7. A simple, straightforward linear lamp dimmer circuit.

dissipates considerable power even when the lamp is dimmed. An alternative approach is to drive the lamp with variable width pulses from a simple CMOS 7555 oscillator as in Fig. 8.

In operation, the 7555 switches the VN67 full on and full off. When the switching rate exceeds several tens of hertz, the lamp appears to be on continuously to the human eye. By varying the pulse rate, and thus the width, the lamp may be dimmed or brightened.

The circuit can be controlled by adjusting *R1* or *C1* or both *R1* and *C1*. Note how the VN67 is connected directly to the 7555 output pin with no coupling capacitor or pullup resistor. This illustrates the simplicity of driving a VMOS transistor.

Figure 9 shows an ultra-simple lamp

flasher designed around a VN67 and a two-gate CMOS oscillator. The enable input to the oscillator permits the flash-

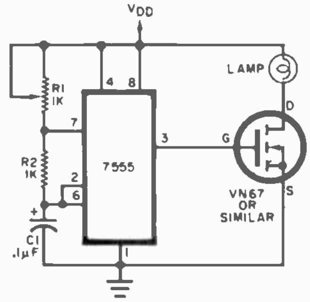


Fig. 8. Schematic of a VMOS light dimmer circuit.

er to be started or stopped by a logic signal or a mechanical switch.

The pulse rate is controlled by *R1* and *C1*. For a very slow on-off cycle, increase *C1* to 10 or more microfarads. V_{DD} should be from 6 to 12 volts. As in the previous circuit, this application also demonstrates the ease of interfacing a VMOS transistor to a CMOS gate.

Other Applications for VMOS. The three circuits presented here are merely representative of what can be done with VMOS transistors. Many other applications are possible, and I plan to present additional ones in a future "Experimenter's Corner." If you wish to experiment on your own, most VMOS manufacturers publish application notes that will help get you started. A good book on

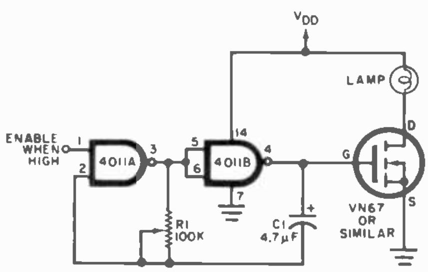


Fig. 9. Pulse-modulated light flasher circuit.

the subject has been written by Robert Stone and Howard Berlin. It's called *Design of VMOS Circuits with Experiments* (Howard W. Sams, Inc., 1980).

Several of the major VMOS/DMOS power transistor makers are mentioned in this column. Obtaining actual transistors, however, may pose somewhat of a problem unless you can find an electronics distributor willing to order them for you.

I have obtained VN67's and VN10's, two Siliconix VMOS power transistors, from Radio Shack. It seems that sales of these devices are relatively low, apparently due to a lack of published circuits suitable for experimenters. This situation should eventually change as more circuit designers and hobbyists discover the impressive advantages of VMOS/DMOS power FETs. ◊

EXPERIMENTER'S CORNER

By Forrest M. Mims

A Pulse-Frequency Modulated Infrared Communicator

IF you've ever built and operated an amplitude-modulated lightwave communicator, you were probably impressed with both the simplicity and high-quality sound transmission of the system. Several such projects have appeared in POPULAR ELECTRONICS since 1970.

This magazine's first voice-modulated laser communicator was described by C. Harry Knowles in a May 1970 cover story. Harry's breakthrough project used a low-power helium-neon laser he offered for a bargain price of only $50.50 postpaid! Harry's company, Metrologic Instruments, Inc. (143 Harding Ave., Bellmawr, NJ 08031) has since become a leading manufacturer of HeNe lasers and related products.

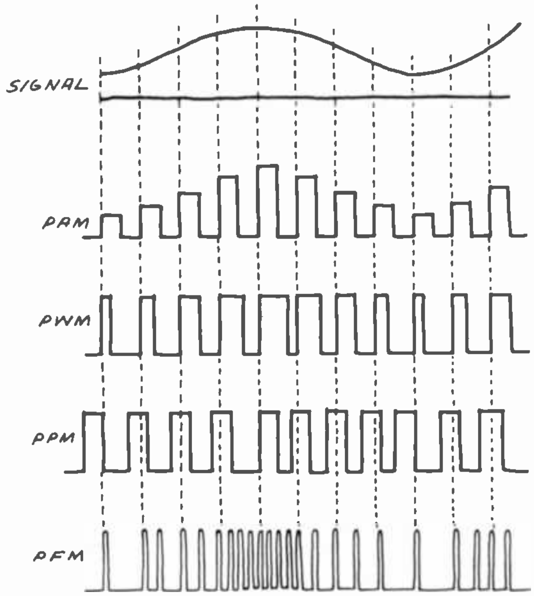


Fig. 1. Waveforms of pulse-modulation techniques.

The first infrared LED communicator described in POPULAR ELECTRONICS also made the cover. The system was called the Opticom, and it was designed primarily by H. Edward Roberts and described by Ed and me in the November 1970 issue. Incidentally, a kit version of the Opticom was one of the first products offered by MITS, Inc., the company that introduced the ALTAIR 8800 microcomputer (and the S-100 bus) in 1975.

This column has described many amplitude-modulated LED communicators over the years. See, for example, the April, May and June 1980 installments. Also see the May 1980 "Project of the Month." (Try your library if you don't happen to have these back issues.)

Amplitude modulation is ideal for ultra-simple lightwave links through either fibers or free space. In free-space systems, however, amplitude modulation is susceptible to noise from both artificial and natural light sources. Furthermore, the transmission range controls the volume of the receiver's audio output unless some form of automatic gain control is provided. Finally, the average power consumption of an amplitude-modulated system is high since the LED or injection laser source is continuously biased.

All these objections can be overcome by selecting one of the various forms of pulse or digital modulation. Though pulse modulation requires more complex transmitter and receiver circuitry than amplitude modulation, its advantages are significant. They include a very high degree of noise immunity, low average power and duty cycle of the optical source and simplified multiplexing.

Pulse Modulation Methods. There are several major pulse-modulation methods suitable for lightwave communications (Fig. 1). Here is a brief description of each method:

Pulse-Amplitude Modulation (PAM). In this modulation scheme the amplitude of the pulses is directly proportional to the amplitude of the modulating signal. PAM is closely related to amplitude modulation in that PAM can be achieved by simply sampling, at a uniform interval, brief segments of an analog signal. An obvious application of PAM is in the transmission of two or more signals over a single light-wave channel.

Pulse-Width Modulation (PWM). This is also known as pulse-duration modulation (PDM). The duration of individual pulses within a pulse train is made proportional to the amplitude of the modulating signal.

Pulse-Position Modulation (PPM). Here the amplitude of the input signal controls the relative position of individual pulses in a pulse stream. Unlike PAM and PWM, *all* the pulses in PPM have precisely the same amplitude and duration. This means the PPM receiver can be optimized for the processing of identically shaped pulses. This gives a higher degree of noise immunity than that provided by PWM and

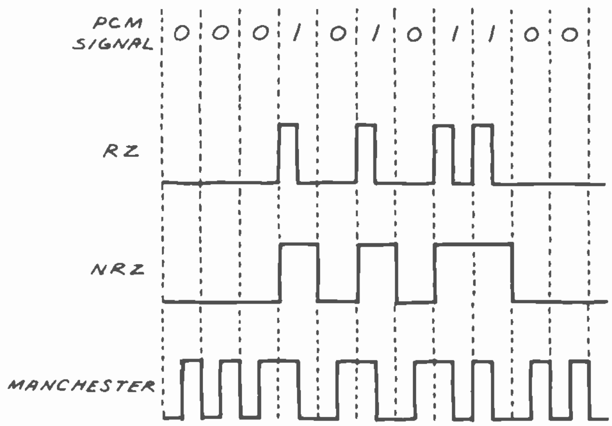


Fig. 2. Three pulse-code modulation formats.

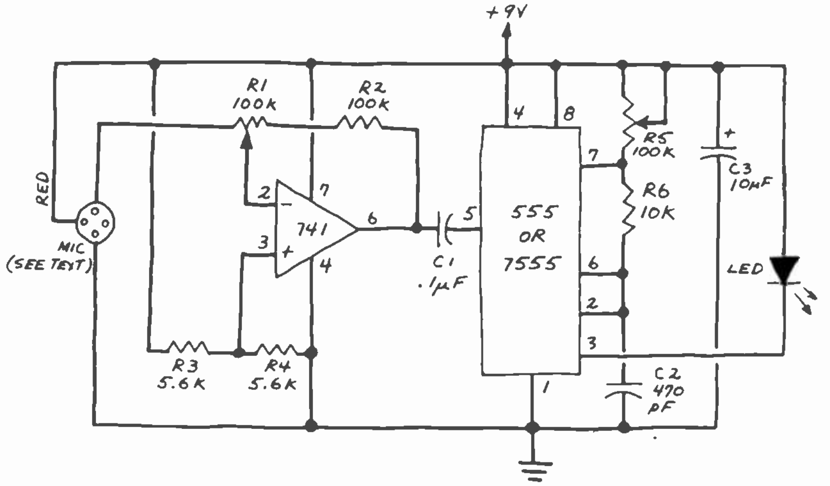


Fig. 3. Schematic of voice-modulated PFM infrared transmitter.

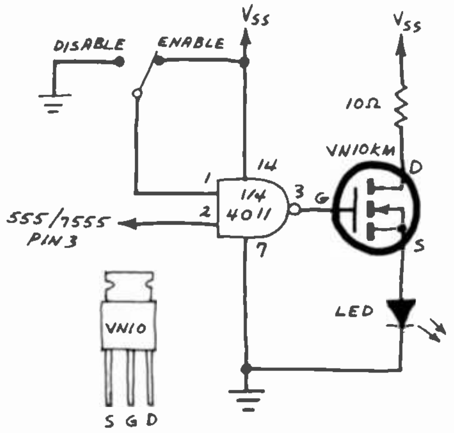


Fig. 4. Led power booster for PFM infrared transmitter.

especially PAM. Another advantage is that high peak power optical sources such as injection lasers can be used to full advantage.

The detection of PPM pulses by a receiver may require synchronization with the transmitter. This implies the necessity to transmit a clock signal along with the data or on a separate channel.

Pulse-Frequency Modulation (PFM). This modulation method resembles that used in FM radio in that the transmitter emits a steady train of pulses called the *carrier*. Information is superimposed on the carrier by altering the frequency of the pulses.

Detection of PFM is straightforward since, unlike PPM, no clock signal from the transmitter is required. Since the pulses have uniform duration and intensity, PFM offers many of the same advanatages of PPM. PFM is particularly well suited to audio bandwidth light-wave links.

Later in this column we'll assemble and evaluate a PFM LED communicator. First, however, I want to explain briefly the most important form of pulse communications.

Digital Pulse-Code Modulation (PCM). All the pulse modulation methods described thus far require that such critical pulse parameters as amplitude, duration or position be altered in response to an analog signal. PCM is a true digital modulation method which involves the transformation of an analog signal into its binary equivalent.

Voice, for example, is sampled at a sufficiently fast rate, and the amplitude at each sample point is converted into a binary word by an analog-to-digital converter. The binary word is then transmitted in serial form a bit at a time.

In PPM, PFM, and PCM, the shape of each pulse is identical. PCM, however, offers two significant advantages over PPM and PFM. First, the pulses remain fixed in time, and a pulse is either absent or present. This greatly enhances the noise immunity of the signal. Second, the predictable spacing between pulses greatly simplifies time division multiplexing. The major disadvantages of PCM are system complexity and bandwidth limitations.

Several pulse formats are used to implement PCM, the most important being return-to-zero (RZ) and non-return-to-zero (NRZ). A binary signal is either high (1) or low (0). A pulse, therefore, represents binary 1 while the absence of a pulse denotes binary 0.

Figure 2 shows three pulse formats. In the RZ mode, all bits return to zero before the next bit is transmitted. In the NRZ mode, a 1 remains high and a 0 remains low for the duration of the bit transmission interval. This means two consecutive 1 bits merge into a pulse having twice the duration of an individual bit position.

The RZ format is more efficient than the NRZ format since only half the time is required to transmit a single bit position. Both the NRZ and RZ modes require synchronized clocking at both the transmitter and receiver.

The Manchester format is a modification of the RZ format in which half of every bit position is denoted by a pulse. If the bit position contains a 0, the first half of the pulse is low and the second half is high. If it contains a 1, the first half is high and the second half is low.

Manchester coding eliminates the need for a separate clock

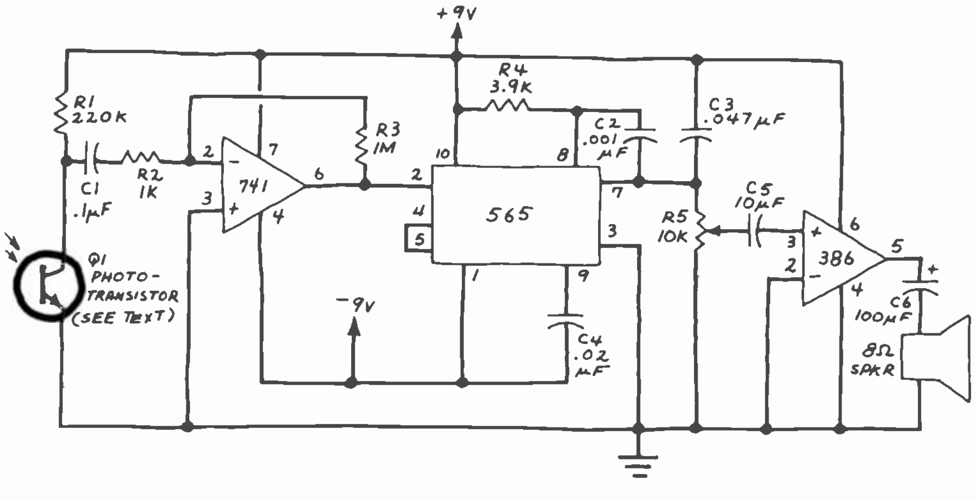


Fig. 5. Schematic of the receiver for the PFM infrared communication system.

channel. Like the NRZ format, however, it requires twice the time space of the RZ format.

In a typical, practical PCM system, one second of voice requires 8000 samples of eight bits each for a total of 64,000 bits/second. Two voices require twice this figure or 128,000 bits/second. The two signals can be multiplexed onto the same channel by placing the individual bits in each voice signal in unique time slots within discrete pulse windows of the signal.

PCM greatly simplifies multiplexing. One established channel frequency, for example, is 44.736 megabits/second (the T3 rate). This permits the transmission of 672 voices over a single channel. The actual information content is 64,000 × 672 or 43.0008 Mbits/sec. The remaining bits provide demultiplexing information for the receiver.

A Pulse-Modulated Communicator. Now that we've reviewed the different pulse-modulation methods, let's assemble a working system. Since pulse-frequency modulation is particularly easy to implement with low-cost components, we'll build a PFM infrared transmitter and receiver.

Figure 3 is the circuit for a straightforward PFM transmitter designed around the popular 555 timer IC. The 7555 CMOS version of the 555 can also be used. In my experience the 7555 gives better performance.

In operation, the 555 oscillates at a center frequency determined by the time constant of *R5* and *C2*. Typically the center frequency is 40 kHz. Low-level audio signals appearing at the microphone are amplified by the 741 and passed into the modulation input of the 555 where they alter the chip's oscillation frequency. The pulse-frequency modulated signal appears at pin 3 where it is used to drive an infrared LED.

For best results, use an electret microphone (Radio Shack 270-092 or similar). A crystal microphone may also be used.

Better quality op amps can be used in place of the 741 to give a lower transmitted noise level. The LED can be any GaAs, GaAs:Si or AlGaAs infrared emitter. For high power operation, select one of the new super LEDs made from AlGaAs such as Xciton's XC880 series or General Electric's F5D1/F5E1 series. See "Solid State Developments" of February and June 1981 for more information about these high-power emitters. So far, few component dealers stock the new high-power emitters. Radio Shack, however, sells the XC-880-A (catalog number 276-143). This diode emits 1 milliwatt at 20 mA forward bias. The XC-880-D emits a whopping 5 mW at that same current level.

The peak pulse current supplied to the LED by the 555 is about 50 to 60 mA. The pulse width is about 5 microseconds. The circuit in Fig. 4 employs a VFET transistor to raise the pulse current to about 450 mA. Even higher current levels can be obtained by increasing the voltage at V_{ss}.

Figure 5 is a PFM receiver using a 565 PLL tuned via *R4* and *C4* to the approximate center frequency of the transmitter. Incoming optical signals are detected by the phototransistor (*Q1*). The resulting photocurrent is converted to a voltage by load resistor *R1* and coupled via *C1* into the 741 op amp. The signal is then amplified 1000 times (*R3/R2*) and passed into one of the phase comparator inputs of the PLL.

The phase comparator generates an error voltage proportional to the difference between the PLL's on chip vco center frequency and the instantaneous transmitter frequency. The error voltage is fed back to the vco in a feedback loop which causes the vco to track the transmitter frequency. The error voltage represents the demodulated analog of the transmitter signal, so it is tapped via pin 7 for power amplification by the 386. Potentiometer *R5* controls the gain of the system by varying the amount of signal which reaches the 386.

Several modifications can be made to the basic receiver circuit. To reduce the effect of sunlight upon the detector, *Q1* can be replaced by a silicon photodiode. The diode should be connected in the reverse direction.

The gain of the 741 preamplifier can be altered by changing the ratio of *R3/R2*. The center frequency of the PLL's vco can be changed via *R4* and *C4*. For best results, *R4* should be at or near 4 kΩ, although Signetics observes *R4* can range up to about 20 kΩ.

Testing the Communicator. Before applying power to the transmitter and receiver, carefully inspect both circuits for possible wiring errors or omissions. To avoid severe interference when using a phototransistor in the receiver, place an opaque hollow tube over *Q1* to keep artificial light from striking *Q1*'s active region. A photodiode may not require this kind of protection.

For initial tests, disconnect the transmitter's microphone and connect the audio output of a transistor radio to the circuit via a 1-microfarad capacitor. The negative lead of the capacitor should be connected to *R1* of the transmitter. The radio output should be connected to the positive lead of the capacitor and the transmitter's ground connection. For best results use a radio with an earphone jack and make your connections with the help of clip leads soldered to an appropriate plug.

Turn the radio on at low volume and select a station that gives clear reception. Then apply power to both the transmitter and receiver while pointing the transmitter's LED at the receiver's detector. At this point you should hear noise, oscillation or, ideally, the sound of the radio from the receiver's speaker. In any event, carefully adjust the setting of *R5* in the transmitter in an effort to match the center frequency of the vco in the receiver's PLL, in this case about 40 kHz.

While adjusting *R5* of the transmitter you will probably hear loud noises and whistles interspersed with very clear sounds of the radio. Select the best-quality transmission point with *R5* of the transmitter and then adjust the gain of the receiver (*R5* in Fig. 5) for comfortable listening. You can then experiment with the setting of the transmitter's *R1* to find the optimum gain of the transmitter's preamplifier. ◇

DX LISTENING

By Glenn Hauser

More American Shortwave Stations on the Air Soon

PRIVATE interest in shortwave broadcasting, long dormant in the United States, is growing. *WRNO*, New Orleans, could be on the air by the time you read this, although it has been plagued with a series of construction delays (see January PE for schedule). Both *WRNO*, and *WYFR* (Family Radio) with its "Northern Mexico" and "Canadian" services are using wide-angle log-periodic antennas that efficiently cover vast areas of the U.S. where domestic shortwave broadcasting is (technically) not allowed.

Meanwhile, another private commercial shortwave station is under construction in Miami, FL. *Radio Miami*, whose call may become *WRMF*, wants to reach affluent Latin Americans who are likely to go shopping in Florida, although its parent station, *WQBA*, is heavily Cuban-oriented. *Radio Miami* may be on the air by year end, with 50 kilowatts on 31 and 49 meters.

Florida is also the likely site for the U.S. government's *Radio Martí*, designed to be a "Radio Free Europe" for Cuba—more credible than the Cuban exiles' clandestine stations, and more involved with Cuban issues than the *Voice of America*. It would probably operate daytime only from the Florida keys, using the low end of the medium-wave band (650 kHz) and would produce a high-power groundwave. However, 1040 is also being considered.

However, Cubans of all political persuasions find it offensive for the U.S. government to name this station after Cuba's 19th-century independence hero, whom they venerate. The Cuban government objects vehemently, too, and it could escalate the radio war by putting on a superpower 500-kilowatt station and several other high-power transmitters which would disrupt U.S. domestic broadcasting.

A massive tower for the 500-kW station has already been constructed in a Havana suburb, probably for 550 kHz. Other projected high-power transmitting frequencies are 900 kHz for the *Radio Progreso* domestic net, and 1010 kHz, for a second Moscow relay. Technical and operational standards are so low in Cuba that there's plenty of trouble now, even without deliberate disruption. One evening, for instance, the *Radio Moscow* relay (9600 kHz) was apparently mistuned and it twice landed smack on top of WWV (10,000 kHz).

Jamming of the *Radio Martí* signal can also be expected, since the Castro government already jams two other less offensive U.S. stations (*WQBA*, 1140 kHz, and *VOA*, 1180 kHz). The U.S. government has threatened to jam the Radio Moscow relay on 600 kHz in retaliation. (Traditionally the U.S. has left jamming to the "bad guys." Besides, domestic U.S. stations on 600 kHz would hardly welcome the interference from jamming).

The original target date for *Radio Martí* was January 1, 1982, but the project has run into opposition in Congress. Even the U.S. diplomatic staff in Havana has come out against it. Florida broadcasters have offered to help offset some of the $10 million needed to start the station from scratch. Meanwhile, *Radio Havana Cuba* has announced the subject of its annual essay contest for 1982: "Historically, what have relations been like between the U.S. and Latin America?" The deadline is April 30, 1982. Write *RHC* at Box 7026, Havana, for particulars.

The most active clandestine Cuban has been *La Voz de Cuba Independiente y Democrática* (*La Voz del Cid* for short—a play on words), with a Monday-Saturday broadcast schedule via its own secret transmitter. Programs typically last more than half an hour starting at 9 p.m. local (0200 GMT winter), on 7355 kHz (on 7350 kHz sometimes). This same group produces a different program at 0100 GMT via the commercial Dominican Republic station *Radio Clarín* on 11,700 kHz.

The *Voice of America*, known mainly

as a shortwave station, is moving more and more into mediumwave to increase its audience among listeners to standard AM radio. In September 1981, a relay station went into operation in Botswana on 621 kHz, along with two Caribbean-area relays on 1180 kHz and 1580 kHz. A third medium-wave outlet in the Jamaica or the Cayman Islands is being planned. (Political stability makes the latter site more probable.)

If you can't hear the 1580 kHz Antigua relay, you may be able to hear its "local" program at 0000-0030 GMT as fed from Washington on 17,860 kHz, and (in single sideband) on 15,652 kHz. During the period in question, programming is not parallel with transmissions on the *VOA*'s other English-language frequencies.

USICA, the *VOA*'s parent agency, is slated to revert to its former name, USIA. It is hoped this will lessen its confusion abroad with the CIA. While USICA is taking a 12% budget cut (like most government agencies), next to nothing will come out of the *VOA* budget. In fact, the *VOA* will be hiring about 100 employees (mostly technical).

Another bit of U.S. territory, Saipan, is about to become a shortwave broadcasting center, with two new stations authorized by the Federal Communications Commission. The missionary Far East Broadcasting Co., already operating from the Philippines and several East Asian countries, is expanding to Saipan. And an organization called MARCOM is building a commercial shortwave station for broadcasts to Japan. Here, shortwave listening is a relatively widespread activity.

Some Little-Known Stations. Not all U.S. shortwave broadcasting is high-power and designed for a wide audience. For example, a little-known band straddling 26 MHz is allocated for two-way communications by broadcast stations with mobile units or remote transmitter sites and for the remote pickup of broadcast programs. While most stations now use vhf, uhf, microwave, or phone lines for such purposes, we were pleased to hear one remote pickup active on a Saturday morning between 1430 and 1700 GMT, from Gus's Daughters' Grocery Store in Presque Isle, Maine, using narrowband FM on 26,240 kHz. It took a special occasion to inspire this transmission—the opening of a new building on the store's 50th anniversary. Besides the very limited groundwave at 26 MHz, this "local" signal had a potential audience of at least half the world (beyond the skip zone)!

Computer Tests. On September 10, 1981, Radio Netherlands undertook a novel experiment—broadcasting a basic computer program for range and bearing calculation, in three different formats, to find out whether listeners with home computers would be able to record and run the program successfully. Of the 235 listeners responding, 98 reported success (42%). Of the successes, 61 were with the TRS-80, 36 for the Pet, and only one for the Apple II. It was necessary to use patch cords rather than mike-to-speaker recording, wide bandwidths (over 5 kHz) were required, and treble boosting helped. Ten percent turned failure into success by re-recording their tapes at higher levels.

A second experiment, scheduled for Thursday, January 28, 1982, is a sunrise-sunset program suitable for the Sinclair ZX-81, TRS-80 Model I Level 2, Pet, and perhaps the Atari. Here are the times and frequencies: 2050 GMT on 21,685, 17,695, 17,605, 15,220, and 9,715 kHz. Also on Friday the 29th (but still Thursday in North America) at 0250 GMT on 9,590 and 6,165 kHz; and at 0550 GMT on 9,715 and 6,165 kHz. Address reports on your results to Media Network, Radio Netherlands, Box 222, 1200-JG Hilversum, Holland.

That station is also encouraging listeners to call in short comments or questions to an answering machine. The phone number is announced frequently, especially on the Tuesday "Shortwave Feedback" program where some of the taped calls are put on the air.

Belgium could easily broadcast to England right across the channel on mediumwave, but until now its English programming has only been on shortwave. A mediumwave frequency was to be added January 1, entailing a retiming of the 1705-1750 GMT program (nominally for Africa but also heard in Europe and North America) to 2000-2045 and 2200-2245 GMT. During the winter, the shortwave version of these broadcasts may come in better in North America than the North American service at 0030-0115 GMT. However, the departure of David Monson has made these broadcasts less entertaining.

Soviet stations have been going out of their way to teach us their languages. The Radio Moscow World Service has a "Russian by Radio" course Fridays at 1232 and 2132 GMT, and Saturdays 0432 and 0932 GMT. If you've already mastered Russian, try the *Voice of Yerevan* for an "Armenian by Radio" course that started in October. Listen GMT Fridays (Thursday nights here) after 0330 GMT on 17,870, 15,240 and 15,100 kHz.

While clandestine monitoring is among the most exciting aspects of DX listening, you often must understand languages such as Arabic and Spanish. However, two unusual programs in English have been heard recently. The *Voice of Namibia*, from SWAPO via Angola, is on 9,535 kHz at 1600-1630 GMT (Sundays), reports Ron Howard in California. Such long-path reception (probably erratic) is best along the west coast. Syria is one of few countries now silent on shortwave. But there is a program opposing the Syrian government (from transmitters in Iraq), the *Voice of the Arab Syria*, that puts a brief English segment at the end of its Arabic broadcasts. Listen for this around 1950 GMT on 21,585 kHz. It is easily audible, especially in eastern North America.

Although its English department has been short-staffed, Ecuador's *HCJB* has been trying to broaden the appeal of its programming. DX Party Line, now less evangelical, has been reduced to two programs a week, Saturdays and Mondays at 2130 GMT. It is repeated the following GMT days at 0230 and 0630 GMT. "Música del Ecuador," reviewed favorably in this column last year before being dropped from the schedule, returned to the air in October 1981 at 0035 GMT on the North American service Saturday nights (GMT Sundays) on 17,880, 15,155, and 9,745 kHz. The magazine show, "Passport," has been revamped to include more features about Ecuador, including "the smells of Quito." Weeknight hours (0100-0200 GMT) include the following segments: "Ecuador Yesterday and Today" (daily), "Embassy Roundup" (Monday), "Profiles of South Americans" (Tuesday), "National Geographic News" (Wednesday), "Visiting Ecuador" (Thursday), and "Latin American Press Review" (Friday).

Another good English broadcast from Latin America comes from Brazil's *Radio Nacional*. Reception is usually ex-

dx listening

cellent at 0200-0300 GMT on 17,830 and 15,290 kHz. There's a good mix of Brazilian music and brief talk features. On Sundays the talks are on a single subject, alternating with music. The Sunday schedule for January is "History of Brazilian Soccer" (10th), "Classics of Brazilian Music" (17th), "Medicinal Herbs in Brazil" (24th), "Brazilian Folk Music" (31st).

The easily heard *Voice of Nicaragua* (5,950 kHz, evenings) was expecting to begin an English broadcast last March, but has not followed through. However, *Radio Zinica*, a tiny station at Bluefields on the Caribbean coast, where English is the primary local language, does have an English hour, "Revolution Now," at 0100 GMT. Unfortunately, it was discovered by DX listeners just a few days before the broadcasting strike in Canada was settled last September. Now the BBC relay on 6,120 kHz has resumed, effectively blocking *Radio Zinica*.

English-Language Listings. the following changes and additions should be made to the listings that appeared in the June issue. To make the corrections as concise as possible, only the GMT, station name, and frequency correction are given.

1000-1100 R. Korea 9570 only
1130-1230 R. Thailand 9650 not 9655
1200-1235 R. Ulan Bator 12070, 6383, not 1220-1250
1235-1245 V. of Greece 21460, not 21455
1330-1430 R. Korea 9720 ex-1230-1330
1400-1430 BRT, Belgium 21525, 21810 (Mon.-Fri.) ex-1335-1405
1400-1435 R. Ulan Bator 12070, 7235
1445-1520 R. Ulan Bator 12070
1535-1545 V. of Greece 21460, not 21455
1600-1615 R. Pakistan 15565
1800-0200 AFRTS not 17765
1830-1837 UN Radio 15120 (Fri.) not 15410
1845-1930 BRT, Belgium 17595 (Sun.) ex-1705-1750
1900-1930 UN Radio 15120 (Fri.) not 15410
1900-1930 R. Afghanistan 9665 (via USSR)
2010-2140 R. Havana Cuba 11950
2015-1115 R. New Zealand 15485, not 11960
2200-2245 BRT, Belgium 15285, 6080 (not Sun.)
2200-2230 R. Argentina add 9690
2200-0200 AFTRS 25615
0100-0130 R. Argentina add 9690
0100-0200 R. Australia 21650, not 21740 and 17795
0130-0140 V. of Greece 7295, ex-9655
0130-0200 Radio Budapest 6000, ex.-6025
0200-0230 "
0300-0330 "
0400-0415/30 "
0200-0300 R. Korea 15575, 11810
0230-0300 R. Sweden add 17840 USB
0300-0330 R. Portugal 6155 or 6005
0330-0400 UAE Radio, Dubai 11755
0340-0350 V. of Greece 7295, ex-9650
0400-0500 FEBA, Seychelles 11810, 15200
0400-0700 TWR, Bonaire 9755, ex-9700
0645-0730 R. Berlin International 11890, 6080
0645-0700 UN Radio 9450 (Sat.) not 15125
0707-0715 "
0737-0745 "
0800-0815 "

◇

PROJECT OF THE MONTH

By Forrest M. Mims

Bomb-Burst Synthesizer

HERE's a circuit that realistically synthesizes the whistle and explosion of an aerial bomb or shell. This attention-getting sound sequence is generated by an SN76488, the Texas Instruments complex sound generator chip. This chip is used in some video arcade games to synthesize the sounds of race cars, gun shots and explosions.

The circuit diagram for the bomb-burst synthesizer is shown below. The circuit is adapted from one suggested in a Texas Instruments application note. Closing and then opening *S1* starts the sound sequence. Initially a tone having a frequency of a few kilohertz is produced. The frequency of the tone decreases over a span of several seconds. The tone is then replaced by the sudden and very realistic sound of an explosion.

The sound patterns produced by the SN76488 are governed by the RC (resistor-capacitor) time constants of the on-chip voltage controlled oscillator (vco), super low-frequency oscillator (slf), noise-generator filter and monostable multivibrator (one-shot). The detailed operation of these and the various other circuits contained in the SN76488 is beyond the scope of this column. (Consult the Texas Instruments' data sheet for more information.) However, we can examine how the various RC components control the operation of the circuit.

As shown in the schematic, vco RC components *R3* and *C3* control the overall frequency range of the pre-burst tone. Reducing the time constant by reducing either or both *R3* or *C3* produces a high-pitched whistle.

The duration of the tone is determined by the RC time constant of the on-chip one-shot. Increasing the value of either or both *R5* or *C5* stretches the duration of the pre-burst tone (or whistle), thus simulating a high-altitude bomb drop.

The sound of the explosion is governed by the noise generator's output filter, *R1* and *C1*. Reducing *R1*, for example, to less than 100 kilohms suppresses the low-frequency component of the noise and gives a sound which resembles a stretched gun shot. Increasing *R1* to a megohm or more produces a deep, rumbling explosion.

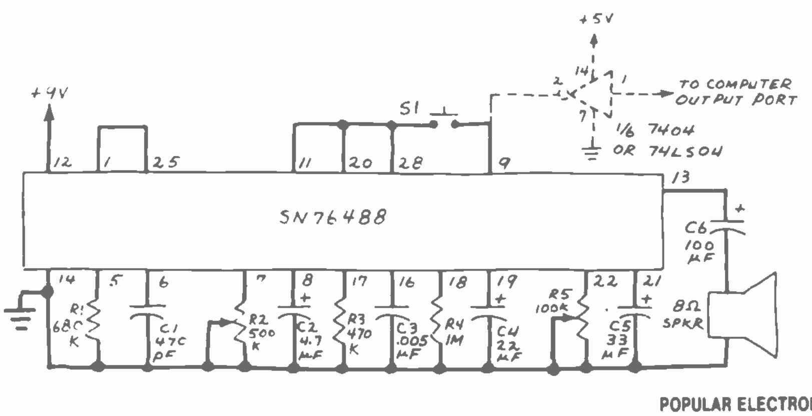
Duration of the explosion is controlled by the RC time constant of an on-chip decay circuit. Reducing *R2* or *C2* gives a very brief explosion which closely simulates a gun shot if the low-frequency component of the output from the noise generator is suppressed by reducing *R1*.

For best results, *R2* and *R5* should be trimmer resistors or potentiometers. For even more flexibility, *R1* and *R3* can also be pots.

An interesting variation of the tone-explosion sound sequence can be obtained by reducing *R4*. When, for example, *R4* is 2.2 kilohms, the gradually falling pitch of the whistle will be replaced by three up-down cycles of a siren followed by the explosion sound.

Other variations are also possible. Disconnect pins 1 and 25 and the explosion sound will be eliminated. Disconnect pin 11 to produce a continuous, nondecaying explosion after a silent delay period. Disconnect pin 20 to produce a gun shot or explosion after a silent delay. The length of the delay is controlled by *R2* and *C2*. Substitute pin 27 for pin 28 to give a descending whistle followed by a continuous explosion.

I've had so much fun with a breadboard version of this circuit that I'm going to assemble a permanent version in a small plastic enclosure. A pushbutton will permit manual activation of the sound sequence. A 7404 (or 74LS04) hex inverter connected to pin 9 will permit the sequence to be actuated by the output port on a computer. A gadget like this will make a great gift for a youngster. ◊



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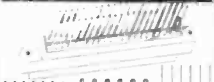

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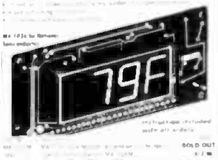

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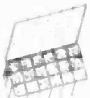

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74LS75	276-1920	.99	79
74LS90	276-1923	1.09	89
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74LS54	.35	74LS156	.95	74LS259	2.85	74LS683	2.30
74LS55	.35	74LS157	.75	74LS260	.65	74LS684	2.40
74LS63	1.25	74LS158	.75	74LS266	.55	74LS685	2.40
74LS73	.40	74LS160	.90	74LS273	1.65	74LS688	2.40
74LS74	.45	74LS161	.95	74LS275	3.35	74LS689	2.40
74LS75	.50	74LS162	.95	74LS279	.55	81LS95	1.69
74LS76	.40	74LS163	.95	74LS280	1.98	81LS96	1.69
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74C90	1.75	74C923	5.95	4044	.85	4520	1.25
74C93	1.75	74C925	6.75	4046	.95	4522	1.25
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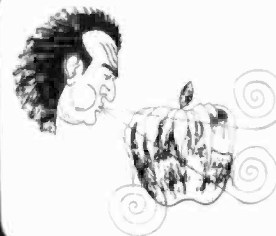

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24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39

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7824T	.99		
7805K	1.39	7905K	1.49
7812K	1.39	7912K	1.49
7815K	1.39	79L05	.79
78L05	.69	79L12	.79
78L12	.69	79L15	.79
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T = TO-220 K = TO-3 L = TO-92

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LM556	.69
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7404	.19	7470	.35	74144	2.95	74193	.79
7405	.22	7472	.29	74145	.60	74194	.85
7406	.22	7473	.34	74147	1.75	74195	.85
7407	.22	7474	.35	74148	1.20	74196	.79
7408	.24	7475	.49	74150	1.35	74197	.75
7409	.19	7476	.35	74151	.65	74198	1.35
7410	.19	7480	.59	74152	.65	74199	1.35
7411	.25	7481	1.10	74153	.55	74221	1.35
7412	.30	7482	.95	74154	1.40	74246	1.35
7413	.35	7483	.50	74155	.75	74247	1.25
7414	.55	7485	.65	74156	.65	74248	1.85
7416	.25	7486	.35	74157	.55	74249	1.95
7417	.25	7489	4.95	74159	1.65	74251	.75
7420	.19	7490	.35	74160	.85	74259	2.25
7421	.35	7491	.40	74161	.70	74265	1.35
7422	.29	7492	.50	74162	.85	74273	1.95
7423	.29	7493	.49	74163	.85	74276	1.25
7425	.29	7494	.65	74164	.85	74279	.75
7426	.29	7495	.55	74165	.85	74283	2.00
7427	.29	7496	.70	74166	1.00	74284	3.75
7428	.45	7497	2.75	74167	2.95	74285	3.75
7430	.19	74100	1.00	74170	1.65	74290	.95
7432	.29	74107	.30	74172	5.95	74293	.75
7433	.45	74109	.45	74173	.75	74298	.85
7437	.29	74110	.45	74174	.89	74351	2.25
7438	.29	74111	.55	74175	.89	74365	.65
7440	.19	74116	1.55	74176	.89	74366	.65
7442	.49	74120	1.20	74177	.75	74367	.65
7443	.65	74121	.29	74178	1.15	74368	.65
7444	.69	74122	.45	74179	1.75	74376	2.20
7445	.69	74123	.55	74180	.75	74390	1.75
7446	.59	74125	.45	74181	2.25	74393	1.35
7447	.69	74126	.45	74182	.75	74425	3.15
7448	.69	74128	.55	74184	2.00	74426	.85
7450	.19	74132	.45	74185	2.00	74490	2.55

74S00 SERIES

74S00	.44	74S74	.69	74S163	3.75	74S257	1.39
74S02	.48	74S85	2.39	74S168	4.65	74S258	1.49
74S03	.48	74S86	1.44	74S169	5.44	74S260	1.83
74S04	.79	74S112	1.59	74S174	1.09	74S274	19.95
74S05	.79	74S113	1.98	74S175	1.09	74S275	19.95
74S08	.48	74S114	1.50	74S181	4.47	74S280	2.90
74S09	.98	74S124	2.77	74S182	2.95	74S287	4.75
74S10	.69	74S132	1.24	74S188	3.95	74S288	4.45
74S11	.88	74S133	.98	74S189	14.95	74S289	6.98
74S15	.70	74S134	.69	74S194	2.95	74S301	6.95
74S20	.68	74S135	1.48	74S195	1.89	74S373	3.45
74S22	.98	74S138	1.08	74S196	4.90	74S374	3.45
74S30	.48	74S139	1.25	74S197	4.25	74S381	7.95
74S32	.98	74S140	1.45	74S201	14.95	74S387	5.75
74S37	1.87	74S151	1.19	74S225	8.95	74S412	2.98
74S38	1.68	74S153	1.19	74S240	3.98	74S471	9.95
74S40	.44	74S157	1.19	74S241	3.75	74S472	16.85
74S51	.78	74S158	1.45	74S244	3.98	74S474	17.85
74S64	.79	74S161	2.85	74S251	1.90	74S482	15.60
74S65	1.25	74S162	3.70	74S253	7.45	74S570	7.80
						74S571	7.80

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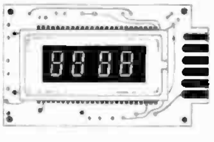
CIRCLE NO. 33 ON FREE INFORMATION CARD

National Semiconductor Clock Modules



12VDC AUTOMOTIVE/INSTRUMENT CLOCK

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

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

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

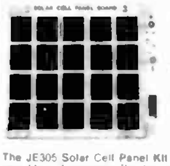
CLOCK MODULES

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

TRANSFORMERS

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

NEW! Sun Power Your Electronics! SOLAR CELL PANEL KIT



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

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

JE305 . . . . **$39.95**

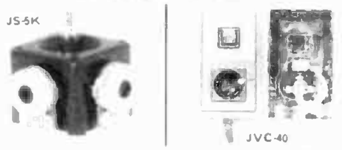
EPROM Erasing Lamp

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

UVS-11EL Replacement Bulb $16.95

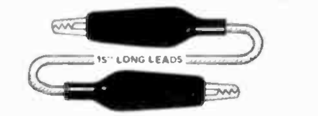
UVS-11E **$79.95**

JOYSTICKS



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

ALLIGATOR CLIP TEST LEADS



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

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

NEW! JE215 Adjustable Dual Power Supply

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

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

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

(Picture not shown but similar in construction to above)

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

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A	CPU	4.95
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.49
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.49
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8243	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	6.95
DP8253	Prog. Interval Timer	8.95
DP8255	Prog. Peripheral I/O (PPI)	5.95
DP8257	Prog. DMA Control	9.95
DP8259	Prog. Interrupt Control	9.95
DP8275	Prog. CRT Controller	39.95
DP8279	Prog. Keyboard/Display Interface	9.95
DP8301	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95
DP8310	Octal Latched Peripheral Driver	5.25
DP8311	Octal Latched Peripheral Driver	5.25

6800/6800 SUPPORT DEVICES

MC6800	MPU	7.95
MC6802CP	MPU with Clock and RAM	14.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	17.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.98
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	11.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	13.95
CDP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MC6802	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	7.95
INS8039N-6	CPU—Sgl. Chip 8-Bit (128bytes RAM)	9.95
INS8040N-4	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
P8085	CPU	9.95
TMS9900JL	MPU—16-Bit	39.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	2.95
MM5013N	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	1.95
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V (1404A)	1024-Bit Dynamic	1.85
2518N	Hex 32-Bit Static	1.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN	Universal Active Filter 2.5%	5.95
AF121-1CJ	Touch Tone Low Band Filter	18.95
AF122-1CJ	Touch Tone High Band Filter	19.95
LM308CH	Super Gain Op Amp	1.15
LM334Z	Constant Current Source	1.30
LM335Z	Temperature Transducer	1.40
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/C°)	5.00
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0806LCN	8-Bit D/A Converter (0.78% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

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

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	1.75
21L02	1024x1 Static	1.95
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	3.25
2114L	1024x4 Static 450ns Low Power	3.49
2114-2	1024x4 Static 200ns	3.95
2114L-2	1024x4 Static 200ns Low Power	4.95
TMS200	256x1 Static	6.95
4116N-4 (UPD416)	16K Dynamic 250ns (MMS290N-4)	2.95
4164N-3	64K Dynamic 200ns	19.95
MM2147J	4096x1 Fast 70ns	7.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.99
MM5280/2107	4096x1 Dynamic	4.95
MM5290N-2 (4116)	16K Dynamic 150ns (UPD416C-1)	3.95
MM5298J-3A	8K Dyn. 200ns (lower ½ of MM5290J)	3.95
HM6116-4	16K (2Kx8) Static 200ns	14.95
82S25	64 Bit RAM (16x4OC)	2.95
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	3.95
TMS4045	1024x4 Static	8.95

PROMS/EPROMS

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

— Over 30 More PROMS Listed in Our Catalog —

ROM'S

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

NMOS READ ONLY MEMORIES

MCM66710P	128x9x7 ASCII Shiftec w/Greek	13.50
MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

MICROPROCESSOR MANUALS

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

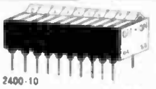
SPECIAL FUNCTION

DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
INS2651N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	8.95
MM58174N	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Buss Int.	7.00
COP470N	32-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

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

EECO Rocker DIP Switch — "Mini-Dip™" 2400 Series



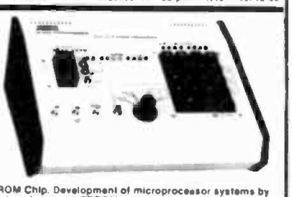
2400-10

THE MOST UNIQUE DIP SWITCH AVAILABLE!

MINI DIP is designed to retrofit all major brands of Dip switches. Unique features include locking rod design to prevent accidental actuation and gold self wiping contact. One-piece housing and press fit terminals prevent contamination. 2-10 station Form "A" and 1-5 station Form "C". • Terminals on .100 x .300 (2.54 x 7.62) centers • PCB or dip socket mountable • Positive cleaning/wiping action with gold contact • Total seal and bottom seal

Part No.	Pos.	Configuration	Socket	Price	Part No.	Pos.	Configuration	Socket	Price
2400-2	2	12	8 pin	.79 - 10/ 6.95	2400-6	6	123456	14 pin	1.09 - 10/ 9.95
2400-3	3	123	8 pin	.89 - 10/ 7.95	2400-7	7	1234567	14 pin	1.19 - 10/10.95
2400-4	4	1234	8 pin	.99 - 10/ 8.95	2400-8	8	12345678	16 pin	1.29 - 10/11.95
2400-ABCD	4	ABCD	8 pin	.99 - 10/ 8.95	2400-9	9	123456789	18 pin	1.39 - 10/12.95
2400-5C	6	C54321	14 pin	1.09 - 10/ 9.95	2400-10	10	0123456789	20 pin	1.49 - 10/13.95

JE608 PROGRAMMER
2704/2708 EPROM PROGRAMMER



GENERAL APPLICATIONS:
- To program EPROMS 2704 and 2708.
- Developmental system for microcomputer circuits
- To read the contents of a pre-programmed EPROM
- To compare EPROM(s) for content differences
- To emulate a programmed EPROM
- To store program in RAMS for alterations
- Three separate Display Registers: 8 LED's for Hex Key entries, 10 LED's (2^0-2^9) for Address Register and 8 LED's for Data Memory Register. The Data Memory Register displays the content of the RAMs from the EPROM Chip. Development of microprocessor systems by means of a ribbon cable from the programmer panel test socket to the EPROM socket on the microprocessor board. Rapid checking verification of programmed data changes. User may move data from a master to RAM's or write into RAM's with keyboard entries. Allows manual stepping manipulation (up and down) at any address location. Stand-alone EPROM Programmer consisting of: A 19-key Hexadecimal Keyboard assembly, Programmer Board assembly with 4 power supplies and a LED/Test Socket Panel Board assembly. The Test Socket is zero force insertion type. Power requirements: 115VAC, 60Hz, 6W. Compact desk-top enclosure: Color-coordinated designer's case with light tan panels and molded end pieces in mocha brown. Size: 3¼"H x 11"W x 6¼"D. Weight: 5 lbs.

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

JE608K Kit **$399.95**

JE608A Assembled and Tested **$499.95**

JE608-16K ADAPTER BOARD
FOR 2716/2758 EPROMS

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

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

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BOOKS

National Semiconductor — Intersil — Intel

30001	**National CMOS Data Book** (640 pages) 74C, CD4000, and A/D Converters	$6.95
30002	**National Interface Data Book** (704 pages) DP, DS8000, DS3600, DS75000, etc.	$5.95
30003	**National Linear Data Book** (1376 pages) LM, LF, ADC, DAC, LH Series	$8.95
30004	**National Series 80 — Board Level Computer** (224 pages)	$4.95
30005	**National TTL Logic Data Book** (624 pages) 7400, LS, L, H, S, and DM8000 Series	$8.95
30006	**Buy above (3) 30001,3,5 as a set**	$19.95/lot
30009	**Intersil Data Book** (1074 pages)	$6.95
010400	**Intel Component Data Catalog** Full data sheets for Intel's products incl. memory devices, microproc., peripherals & indust./mil. products (1328 pages)	$10.00
205610	**Intel Peripheral Design Handbook** Full data sheets, appl. notes for Intel peripheral device components (644 pages)	$7.50

AC and DC Wall Transformers

With Universal Plug and 9V Battery Snap

Selective voltages: 6,9,12VDC. Polarity selection (+/-), six-foot line from adapter to plugs — six-inch line from adapter to battery snap. 120V/60Hz, 300mA.

Part No.	Input	Output	Price
AC 250	117V/60Hz	12VAC 250mA	$3.95
AC 500	117V/60Hz	12VAC 500mA	$4.95
AC1000	117V/60Hz	12VAC 1 amp	$5.95
AC1700	117V/60Hz	9VAC 1.7 amp	$9.95
DC6912	120V/60Hz	6,9,12VDC 300mA	$9.95
DV9200	117V/60Hz	9VDC 200mA	$3.25
DC900	120V/60Hz	9VDC 500mA	$3.95

CONNECTORS

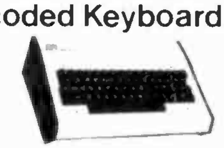
DB25P	D-Subminiature Plug	$2.95
DB25S	D-Subminiature Socket	$3.50
D20418-2	Screw Lock Hdwr. (2) DB25S/P	2/$.99
DB51226	Cover for DB25P/S	$1.75
22/44SE	P.C. Edge (22/44 Pin)	$2.95
UG88/U	BNC Plug	$1.79
UG89/U	BNC Jack	$3.79
UG175/U	UHF Adapter	$ .49
SO239	UHF Panel Recp.	$1.29
PL258	UHF Adapter	$1.60
PL259	UHF Plug	$1.60
UG260/U	BNC Plug	$1.79
UG1094/U	BNC Bulkhead Recp.	$1.29

TRS-80 16K Conversion Kit

Expand your 4K TRS-80 System to 16K.
Kit comes complete with:
- ★ 8 ea. MM5290 (UPD416/4116) 16K Dyn. Rams (*NS)
- ★ Documentation for Conversion

TRS-16K2	*150NS	$29.95
TRS-16K3	*200NS	$24.95
TRS-16K4	*250NS	$19.95

JE610 ASCII Encoded Keyboard Kit



The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The 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 @ 10 mA for operation. Features: 60 keys generate the 126 characters, upper and lower case ASCII set. Fully buffered. Two 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. Size: 3½"H x 14¾"W x 8¾"D

JE610/DTE-AK (After assembled as pictured above) . . . **$124.95**

JE610 Kit 62-Key Keyboard, PC Board, & Components (no case) . . . **$ 79.95**

K62 62-Key Keyboard (Keyboard only) . . . **$ 34.95**

DTE-AK (case only — 3½"Hx11"Wx8¾"D) **$ 49.95**

NEW! JE212 — Negative 12VDC Adapter Board Kit for JE610 ASCII KEYBOARD KIT
Provides -12VDC from incoming 5VDC . . . $9.95

JE600 Hexadecimal Encoder Kit

FULL 8-BIT LATCHED OUTPUT 19-KEY KEYBOARD

The JE600 Encoder Keyboard Kit provides two separate hexadecimal digits produced from sequential key entries to allow direct programming for 8-bit microprocessor or 8-bit memory circuits. Three additional keys are provided for user operations with one having a bistable output available. The outputs are latched and monitored with 9 LED readouts. Also included is a key entry strobe. Features: Full 8-bit latched output for microprocessor use. Three user-define keys with one being bistable operation. Debounce circuit provided for all 19 keys. 9 LED readouts to verify entries. Easy interfacing with standard 16-pin IC connector. Only +5VDC required for operation. Size: 3½"H x 8¼"W x 8¾"D

JE600/DTE-HK (After assembled as pictured above) **$99.95**

JE600 Kit 19-Key Hexadec. Keyboard, PC Board & Cmpnts. (no case) . . . **$59.95**

K19 19-Key Keyboard (Keyboard only) . . . **$14.95**

DTE-HK (case only — 3½"Hx8¼"Wx8¾"D) **$44.95**

7400

SN7400N	.20	SN7472N	.29	SN74156N	.79
SN7401N	.20	SN7473N	.35	SN74157N	.69
SN7402N	.25	SN7474N	.35	SN74160N	.89
SN7403N	.25	SN7475N	.49	SN74161N	.89
SN7404N	.25	SN7476N	.35	SN74162N	.89
SN7405N	.29	SN7479N	5.00	SN74163N	.89
SN7406N	.35	SN7480N	.50	SN74164N	.89
SN7407N	.35	SN7482N	.99	SN74165N	.89
SN7408N	.29	SN7483N	.69	SN74166N	1.25
SN7409N	.29	SN7485N	.89	SN74167N	2.79
SN7410N	.25	SN7486N	.35	SN74170N	1.95
SN7411N	.29	SN7489N	1.75	SN74172N	4.95
SN7412N	.35	SN7490N	.49	SN74173N	1.39
SN7413N	.40	SN7491N	.59	SN74174N	.99
SN7414N	.69	SN7492N	.45	SN74175N	.89
SN7416N	.29	SN7493N	.45	SN74176N	.79
SN7417N	.29	SN7494N	.69	SN74177N	.79
SN7420N	.25	SN7495N	.69	SN74179N	1.49
SN7421N	.29	SN7496N	.69	SN74180N	.79
SN7422N	.45	SN7497N	3.00	SN74181N	2.25
SN7423N	.29	SN74100N	1.49	SN74182N	.79
SN7425N	.29	SN74104N	.89	SN74184N	2.49
SN7426N	.29	SN74105N	.89	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7428N	.49	SN74109N	.39	SN74191N	1.25
SN7430N	.25	SN74116N	1.95	SN74192N	.89
SN7432N	.29	SN74121N	.39	SN74193N	.89
SN7437N	.25	SN74122N	.55	SN74194N	.89
SN7438N	.40	SN74123N	.59	SN74195N	.69
SN7439N	.25	SN74125N	.49	SN74196N	.89
SN7440N	.20	SN74126N	.49	SN74197N	.89
SN7441N	.89	SN74132N	.75	SN74198N	1.49
SN7442N	.59	SN74136N	.75	SN74199N	1.49
SN7443N	1.10	SN74141N	.99	SN74221N	1.25
SN7444N	1.10	SN74142N	3.25	SN74251N	.99
SN7445N	.89	SN74143N	3.49	SN74276N	1.95
SN7446N	.79	SN74144N	3.49	SN74279N	.79
SN7447N	.69	SN74145N	.79	SN74283N	1.49
SN7448N	.79	SN74147N	1.95	SN74284N	3.95
SN7450N	.20	SN74148N	1.29	SN74285N	3.95
SN7451N	.20	SN74150N	1.25	SN74365N	.69
SN7453N	.20	SN74151N	.69	SN74366N	.69
SN7454N	.20	SN74152N	.69	SN74367N	.69
SN7459A	.25	SN74153N	.79	SN74368N	.69
SN7460N	.20	SN74154N	1.25	SN74390N	1.49
SN7470N	.29	SN74155N	.79	SN74393N	1.49

74LS

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

74S

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

CA–LINEAR

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

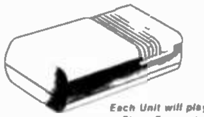
CD–CMOS

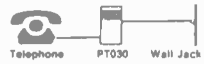
CD4000	.39	CD4041	1.49	CD4098	2.49
CD4001	.39	CD4042	.99	CD4506	.75
CD4002	.39	CD4043	.89	CD4507	.99
CD4006	1.19	CD4044	.89	CD4508	3.95
CD4007	.25	CD4046	1.79	CD4510	1.39
CD4009	.49	CD4047	2.50	CD4511	1.29
CD4010	.49	CD4048	1.35	CD4512	1.49
CD4011	.39	CD4049	.49	CD4514	3.95
CD4012	.25	CD4050	.69	CD4515	2.95
CD4013	.49	CD4051	1.19	CD4516	1.49
CD4014	1.39	CD4052	1.19	CD4518	1.79
CD4015	1.19	CD4053	1.19	CD4519	.89
CD4016	.59	CD4056	2.95	CD4520	1.29
CD4017	1.19	CD4059	9.95	CD4526	1.79
CD4018	.99	CD4060	1.49	CD4528	1.79
CD4019	.49	CD4066	.79	CD4529	1.95
CD4020	1.19	CD4068	.39	CD4543	2.79
CD4021	1.39	CD4069	.45	CD4562	11.95
CD4022	1.19	CD4070	.55	CD4566	2.79
CD4023	.29	CD4071	.49	CD4583	2.49
CD4024	.79	CD4072	.49	CD4584	.75
CD4025	.23	CD4073	.39	CD4723	1.95
CD4026	2.95	CD4075	.39	CD4724	1.95
CD4027	.69	CD4076	1.39	MC14409	17.95
CD4028	.89	CD4078	.55	MC14410	18.95
CD4029	1.49	CD4081	.39	MC14411	15.95
CD4030	.49	CD4082	.39	MC14412	15.95
CD4034	3.49	CD4093	.99	MC14419	7.95
CD4035	.99			MC14433	15.95
CD4040	1.49			MC14538	2.49
				MC14541	1.95

Phone Tunes

As Seen on "Good Morning America"

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





Each Unit will play any of the following tunes:

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

FEATURES

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

PT030 Phone Tunes $49.95
AD30 AC Adapter $8.95

DISCRETE LEDS

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

.200(T1¾) Red/Green
Diffused Bi-Color LED

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

XC114 RED LED, METAL MTG. HDW. 24" LEADS
RL-2 . . $.39 ea. or 3/$1.00

DISPLAY LEDS

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

Type	Polarity	Ht	Price	Type	Polarity	Ht	Price
MAN 1	C.A.–red	.270	2.95	DLG507	C.A. green	.500	1.25
MAN 2	5x7 D.M.–red	.300	4.95	DL704	C.C red	.300	1.25
MAN 3	C.C.–red	.125	.25	DL707	C.A.–red	.300	1.25
MAN 52	C.A.–green	.300	.99	DL728	C.C –red	.500	1.49
MAN 54	C.C.–green	.300	.99	DL741	C.A. red	.600	1.25
MAN 71	C.A. red	.300	.75	DL747	C.A.–red	.600	1.49
MAN 72	C.A.–red	.300	.75	DL750	C.C. red	.600	1.49
MAN 74	C.C. red	.300	1.25	DLO847	C.A.–orange	.800	1.49
MAN 82	C.A.–yellow	.300	.49	DLO850	C.C orange	.800	1.49
MAN 84	C.C –yellow	.300	.99	DL338	C.C red	.110	.35
MAN 3620	C.A.–orange	.300	.49	FND358	C.C. +1	.357	.99
MAN 3630	C.A orange +1	.300	.99	FND357	C.C.	.357	.75
MAN 3640	C.C.–orange	.300	.99	FND500	C.C. (FND503)	.500	.99
MAN 4610	C.A. orange	.400	.99	FND507	C.A (FND510)	.500	.99
MAN 6610	C.A. orange DD	.560	.99	HDSP-3401	C.A.–red	.800	1.50
MAN 6630	C.A orange +1	.560	.99	HDSP-3403	C.C –red	.800	1.50
MAN 6640	C.C.–orange DD	.560	.99	HDSP-3406	C.C. red +1	.800	1.50
MAN 6650	C.C.–orange +1	.560	.99	5082-7751	C.A.,R.H.D. red	.430	1.25
MAN 6660	C.A. orange	.560	.99	5082-7760	C.C.,R.H.D. red	.430	1.25
MAN 6710	C.A. red DD	.560	.99	5082-7300	4x7 Numeric (RHD)	.600	22.00
MAN 6740	C.C red –DD	.560	.99	5082-7302	4x7 Numeric (LHD)	.600	22.00
MAN 6750	C.C.–red +1	.560	.99	5082-7340	4x7 Hxdcl. (0-9/A-F)	.600	22.50
DLO304	C.C. orange	.300	1.25	4N28	Photo Xsistor Opto-Isol.		.69
DLO307	C.A. orange	.300	1.25	LIT-1	Photo Xsistor Opto-Isol		.69
DLG500	C.C. green	.500	1.25	MOC3010	Optically Isol. Triac Driver		1.25

COMPUTER GRADE CAPACITORS

MFD	WVDC	PRICE	MFD	WVDC	PRICE	MFD	WVDC	PRICE
750	150	1.95	10,000	15	2.95	24,000	20	2.95
500	200	7.49	10,000	16	3.95	27,000	10	2.95
1,250	3	.99	11,000	19	4.95	32,500	25	4.95
1,500	25	1.95	11,000	55	5.49	40,000	25	5.95
1,500	50	2.95	11,000	60	5.95	43,000	10	5.95
2,000	10	2.95	13,000	16	2.95	50,000	20	7.95
2,750	100	3.95	14,000	13	2.95	52,000	20	5.95
2,300	33	2.95	14,000	35	3.95	56,000	15	5.95
2,500	15	2.95	18,000	10	3.95	58,000	20	5.95
3,000	25	1.95	20,000	20	2.95	65,000	10	7.95
3,600	40	3.95	20,000	55	3.95	73,000	5	7.95
4,500	50	3.95	21,000	15	3.95	80,000	15	9.95
5,500	25	4.49	23,000	7	1.95	90,000	10	8.95
6,100	40	2.49	23,000	10	2.95	160,000	10	8.95
6,600	50	4.95	23,000	20	1.95	200,000	3	12.95

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

LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL (GOLD) STANDARD

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

WIRE WRAP SOCKETS (GOLD) LEVEL #3

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

1/4 WATT RESISTOR ASSORTMENTS – 5%

ASST. 1	5ea.	10 Ohm 12 Ohm 15 Ohm 18 Ohm 22 Ohm 27 Ohm 33 Ohm 39 Ohm 47 Ohm 56 Ohm	50pcs.	$1.95
ASST. 2	5ea.	68 Ohm 82 Ohm 100 Ohm 120 Ohm 150 Ohm 180 Ohm 220 Ohm 270 Ohm 330 Ohm 390 Ohm	50pcs.	$1.95
ASST. 3	5ea.	470 Ohm 560 Ohm 680 Ohm 820 Ohm 1K 1.2K 1.5K 1.8K 2.2K 2.7K	50pcs.	$1.95
ASST. 4	5ea.	3.3K 3.9K 4.7K 5.6K 6.8K 8.2K 10K 12K 15K 18K	50pcs.	$1.95
ASST. 5	5ea.	22K 27K 33K 39K 47K 56K 68K 82K 100K 120K	50pcs.	$1.95
ASST. 6	5ea.	150K 180K 220K 270K 330K 390K 470K 560K 680K 820K	50pcs.	$1.95
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NRI Model 212 VOM. Need operation manual and schematic. Mike Adams, Route 4, Box 764, Panama City, FL 32405.

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Hewlett Packard Model 400D VTVM. Need instruction book and schematic. J. P. Andrasko, 54-31 65th Pl., Maspeth, NY 11378.

Paco Model SA-40 amplifier. Need operating manual, schematic and service manual. G. Balok, 72000 Lassier, Romeo, MI 48065.

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RCA Model 280 console radio. Need owners manual, parts list, diagram, and service information. Harry T. Hubbart, W9ABF, Illinois Verterans Home, Cottage 90, Section 109-4, Quincy, IL 62301.

Precision Apparatus Model 860 multi-range volt-ohm-ampmeter. Need schematic or construction book. Allan Madsen, 4608 38th Ave NE, Salem, OR 97305.

Knight Model R-100A receiver. Need assembly and operation manuals. G. Ziolkowski, 700 E. Oakwood Rd., Oak Creek, WI 53154.

RCA Model 153 test oscillator. Need schematic and service manual. Dick Berzsenyi, 5240 Kenicott, Brighton, MI 48116.

Knight Model KN2500 CB radio. Need schematic and manual. Randy Stanley, 226 Rockwell Rd., Wilmington, NC 28405.

Lafayette Model 550 power amplifier. Need power transformer. Chris Lynt, 1316 Janney's Lane, Alexandria, VA 22302.

Roberts Model No. 450A, Serial No. 8387-0559 tape deck. Need schematic. Tony Morales, 1761 Virgo St., Venus Gardens, Rio Piedras, PR 00926.

Omnitec Model 701 acoustic modem. Need schematic, operating manual or any information available. Ron Hackett, 104 Fruita St., Port Jefferson, NY 11777.

Hallicrafters Model S-38 receiver. Need schematic, alignment information and manual. **Audiovox** MCB-1000 and **Sonic** Model 23 CB's. Need schematics. Thomas Sessa, 44 Ridge Rd., Yonkers, NY 10705.

Record-A-Call Model 80A telephone answering machine. Need schematic. Joseph Seidman, 8239 Brattle Rd., Pikesville, MD 21208.

FXR Model SG-215, serial #2A signal generator. Need service manual. T.S. Sebo, # 100-804 18 Ave., South-West, Calgary, Alberta, Can. T2T068.

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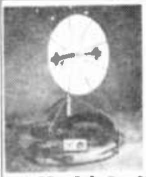

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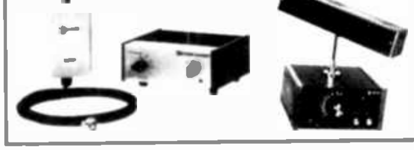

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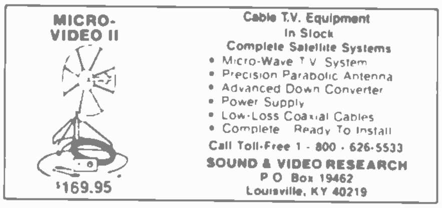

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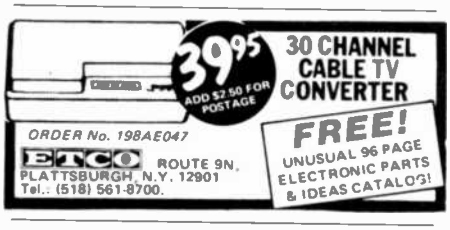

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VCR COPYRIGHT RULING from a 3-judge panel that stated it's illegal to record copyrighted material from TV broadcasts is being challenged by Sony Corp. Sony, filing for a rehearing, urged that a full 24-member panel of the Ninth Circuit Court of Appeals consider the issue. Interestingly, the chairman of Walt Disney Productions, a plaintiff, indicated he would support legislation making it legal to use a VCR to record copyrighted material in the home.

HANDS-ON MATHEMATICS for kids and other smart people is offered in an exhibit at the Boston Museum of Science. Called "Mathematica: A World of Numbers. . . and Beyond," it features an array of interactive devices, demonstrations, and models that involve the visitor in basic mathematical and scientific theories and principles to help him understand them. Integral calculus, for example, is illustrated by lowering wire frames into a soap solution. The soap film stretches across the frame to form the connecting surface with the least area. The principle of the Moebius Band is demonstrated by a 15-ft high model with a three-dimensional red arrow that travels continuously over its surface. The exhibit is sponsored by IBM.

RCA SHIPS TWO-MILLIONTH CED DISC, thereby providing a basis for a production goal of 10-million discs for 1982. Also planned for 82 is a new stereo model to be introduced to retailers in May. The current monophonic model, the SFT100, will be updated and released at about the same time. To date, RCA has produced 174 video disc titles under its own and MGM/CBS labels.

QUBE INTERACTIVE TELEVISION has been expanded to allow subscribers at home to retrieve a variety of consumer information directly from data banks, including that provided by national news organizations such as The New York Times and Washington Post. The new service, which is a joint project of Warner Amex, Atari, and CompuServe, was demonstrated live in Columbus, OH. An Atari 800 personal computer was used to access information from CompuServe data banks, which then appeared on a television screen. This included: news, weather, sports, food recipes and shopping tips, financial information, computer games, etc.

LOW-POWER TV STATIONS must comply with "sure and substantive interference standards and protections" according to the National Association of Broadcasters (NAB). The FCC, to which the NAB has made its appeal, would be responsible for ensuring that the transmission of full-service TV beyond the Grade B contour continues to be protected against low-power TV interference. NAB is therefore in favor of mileage separation requirement for transmitters; and against the use of additional receiving antenna directivity as an allocations tool.

SATELLITE SPACING may be reduced to 2° if the FCC has its way. The proposal would have the effect of doubling the present number of 4/6-GHz slots in geosynchronous orbit by eliminating the present requirement that there be 4° of longitude between each satellite. The loss of signal integrity and operational flexibility would be offset by recent improvements in antenna performance, according to the FCC. The step is necessary because of the sharp increase in geosynchronous satellite traffic expected during this decade: the FCC has already approved the construction of 25 new satellites and the launching of 20 others.

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