Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE NOVEMBER 1980/95¢

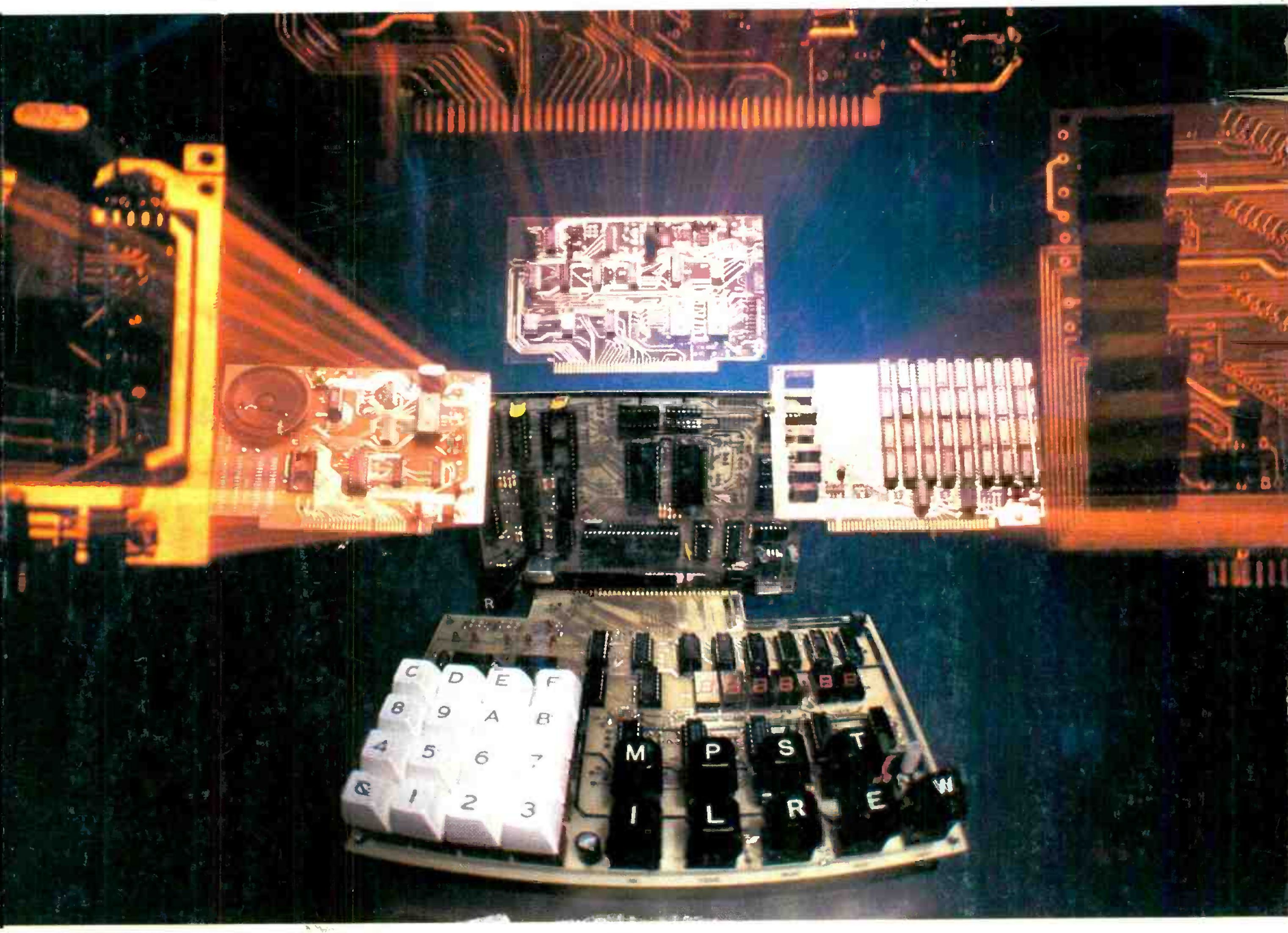
Preview: Panasonic's Four-Head Video Recorder

Guide To Floppy-Disk Formats

Computerized Tune Player With Expandable Memory

PE EXCLUSIVE:

Microprocessor Product Development System



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NOVEMBER 1980 VOLUME 18, NUMBER 5

Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

Feature Articles

Construction Articles

Equipment Reviews

Columns

Departments

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Editorial

The Great Software Ripoff

It is really amazing how many good, honest citizens who are kind to children and pets, help senior citizens across streets, and wouldn't think of keeping the extra nickel in change that the newsdealer gave by mistake are perfectly willing to steal software. After all, that's what it is when you make up ten cassettes of that new computer game for the guys in your club or when you and your brother-in-law chip in on a new album, one taking the disc and the other making a cassette copy. Not only are these practices fundamentally unethical, but they amount to taking potshots at the goose that lays the golden egg.

Naturally enough, anyone who invests capital in producing software of any description does so with the expectation of making a profit, and if the opportunity for that is taken away so is the motivation for creating the software in the first place. It was not too long ago that owners of the rights to high-level languages were almost willing to bypass the hobby market completely, fearing that they could not adequately fend off unauthorized distribution of their products. A repeat of that situation does not seem likely, but many of the small independent suppliers may well bail out if they find themselves working as a public service.

Though sanctions against unauthorized copying by individuals exist, even the RIAA (Recording Industries Association of America), the watchdog for the music recording industry, admits that enforcement is virtually impossible. And while sophisticated producers of computer software are often able to protect against piracy by hiding secret identifiers in their code (record companies cannot do the equivalent), they are equally powerless against individuals.

The only real solution to this is that people remember what is fair and act accordingly. Making a back-up copy (technically a violation of copyright) is one thing, but giving copies to all your friends is clearly another. If the problem remains serious, we may end up with a legislative solution (probably expensive) that no one will like. More important, the victims of software ripoffs are not faceless companies, but honest individuals who pay the price driven up by others who lack scruples. Another point to remember is that many software suppliers started as hobbyists, and you may someday be selling programs yourself.

Hal Rodgers

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Buzz Box

My wall timers were great for the first year. Then a strange thing happened.

By Joseph Sugarman, President JS&A Group, Inc.

This advertisement is about a few wall timers I installed in my home. I expected them to automatically turn my lights on and off and make my home appear lived-in, even when I wasn't at home.

But I was in for a surprise. The timers started to buzz. Not loudly, at first, but still very noticeably. Then, after a few months, they started buzzing more loudly. And finally a few of them pooped out completely.

ABSOLUTELY SILENT

No wonder. The timers I bought were mechanical devices with a motor and moving parts that switched on and off every 24 hours. In time, the parts aged and buzzed as they wore out. Eventually, they went out completely. I called my light timers, "Buzz Boxes" and knew the electronic revolution was not far behind with a silent and more dependable unit that would do a lot more.

Last month Dynascan Corporation contacted me with a new wall timer which they called the "Night Sentry." This one was totally solid state, no moving parts and above all, absolutely silent. But there were a few pleasant surprises.

LIVING PATTERN PROGRAM

The Night Sentry is very easy to program. Just turn a dial to the time (an AM or PM indicator appears) and press a button which turns on the light. Set the time you want the light to go off and press the same button to turn the light off. Keep repeating this process and the Night Sentry will remember the entire program and repeat it for you in silent accuracy year after year after year.

You can also program it in its 'living-pattern' mode. Simply turn your lights on and off throughout a typical day as you normally do. After 24 hours the Night Sentry will remember the exact pattern and your timer will operate your lights just as you yourself did—all automatically.

LONGER BULB LIFE

If by chance you have a power failure, the Night Sentry will keep its memory for at least 5 minutes. Since most power failures are momentary, you won't have to reprogram it. But if the power failure is longer than five minutes, when the power does come back on, your lights will remain in their off position.

The Night Sentry has a unique feature that in time could actually pay for the unit. Most bulbs burn out because the power surges each time a bulb is turned on. These power surges weaken a bulb. The Night Sentry has a built-in 'soft start' system that eliminates the surge and thus your bulb will last up to three times longer than its normal life. This is a very important feature for outdoor lighting where bulbs are often more difficult to change and seem to always go out in the dead of winter.

BATTLESHIP CONSTRUCTION

When Dynascan Corporation developed the Night Sentry, they decided to go overboard and produce a product that far exceeded standard specifications. For example, the Raytheon Triac used in the system was designed for 220-volt products—not just your

The Night Sentry is almost as small as a typical light switch so you could even install two of them in a double gang wall plate.

standard 110-volt wall switch. There are transient surpressors built to take a voltage surge of up to 2500 volts—in short the Night Sentry was built like a battleship.

Even if you've never installed a light switch in your life, you'd find it a snap to install the Night Sentry. Just turn off the power at your fuse box, connect two wires by twisting them together and screw the Night Sentry into your old electrical box. Installation takes less than five minutes and you use the same wall plate you had on your switch before.

I have recently replaced all of the timers in my home. I even added a few in places like my bedroom so that all my lights turn on when it's time to get up. I don't need an alarm clock now. My outdoor and indoor lights are now silently and efficiently controlled, and my house looks lived in even when I'm away.

TRY ONE OUT

We urge you to order a Night Sentry for only $24.95 plus $2.50 for postage and handling (Illinois residents add 6% sales tax) or order two for $47 plus $3.00 postage and handling. Credit card buyers may call our toll-free number below. We'll send you a Night Sentry solid-state timer complete with easy-to-install instructions and a one-year limited warranty. There is also a three-way switch timer for $5 extra per unit.

Then use the Night Sentry for a month. Program it. See how silently it operates and then order more for the other rooms in your house. If, however, you're not completely satisfied, return your unit within 30 days for a prompt and courteous refund, including your postage and handling.

I can personally recommend the Dynascan Night Sentry timers. I have them throughout my home and my friends have them too. They really add to our security and peace of mind and I urge you to at least order one at no obligation, today.

JS&A

Dept.PE One JS&A Plaza
Northbrook, Ill. 60062 (312) 564-7000
Call TOLL-FREE 800 323-6400
In Illinois Call .... (312) 564-7000

The Age of Affordable Pers

In 1978 Ohio Scientific introduced a revolutionary new low cost computer — the Superboard II. This computer provides all important personal computer features on a single board at a cost of under $300. The Superboard II received rave reviews by microcomputer experts such as:

"We can heartily recommend the Superboard II computer system for the beginner who wants to get into microcomputers with a minimum of cost. Moreover, this is a 'real' computer with full expandability."
POPULAR ELECTRONICS MARCH, 1979

"The Superboard II weighs in at $279 and provides a remarkable amount of computing for this incredible price."
KILOBAUD MICROCOMPUTING FEBRUARY, 1979

"The Superboard II and its fully dressed companion the Challenger 1P series incorporate all the fundamental necessities of a personal computer at a very attractive price. With the expansion capabilities provided, this series becomes a very formidable competitor in the home computer area."
INTERFACE AGE APRIL, 1979

"The graphics available permit some really dramatic effects and are relatively simple to program . . . The fact that the system can be easily expanded to include a floppy means that while you are starting out with a low-cost minimal system, you don't have to throw it away when you are ready to go on to more complex computer functions. At $279, Superboard II is a tough act to follow."
RADIO ELECTRONICS JUNE, 1979

"The Superboard is an excellent choice for the personal computer enthusiast on a budget."
BYTE MAY, 1979

Since the introduction of Superboard II, the cost of personal computers has actually gone up with new models by major manufacturers ranging from $1000 to well over $4000 due to the general cost of inflation and the increasing functionality included in these computers. Today Cleveland Consumer Computers is offering you the original Superboard II at its original price of just $279. In today's economy this is by far the best buy in personal computing ever!

The Superboard II can entertain your whole family with spectacular video games and cartoons, made possible by its ultra high resolution graphics and super fast BASIC. It can help you with your personal finances and budget planning, made possible by its decimal arithmetic ability and cassette data storage capabilities. It can assist you in school or industry as an ultra powerful scientific calculator, made possible by its advanced scientific math functions and built-in "immediate" mode which allows complex problem solving without programming! This computer can actually entertain your children while it educates them in topics ranging from naming the Presidents of the United States to tutoring trigonometry — all possible by its fast extended BASIC, graphics and data storage ability.

The machine can be economically expanded to assist in your business, remotely control your home, communicate with other computers and perform many other tasks via the broadest line of expansion accessories in the microcomputer industry.

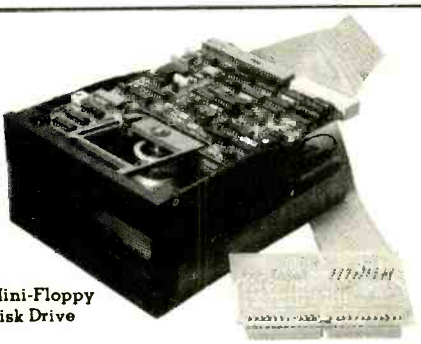
This machine is super easy to use because it communicates naturally in BASIC, an English-like programming language. So you can easily instruct it or program it to do whatever you want, but you don't have to. You don't because it comes with a complete software library on cassette including programs for each application stated above. Ohio Scientific also offers you hundreds of inexpensive programs on ready-to-run cassettes. Program it yourself or just enjoy it; the choice is yours.

The Superboard II comes fully assembled and tested. It requires +5V at 3 Amps and a video monitor or TV with RF converter to be up and running. $279.00

Standard Features:

- Uses the ultra powerful 6502 Microprocessor.
- 8K Microsoft BASIC-in-ROM. Full feature BASIC runs faster than currently available personal computers and all 8080 based business computers.
- 4K static RAM on board expandable to 8K.
- Full 53-key keyboard with upper/lower case and user programmability.
- Kansas City standard audio cassette interface for high reliability.
- Full machine code monitor and I/O utilities in ROM.

onal Computing is Still Here.



Mini-Floppy Disk Drive

Direct access video display has 1K of dedicated memory (besides 4K user memory), features upper case, lower case, graphics and gaming characters for an effective screen resolution of up to 256 x 256 points. Normal TV's with overscan display about 24 rows of 24 characters without overscan up to 30 x 30 characters.

Optional Extras:

- Available 610 expander board features up to 24K static RAM (additional), dual mini-floppy interface, and an OSI 48 line expansion interface.
- Assembler/Editor and Extended Machine Code monitor available.
- 630 I/O Expander. RGB color and NTSC composite color outputs with up to 16 colors, Dual 8-axis joystick interface, AC remote control interface which mates with AC-12P, home security interface which mates with the AC-17P, 16-line parallel I/O interface, 16-pin I/O bus interface which allows the connection of parallel I/O lines or high speed analog I/O module, or a PROM blaster or solderless interface prototyping board, programmable sound generator and program selectable modem and high speed printer ports, and more.

Freight Policies All orders of $100 or more are shipped freight prepaid. Orders of less than $100 please add $4.00 to cover shipping costs. Ohio Residents add 5.5% Sales Tax.

Guaranteed Shipment Cleveland Consumer Computers & Components guarantees shipment of computer systems within 48 hours upon receipt of your order. **Our failure to ship within 48 hours entitles you to $35 of software, FREE.**

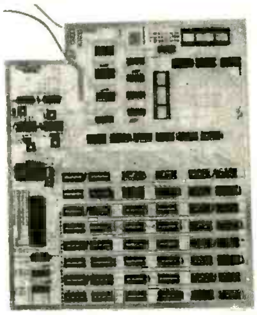
master charge VISA

Hours:
Call Monday thru Friday
8:00 AM to 5:00 PM E.D.T.

Software:

Ohio Scientific and independent suppliers offer hundreds of programs for the Superboard II, in cassette and mini-floppy form. Here is a sampling of popular Ohio Scientific programs for the Superboard II.

EDUCATIONAL PROGRAMS	SBII&C1P	Price
BASIC Tutor Series	SCE-336	$35.00
Clock Tutor	SCE-353	6.50
Continents Quiz	SCE-332	6.50
Definite Integral	SCE-326	6.50
French Drill & Tutor	SCE-339	6.50
German Tutor & Drill	SCE-342	6.50
Hangman (8K)	SCE-324	9.00
Log Tutors 1-3	SCE-344	6.50
Math Blitz	SCE-329	6.50
Math Intro	SCE-319	6.50
Mathink	SCE-337	9.00
Matrix Tutors 1-3	SCE-345	6.50
Metric Tutor & Quiz	SCE-335	6.50
Spanish Drill & Tutor	SCE-352	6.50
Spelling Quiz	SCE-333	6.50
Trig Tutor (8K) I & II	SCE-318	6.50
BUSINESS PROGRAMS		
Address Book	SCB-523	9.00
Advertisement Demo	SCB-520	6.50
Inventory Demo	SCB-518	6.50
Mailing List (8K)	SCB-524	6.50
Straight & Constant Depreciation	SCB-500	9.00
Time Calculator	SCB-525	9.00
PERSONAL PROGRAMS		
Biorhythm	SCP-716	9.00
Calorie Counter	SCP-708	6.50
Checking Account	SCP-719	9.00
Loan Finance	SCP-717	6.50
Personal Calendar	SCP-718	6.50
Savings Account	SCP-720	9.00
GAME PROGRAMS		
Baseball I	SCG-975	6.50
Black Jack	SCG-955	6.50
Civil War	SCG-977	6.50
Destroyer	SCG-951	6.50
High Noon	SCG-960	6.50
Hockey	SCG-979	6.50
Lander	SCG-925	6.50
New York Taxi	SCG-956	6.50
Poker	SCG-962	6.50
Racer	SCG-949	6.50
Space War	SCG-942	6.50
Star Trek	SCG-946	6.50
Star Wars	SCG-926	6.50
Tic-Tac-Toe	SCG-945	6.50
Tiger Tank	SCG-950	14.00



610 Board

CS-600

Hardware:

Superboard II	as specified in the advertisement.	$279
610 Board	For use with Superboard II and Challenger 1P, 8K static RAM expandable to 24K or 32K system total. Accepts up to two mini-floppy disk drives. Requires +5V@ 4.5 amps.	298
Mini-Floppy Disk Drive	Includes Ohio Scientific's PICO DOS software and connector cable. Compatible with 610 expander board. Requires +12V@ 1.5 amps and +5V@ 0.7 amps.	299
630 Board	As specified in the advertisement.	229
AC-3P	12" combination black and white TV/video monitor.	159
4KP	4K RAM chip set.	79
PS-005	5V 4.5 amp power supply for Superboard II.	35
PS-003	Mini-floppy power supply.	29
C1P Sams	C1P/Superboard II Manual.	8
OS-65D	V3.2 Disk Operating System with 9-digit extended BASIC, random access and sequential files.	49
CS-600	Metal case for Superboard II, 610 and 630 board and two power supplies.	49
CS-610	Metal case for single floppy disk drive and power supply.	49
AC-12P	Wireless AC remote control system. Includes control console, two lamp modules and two appliance modules for use with 630 board.	175
AC-17P	Home security system. Includes console, fire detector, window protection devices and door unit for use with 630 board.	249
C4P Sams	C4P Manual.	16
C3 Sams	Challenger III Manual.	40

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Or to get our free catalog **CALL 1-800-321-5805 TOLL FREE.**
Charge your order to your **VISA** or **MASTER CHARGE** ACCOUNT
Ohio Residents Call: (216) 464-8047. Or write, including your check or money order, to the address listed below.

CLEVELAND CONSUMER COMPUTERS & COMPONENTS
P.O. Box 46627
Cleveland, Ohio 44146

Order Form:

CLEVELAND CONSUMER COMPUTERS & COMPONENTS **P.O. Box 46627 Cleveland, Ohio 44146**

☐ Superboard II $279. ☐ 630 Board $229.
☐ 610 Board $298. ☐ AC-3P 12" B-W Monitor $159.
☐ Mini-Floppy Disk Drive $299. ☐ C1P Sams Manual $8.
(Attach separate sheet for other items.)
NAME:__________
ADDRESS:__________
CITY:__________ STATE:__________ ZIP:__________
Payment by: VISA: __ MASTER CHARGE: __ MONEY ORDER: __
Credit Card Account #__________
Expires:__________ Interbank # (Master Charge)__________
TOTAL CHARGED OR ENCLOSED: $______ (Ohio Residents add 5.5% Sales Tax)
All orders shipped insured UPS unless otherwise requested. FOB Cleveland, Ohio.

CIRCLE NO. 55 ON FREE INFORMATION CARD

Video Review® knows a bright idea when it sees one.

Simulated TV picture. Simulated wood cabinet.

Video Review magazine tests a lot of sophisticated video products.

They get to see virtually every make and type of color TV receiver.

Which makes their selection of Magnavox as their standard TV receiver pretty impressive.

"We thought the Magnavox picture quality and resolution were superb."

"Ever since *Video Review* began testing products," says the magazine, "we've been looking for a top quality, 19-inch TV set that might serve as a standard of reference for all of the other products we test...video cameras, video cassette recorders, video cassettes.

"We thought the Magnavox picture quality and resolution were superb, and that off-the-air sensitivity was also extremely good.

"Major VHF channels were received with uniformly accurate color fidelity. This receiver produced superior color pictures even when using its own indoor VHF and UHF antennas."

"The special tuning features and remote control capabilities of the Magnavox receiver are awesome."

"The tuning system is purely electronic and totally digital," they continue. "There is a fine tune switch and a memory lock button. If any channel is received mistuned, the user simply fine tunes up or down in frequency by holding the button, and when perfect tuning has been achieved, the button is released and the memory lock button is depressed once.

"Nearby is Magnavox's Videomatic feature. Depressing this button activates the electronic eye for automatic brightness adjustment, color adjustment circuits and automatic fine tune."

"...unusually good for any receiver."

Overall, *Video Review* rated the Magnavox 9.5 or better (out of a possible 10.0) on Video Quality, Reception Sensitivity, Color Fidelity, and Video Resolution and Fidelity. As they put it, "...unusually good for any receiver."

We can only add that once you see a Magnavox color TV at your Magnavox dealer, we think you'll agree.

For Magnavox color TV specifications, write Magnavox Consumer Electronics Company, Dept. 700, P.O. Box 6950, Knoxville, Tennessee 37914.

MAGNAVOX

The brightest ideas in the world are here to play.

CIRCLE NO. 46 ON FREE INFORMATION CARD

Letters

Noise Generators and Tinnitus

I have had several letters with regard to uses for noise generators such as those described in my Experimenter's Corner of March 1980. One of the more interesting came from a reader who suffers from tinnitus (the perception of sounds which are not actually present). He wondered if a noise generator would be effective in masking the tinnitus, which, in his case, is both a background noise and a pulsative noise synchronized with his heartbeat. He noted that he gets some relief by listening to the "pepper and salt" noise produced by a nonbroadcast TV channel via an earphone. He also stated that his background tinnitus is almost eliminated by the high-pitched sounds produced by crickets and other insects on a summer evening.

It is indeed possible that a noise generator could be used to partially alleviate tinnitus by simulating and masking the noise. If any reader has suggestions or wishes to correspond with the original letter writer regarding tinnitus or pulse-triggered masking circuits, please send them to me in care of POPULAR ELECTRONICS and I will forward them.—*Forrest M. Mims.*

Switch Identification

In "Experimenting with a Sound-Effects Generator" (May 1980), one side of switches *S14* through *S18* is labeled 0. Does this mean "logic 0"? If so, where is it supposed to be connected? To ground?—*Dale Hileman, Topanga, CA 90290.*

As identified in Table II, one side of each of these switches is connected to logic 0, which in this case is ground, logic 1 being +5 volts. The switch points can all be connected together and then to ground.—Ed.

Out of Tune

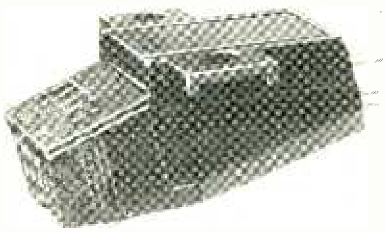
In "Build a LED Pendulum for Digital Clocks" (July 1980, p. 30), the connections between the 7400 and the 7442 should be reversed. That is, pin 1 of the 7400 should go to pin 11 of the 7442 and pin 5 of the 7400 to pin 1 of the 7442.

In the Project of the Month in August 1980, the output terminal of the 741 op amp should be labelled 6 instead of 1.

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.

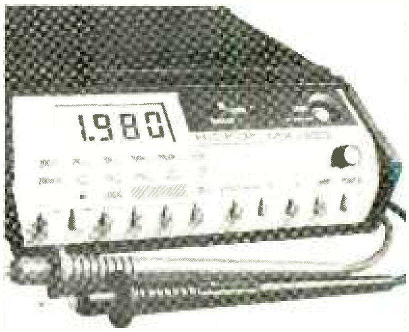
Micro-Acoustics Phono Cartridge



Micro-Acoustics has announced a line of "System II" phono cartridges that it claims are the lightest weight, fastest-transient-response cartridges ever manufactured. The Model 3002 is the middle of the three-model line. It uses a direct-coupled microminiature transducer instead of magnet coils for improved transient response. Use of the electret transducer, a low-mass carbon-fiber housing, hair-thin beryllium cantilever, and an almost microscopic diamond stylus are responsible for the weight reduction. The ultra-low mass of the cartridge is said to aid in accurate tracking and reduced record wear. Specifications: frequency response, 5 to 20,000 Hz ±1.25 dB; tracking force, 0.7 to 1.4 g; transient ability (rise time), 5 μs; channel separation, 30 dB at 1 kHz, 20 dB at 10 kHz; cable capacitance/phono input load resistance (not critical), 25 to 100 pF/5 to 100 kΩ; cartridge weight; 2.5 to 4 g. $150.

CIRCLE NO. 87 ON FREE INFORMATION CARD

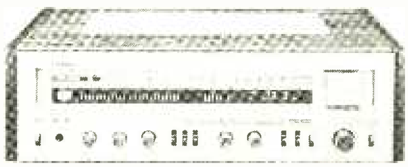
"Singing" DMM



The MX333 Digital Multimeter from Hickok Electrical Instrument Co., features 3½-digit LCD display, auto zero, polarity, and decimal point. It measures dc and ac voltage from 200 mV to 1 kV in five ranges with 10 megohms input resistance. Resistance is measured in seven ranges from 20 ohms to 20 megohms with overload protection to 500 volts dc. The test voltage is 0.25 volt maximum full scale and 3.2 volts open circuit. Current, ac and dc, is measured from 2 mA to 10 A in five ranges, and a diode test function is provided. The MX333 contains VARI-PITCH, an audible tone with frequency proportional to the meter indication, and LOGI-TRAK, which combines the features of a logic probe and voltmeter and is said to catch pulses as short as 5 ns. Any standard 10:1 high-frequency scope probe can be connected to the MX333. $235.

CIRCLE NO. 88 ON FREE INFORMATION CARD

Technics "Class-A" Stereo Receiver



The Model SA-616 stereo receiver from Technics features a power amplifier, said to eliminate switching distortion, and rated to deliver 80 watts/channel into 8 ohms from 20 to 20,000 Hz with no more than 0.005% THD. It uses a quartz synthesizer tuner, with digital display of station frequency. Manual tuning is accomplished by pressing the up/down scanning bar, providing 200-kHz steps on FM and 10-kHz steps on AM. Furthermore, 16 stations (8 each AM and FM) can be preset for instant recall at the touch of a button. Other features: two-way tape dubbing; h/mi-range boost/cut switches; LED power display: and protection/safety indicators.

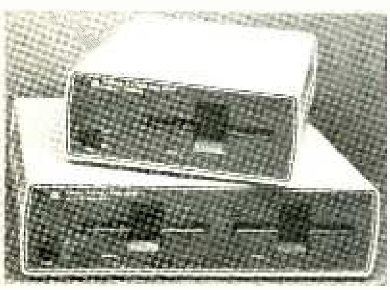
CIRCLE NO. 89 ON FREE INFORMATION CARD

Indoor Scanner Antenna

Antenna Incorporated's Persuader is designed for scanner monitoring of the public service bands between 25 and 900 MHz. It is meant to be hidden behind curtains or drapes and is said to outperform the short, stock telescopic antennas provided with most scanning monitors. It consists of a seven-foot wire antenna element that is to be attached vertically to an interior wall, a small adhesive-backed box to be mounted on the baseboard, a two-foot length of wire for attachment to a ground, and a ten-foot length of signal cable terminated with a pin plug for insertion into the scanning monitor's antenna receptacle. $11.95.

CIRCLE NO. 91 ON FREE INFORMATION CARD

Disk Drive for HP-85 Computer

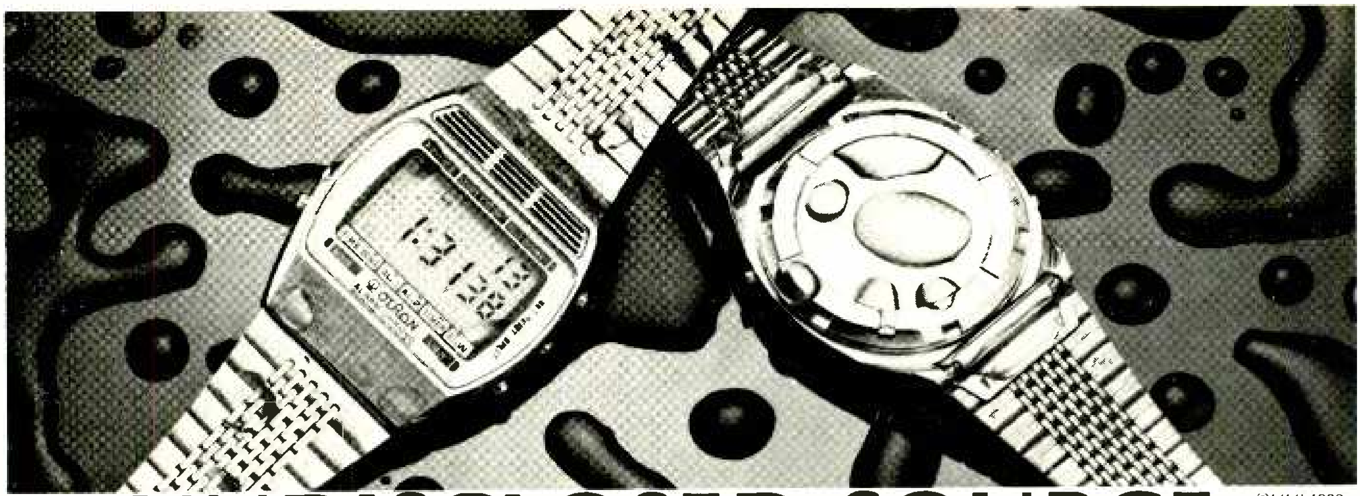


The HP 82900 Series disk drive from Hewlett-Packard reads double-sided, double-density 5¼" diskettes and can be configured to provide from 270K bytes to 1.08M bytes of storage for the HP-85 Personal Computer. With its interface, the HP-85 Mass Storage ROM ($145), plugged into the HP-85, the disk system is ready at power turn-on. The ROM also includes 30 additional BASIC commands, as well as a TRANSLATE command to automatically upgrade tape-based programs for the disk. It provides the ability to store and retrieve graphics, data forms and labelled charts; automatic default to disk; and volume labeling that allows the user to refer to disks by name and write programs independent of drive addresses. The HP 82901M dual master drive having 540K bytes storage costs $2500, the HP 82901S dual add-on drive for 1.08M bytes $2200, the HP 82902M single drive (270K bytes) $1500, and the HP 82902S single add-on drive (total 540K bytes) $1300.

CIRCLE NO. 86 ON FREE INFORMATION CARD

FET Power Amplifier

Optonica's Model SX-9305 power amplifier is rated to deliver 100 watts minimum power per channel into 8 ohms from 20 to 20,000 Hz with no



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UNDISCLOSED SOURCE

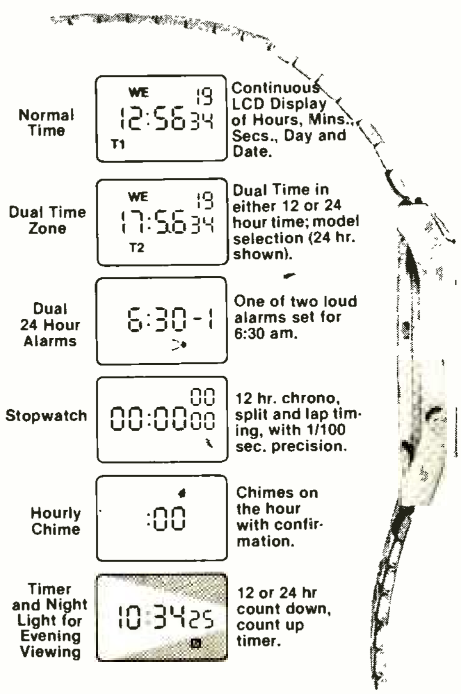
Now, the closely held secret behind many of today's quartz timepieces is revealed.

Most major companies would rather have these facts remain secret, but one little-known company decided to show its genius to the world.

To effectively compete in world markets and when lacking in necessary technology, many major companies have turned to smaller more dynamic companies to build their products. Sometimes the product is built to the specs of the major company. But more often than not, the only unique parts are a label and different owner's manual. This practice is quite prevalent in the digital watch industry.

One company that has been the real source behind products introduced in the U.S. by companies like Mattel, Timex and Texas Instruments, is Olympos Electronic Co., also known as Otron.

Olympos Electronic now wants the world to know its name and genius. We feel lucky to be selected to bring this story to you.



Olympos Electronic Co. is now introducing products into this country under its own trade name—Otron. We are introducing one of the first Otron products into the U.S.

12 or 24 HOUR DUAL TIME, DUAL ALARM CHRONOGRAPH

The first product we selected is the Alarm Chrono X watch. It may be the most advanced Quartz timepiece in the world today for under $200.

We know of no other watch that combines these unique features and design. It has both a 2nd time zone capability and a 2nd separate alarm. It comes in either 12 or 24 hour version. These features are just the beginning. Compare this watch feature-for-feature against any other in the world. We believe you will be convinced that there is not a better watch dollar-for-dollar anywhere.

TESTED TO 100 FEET OF WATER

Three years ago, there were no digital water resistant alarm watches. Today they exist in some more advanced models, but cost $100, $200 or more. Our Alarm Chrono X is submersible to 100 feet of water. Its unique alarm emits sound right thru the stainless steel case. The O-ring construction and rock hard mineral glass lens provide a lock tight seal against water to 100 feet—it's guaranteed.

THINNESS AND BOLD MASCULINE DESIGN

The Alarm Chrono X is a combination of bold masculine design and just the right degree of thinness. No sacrifice in function or masculinity, the Chrono X measures 8.9 mm from the top of its mineral glass lens to the back of its stainless steel case. That's 1.6 mm thinner than the popular Seiko Alarm Chronograph, 2.1 mm thinner than the Citizen and 3.1 mm thinner than Texas Instruments. Yet Alarm Chrono X has the same bold design of each. The Seiko sells for $250; the Citizen for $200; and the T.I. for $125. . .What does Otron know that these other companies don't?

UNSURPASSED QUALITY AND ACCURACY FOR UNDER $70

Stainless steel case, and finely woven mesh bracelet, mineral glass lens, water resistant to 100 feet and quartz accuracy to ±5 seconds per month. That's quality and accuracy found only in watches costing $200 or more. The Alarm Chrono X sells for $69.95 in stainless steel case and $79.95 in gold with 3 microns of real gold over stainless. Compare features and price for yourself before you call to order.

ORDER TOLL FREE AT NO-RISK

The Alarm Chrono X is offered with a 15 day no-risk trial period. If during 15 days, you find the Alarm Chrono X not to your liking return it for a prompt refund of your purchase price.

In the unlikely event that anything should go wrong after the trial period, your Alarm Chrono X is backed by a full year warranty thru Otron's Service by mail repair facility in this country.

To order your Alarm Chrono X fill out the order form below and send it with check or money order to us. For faster service, credit card customers call Toll Free 1-800-527-7066. Don't wait — order today to insure getting a watch of this quality, with these functions, at this price.

MEDIA MARKETING

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☐ 12 Hour time ☐ 24 Hour time

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State ________ Zip ____________

☐Check or M.O. enclosed

For even faster service, charge to:

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Account # ____________________

Signature ____________________

Order Toll Free **1-800-527-7066.**

In Texas call COLLECT: **214-349-3120.** PE-110

CIRCLE NO. 48 ON FREE INFORMATION CARD

more than 0.01% THD. It uses FET circuitry and direct coupling throughout. The power supply employs a toroidal transformer, and a gas/liquid heat-radiation system cools the output stage. The package includes a 10-band audio spectrum analyzer (switchable to display left or right channel) and LED power indicators, as well as a detented volume control and speaker selector switch (A, B, or A + B). $850.

CIRCLE NO. 92 ON FREE INFORMATION CARD

EPROM Eraser

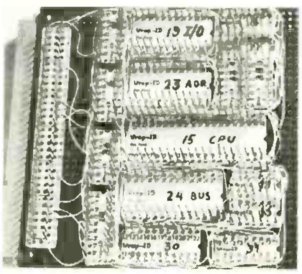
Operating at 2537 Angstroms with a power of 1.5 watts, the QUV-T8 UV EPROM Eraser can be used with 2704, 2708, 2716, 2532, 2564, and similar ultraviolet erasable EPROMs. Claimed erase time is 25 minutes at a distance 1 inch from the ultraviolet source. The ultraviolet lamp requires 8 watts and has a rated 7700-hour operating life. $34.95. Address: Logical Devices, Inc., 1525 N. E. 26th St., Ft. Lauderdale, FL 33305.

Kenwood 2-Meter FM Transceiver

Trio-Kenwood Communications' new Model TR-7800 FM transceiver covers the 2-meter amateur band as well as adjacent CAP and MARS frequencies (143.900-148.995 MHz). The microprocessor-controlled transceiver can be tuned to a desired frequency by means of either a keypad or a rotary tuning control. Fifteen programmable memory locations accept frequency and offset instructions. One of them accepts transmit and receive frequencies independently for access to repeaters with nonstandard splits, while another is for a "priority" channel. (An audible alert is generated upon receipt of a signal on the priority channel if this function is activated, and the push of a switch tunes the rig to that channel.) Information is retained in the memories after removal of power if four AA NiCd batteries are installed. The front-panel keypad also controls an internal tone encoder for autopatch use, and is used to select transmit offsets, to program the memories, and to control the rig's scanning function. The latter can scan all 15 memory channels and the entire band in 5- or 10-kHz steps. Two buttons (UP and DOWN on the microphone's case) permit manual scanning of the band. Two seven-segment LED readouts display the memory channel selected and the receive frequency. A LED bargraph displays received signal strength and transmitter r-f output. Rated sensitivity is 0.5 μV for 30 dB (S+N)/N; selectivity −60 dB at $\pm$12 kHz; and r-f output power into 50 ohms is 25 watts or 5 watts (switchable). Current demand is 6 amperes max. at 13.8 volts. The rig weighs 4.6 lb and measures $8\frac{1}{16}$" D × $6\frac{7}{8}$" W × $2\frac{1}{2}$" H. $399.95.

CIRCLE NO. 95 ON FREE INFORMATION CARD

ID System for Wrapped-Wire Sockets



OK Machine and Tool Corp. is now offering the "Socket-Wrap I.D.," an identification system designed for use with wrapped-wire IC sockets. This system comprises a number of socket-size plastic panels with numbered holes punched at the appropriate hole locations. A panel is simply slipped onto the protruding pins of the socket to be identified, after the socket has been mounted on the perforated circuit board but before any wrapped-wire connections have been made. The user can write the socket location, its IC type number, function, or similar data on the plastic panel with a felt-tipped marking pen. Benefits of the Socket-Wrap I.D. system include simplified assembly of a wrapped-wire project and easier troubleshooting and repair should they be required.

CIRCLE NO. 93 ON FREE INFORMATION CARD

JBL Compact Speaker System

A new three-way ported speaker system from James B. Lansing, Model L112, is designed in mirror-image pairs for more accurate stereo. The system features a new 1" dome-radiator tweeter, 5" midrange driver, and 12" woofer, plus a "High Resolution" dividing network. Tweeter and midrange level controls are located on the front panel, behind the grille cloth. The enclosure is constructed of dense compressed-wood panels faced with American black walnut veneer. The L112 can be driven by as little as 10 watts of power, and handles up to 300 watts continuous power. Size is $24\frac{1}{2}$" H × $14\frac{1}{4}$" W × 13"D.

CIRCLE NO. 94 ON FREE INFORMATION CARD

TRS-80 Cassettes Load at Disk Speed

Personal Micro Computers Inc., announces a Fastload Cassette Interface said to input data to a TRS-80 Model I, Level II computer at 8000 baud (16

times normal speed) using a modified CTR-41 recorder. Any cassette saved at normal (500 baud) speed can now be loaded at high speed. Fastload is also capable of high-speed search for BASIC programs by a single character designation, or system programs having a name up to six characters in length. High-speed recording is not provided. The system contains a keyboard debounce program having automatic repeat and provides a sound output for each keystroke. Instructions for the CTR-41 modification are provided. $188. Modified CTR-41 recorder is $95.

CIRCLE NO. 96 ON FREE INFORMATION CARD

(Continued on page 15)

The first personal computer for under $200.

The Sinclair ZX80. A complete computer— only $199.95 *plus $5.00 shipping.*

Now, for just $199.95, you can get a complete, powerful, full-function computer, matching or surpassing other personal computers costing several times more.

It's the Sinclair ZX80, the computer that independent tests prove is faster than all previous personal computers. The computer that "Personal Computer World" gave 5 stars for 'excellent value.'

The ZX80 cuts away computer jargon and mystique. It takes you straight into BASIC, the most common, easy-to-use computer language.

You simply take it out of the box, connect it to your TV, and turn it on. And if you want, you can use an ordinary cassette recorder to store programs. With the manual in your hand, you'll be running programs in an hour. Within a week, you'll be writing complex programs with confidence.

All for under $200.

Sophisticated design makes the ZX80 easy to learn, easy to use.

We've packed the conventional computer onto fewer, more powerful LSI chips— including the Z80A microprocessor, the faster version of the famous Z80. This makes the ZX80 the world's first truly portable computer (6½" x 8½" x 1½" and a mere 12 oz.). The ZX80 also features a touch sensitive, wipe-clean keyboard and a 32-character by 24-line display.

Yet, with all this power, the ZX80 is easy to use, even for beginners.

Your course in computing.

The ZX80 comes complete with its own 128-page guide to computing. The manual is perfect for both novice and expert. For every chapter of theory, there's a chapter of practice. So you learn by doing—not just by reading. It makes learning easy, exciting and enjoyable.

The ZX80's advanced design features.

Sinclair's 4K integer BASIC has performance features you'd expect only on much larger and more expensive computers. These include:

- Unique 'one touch' entry. Key words (RUN, PRINT, LIST, etc.) have their own single-key entry and are stored as a single character to reduce typing and save memory space.
- Automatic error detection. A cursor identifies errors immediately to prevent entering programs with faults.
- Powerful text editing facilities.
- Also programmable in machine code.
- Excellent string handling capability—up to 26 string variables of any length.
- Graphics, with 22 standard symbols.
- Built-in random number generator for games and simulations.

Sinclair's BASIC places no arbitrary restrictions on you—with many other flexible features, such as variable names of any length.

And the computer that can do so much for you now will do even more in the future. Options will include expansion of 1K user memory to 16K, a plug-in 8K floating-point BASIC chip, applications software, and other peripherals.

Order your ZX80 now!

The ZX80 is available only by mail from Sinclair, a leading manufacturer of consumer electronics worldwide. We've already sold tens of thousands of units in Europe, so demand will be great.

To order by mail, use the coupon below. But for fastest delivery, order by phone and charge to your Master Charge or VISA. The ZX80 is backed by a 30-day money-back guarantee, a 90-day limited warranty with a national service-by-mail facility, and extended service contracts are available for a minimal charge.

Price includes TV and cassette connectors, AC adaptor, and 128-page manual.

All you need to use your ZX80 is a standard TV (color or black and white). The ZX80 comes complete with connectors that easily hook up to the antenna terminals of your TV. Also included is a connector for a portable cassette recorder, if you choose to store programs. (You use an ordinary blank cassette.)

The ZX80 is a family learning aid. Children 10 and above will quickly understand the principles of computing—and have fun learning.

Phone orders only: (203) 265-9171. We'll refund the cost of your call.
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Sinclair Research Ltd., 475 Main St., P.O. Box 3027, Wallingford, CT 06492.

To: **Sinclair Research Ltd., 475 Main St., P.O. Box 3027, Wallingford, CT 06492.**
Please send me ________ ZX80 personal computer(s) at $199.95* each (US dollars), plus $5 shipping. (Your ZX80 may be tax deductible.)
I enclose a check/money order payable to Sinclair Research Ltd. for $________.

Name ____________________

Address ____________________

City ________ State ________ Zip ________

Occupation: ____________________ Age: ________

Intended use of ZX80: ____________________

Have you ever used a computer? ☐ Yes ☐ No.
Do you own another personal computer? ☐ Yes ☐ No. *For Conn. deliveries, add sales tax.

PE-11-0

HEAR WHAT YOU'VE BEEN MISSING!

Listen with an 801 Omnisonic Imager,™ a quantum leap forward in sound reproduction!

OMNISONIC IMAGERY™ IS HERE!
Our innovative state-of-the-art electronics restore the acoustical time-field characteristics and angular sonic positioning of the original recorded signal. The 801 analyzes the input signal and determines relative positions of instruments and vocals on the original source. They are then placed about the listening space creating the physiological sensation of three-dimensional sound – what we call omnisonic imagery™ – using only *two* speakers!* Sound appears to come from many sources within the listening space. A common reaction is to look about for other speakers. *And you don't have to sit rigidly fixed at a focal point between the speakers to enjoy the 801!*
*2 or more speakers!

LIFETIME WARRANTY!
You get a **lifetime warranty** on the active circuitry and one year on all other components (case and line cord excluded) provided your 801 is used as specified.
SUGGESTED LIST: ONLY $179.95

NEW DIMENSIONS IN STEREO AND MONO!
Stereo with an 801 Omnisonic Imager™ creates a vivid feeling of "being there". Depending upon the source, the system, and the listener, sound appears to surround you, emanating from well beyond the speakers, above and below, near and far. The music is so alive it envelopes you. It is the sound of the future!

From mono, the 801 creates omnisonic dimensional sound.™ You can input an AM or TV source (from the earphone jack on your set) via the 801 and into your stereo system. The result is a "live" sound with depth and clarity, as well as separation. Television sound is vastly improved with the 801!

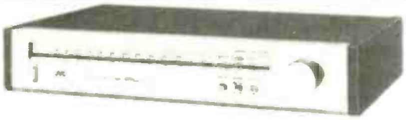
RETROFITS TO MOST STEREO SYSTEMS!
Any system with an internal tape loop can connect to the 801. Component systems can insert the 801 between pre-amp, other accessories, and the amplifier. There's a built-in tape monitor button on the 801, so you don't lose your existing tape monitor facility. The 801 works on any stereo or mono source – FM, tapes, records, AM, TV. You can record selections via the 801 and replay them on conventional home-use stereo equipment.

Now that you've read all about our 801 Omnisonic Imager™, don't you think it's time to hear one? If we have stimulated your interest in seeking the finest sound reproduction in the purest sense, please ask your dealer for a live demonstration. If you have any questions, or need to know the name of the dealer nearest you, call or write to:

ΩMNISONIX, LTD.
P.O. Box 430
Northford CT U.S.A. 06472
(203) 239-6213

DON'T MISS: Highway HiFi Imagery With The 801-A Auto Unit Coming Soon!

Low-Cost AM/FM-Stereo PLL Tuner



JVC's newly announced Model T-X3 is a low-cost stereo FM/AM tuner that features phase-locked-loop (PLL) tuning, phase tracking loop (PTL) FM-detector circuitry, and quieting slope control. The PTL system increases selectivity with wide bandpass response, while the quieting slope control automatically corrects weak FM signals by compensating the amount of left-with-right high-frequency mixing. The tuner's 50-dB quieting sensitivity on FM stereo is 31 dBf (quieting on auto), 36.8 dBf (quieting off). Other specifications: stereo separation, 50 dB at 1 kHz; 0.15% stereo distortion at 100 Hz and 1 kHz; S/N, 78 dB stereo; frequency response, 30 to 15,000 Hz + 0.3/−2 dB; capture ratio, 1.0 dB. Size is 3½" H × 18¹¹⁄₁₆" W × 14⁵⁄₁₆" D. $219.95.

CIRCLE NO. 97 ON FREE INFORMATION CARD

Crown Pressure-Zone Microphone

Crown International's Model PZM-30GP pressure-zone microphone is said to employ a newly developed system of sound pickup, using the pressure zone that arises at an acoustic boundary to suppress frequency-response anomalies and other problems of conventional designs. The electret active element is positioned on a 5" × 6" flat plate so that it faces the acoustic boundary and lies within the pressure zone. Pickup pattern is hemispheric and a cardioid pattern can be produced by placing a foam template behind the transducer. An external buffer circuit/power supply is required. Specifications: frequency response, 50 to 15,000 Hz; impedance, 150 ohms balanced; THD, less than 3% at 150 dB SPL; S/N, less than 26 dB SPL equivalent acoustic input; sensitivity, 76 dB open-circuit voltage where 0 dB = 1 volt/microbar. $349.00.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Spool Solder Dispenser

The Model SM-1 "Solder-Mate" from Electronic Products Equipment Corp. is a new dispenser designed to accommodate 1-lb spools of wire solder. The solder spool mounts in the dispenser's slots with the aid of a plastic spindle. $7.50. Address: Electronic Products Equipment Corp., P.O. Box 5238, Manchester, NH 03108.

Rotatable Antenna Digital Readout

The DX-3 kit takes ham or CB antenna rotor control position and converts it to a digital signal for display on a 3-digit, 7-segment LED readout. Claimed antenna azimuth aiming accuracy is one degree. The kit uses a three-wire interconnect and is adaptable to most rotor systems. $39.95. Address: Monitor, Box 55, Agincourt, Ont., Canada M1S 3B4.

Logic Timing Recorder

The Logic Timing Recorder from AP Products Inc., is a timesaving device for charting logic timing. The Recorder is fabricated from ABS plastic and measures 11¾" by 8¼" and is ¼" thick. It consists of 320 slides arranged in eight horizontal rows. Moving vertically between two click-stop positions, the slides represent the two logic levels in a circuit. After the slides have been placed in the position that represents the logic state of the circuit, the board is placed in a conventional copying machine to make a record for filing. After copying, the Recorder can be re-used for other digital circuits whose waveforms must be retained for future reference. Blank spaces are provided for notes, dates, model and drawing numbers, customer and product names, and space for designers initials. $44.95.

CIRCLE NO. 99 ON FREE INFORMATION CARD

Low-Range Ohmmeter

The Model RX-2 LOHMETER (low-ohmmeter) from Alpha Components Corp., is designed to work in conjunction with a conventional analog or digital voltmeter to make resistance measurements from 0.001 ohm to 100 ohms, in three ranges. The device uses the four-terminal principle to compensate for test-lead resistance. It is powered from the 117-volt ac line but is available in a 240-volt version. A pair of LEDs, coordinated with the range selector switch indicates the range. $39.95. Address: Alpha Components Corp., 115 Eucalyptus Dr., Box 306, El Segundo, CA 90245.

Now NRI takes you inside the world's most popular microcomputer to train you at home as the new breed of computer specialist!

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A wide selection of software makes your life more fun and more efficient. Hundreds of programs for business, home and family are available from Heath User's Group. Also two BASIC languages, Microsoft™ and Fortran.™ And more programs are being developed all the time.

If you haven't seen the latest Heathkit catalog, you haven't seen the latest in computer fun. There's a new Music Synthesizer Board, new Speech Lab, new Color Graphics Board and new Color Monitor. And coming soon, a new three-drive disk system. For an exciting computer hobby, there's no more exciting computer than the Heath H8 – available fully assembled or in money-saving kit.

For complete details and prices on the H8 and the complete line of Heath printers, terminals and accessories, write today for the new, *free* Heathkit Catalog, or pick one up at your nearby Heathkit Electronics Center.

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Audio Product of the Month

CHOSEN BY THE EDITORS OF POPULAR ELECTRONICS

SAE TWO Model R9 AM/FM Stereo Receiver

Features quartz-lock digitally synthesized tuning and 90 watts/channel into 8-ohm loads

THE SAE Model R9 is a deluxe AM/FM stereo receiver featuring digitally synthesized tuning and an exceptionally competent power amplifier section rated at 90 watts per channel into 8-Ω loads with no more than 0.05% total harmonic distortion. Like the other SAE TWO components, the R9 is finished in black, accented by walnut-grain wooden side panels. Accessory handles and mounting adapters are available for mounting the receiver in a standard 19-inch EIA rack. SAE TWO audio components are manufactured in Japan to SAE's design specifications. Suggested retail price is $800.

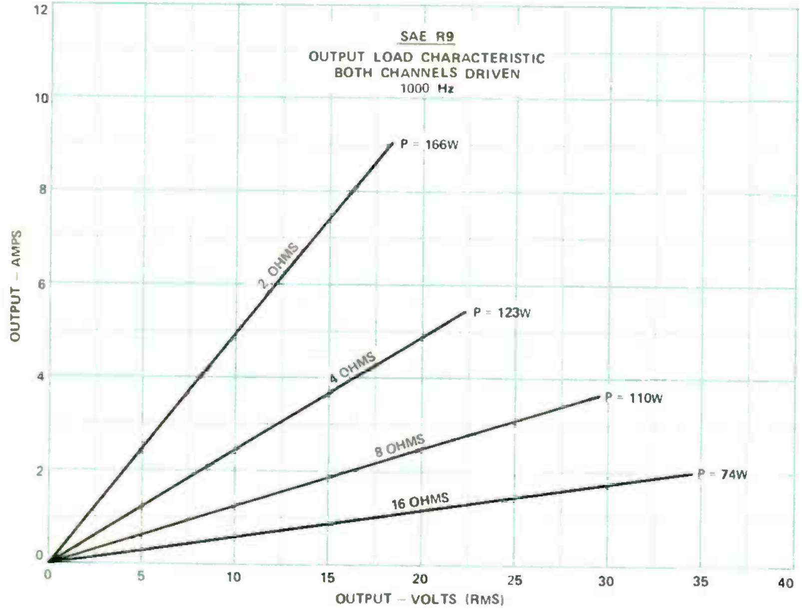
General Description. The "dial window" of the front panel is quite different from the usual receiver tuning display. Frequency is shown by four large (½") blue digits, flanked by the indicators "FM" and "MHz," or "AM" and "kHz," according to the selected band. Only the "odd" FM channels (88.1, 88.3, etc. MHz) can be tuned; AM tuning increments in 1 kHz steps.

Power to the speakers or voltage to the TAPE RECORDER jacks can be read from a dual horizontal LED display. The function chosen is shown by adjacent LEDs. The scale is calibrated in watts and decibels relative to 90 watts into 8-Ω loads. When showing output to the recorder jacks, the display is calibrated so that 0 dB corresponds to "0 VU" (0.77 volts). The DISPLAY selector also has an FM/AM position that converts the upper (LEFT) bar to a relative signal strength indicator for FM and AM, and the lower (RIGHT) bar to a multipath distortion indicator for FM. The LEDs that identify function change accordingly.

A large VOLUME knob is found on the panel, but there is no conventional tuning knob. Instead, a pair of flat pushbuttons to the right of the digital display tune the receiver UP and DOWN in frequency. There are two tuning modes, neither of which is clearly identified in any of SAE's accompanying literature. The choice between the two is implemented via the SCAN button. With SCAN disengaged, a momentary touch of either tuning button will step the tuned frequency in the corresponding direction until a signal is acquired. In the other mode, frequency changes as long as the button is held in, stopping at the first FCC-assigned channel reached after the button is released. A momentary touch of the button shifts the tuning by one channel.

After a signal has been acquired, a quartz-lock feature comes into action automatically. According to the manufacturer's description, quartz-lock fine tunes the receiver to the exact station frequency, instead of to the local oscillator frequency reference. (The need for this is not evident, nor is it explained further.) When the station is locked in, a green Q-LOCK indication comes on below the level display. Below the frequency readout is a red STEREO indicator for FM.

A series of pushbuttons below the display area select the program source (PHONO 1, PHONO 2, AUX, FM, and AM), and engage HI BLEND (for reducing noise on weak FM stereo signals), FM MUTE, and SCAN. FM MUTE is nor-



A voltage-current plot of the output characteristics at clipping of the SAE R9 for various load impedances. Maximum open-circuit voltage is about 34.4 V; current in excess of 9 amperes to a low-impedance load trips protective system. Both channels driven by a 1-kHz signal.

mally on and cuts out when SCAN is depressed.

Under the tuning buttons is a similar set of buttons for L. FILTER, LOUDNESS, and audio MUTING (a −20-dB gain reduction). A similar button below the VOLUME knob is the POWER switch.

Three knobs act as separate BASS, MID, and TREBLE tone controls, and there is a switch that bypasses them all. Other switches provide tape MONITOR functions for two tape decks and cross-connect the decks for dubbing with either as source. Another switch, marked EXT PROS, can connect an accessory such as an equalizer or noise reducer into the signal path, either before or after the tape monitoring and recording circuits.

Normal or reversed stereo or mono operation can be chosen via the MODE switch. Either, both, or neither of two sets of speaker connections can be switched in, and there is a headphone jack that is always active. The balance control has a center detent.

Several internal protective circuits safeguard both the R9 and the speakers connected to it from damage due to failure or careless operation. On initial power-up, there is a delay of 3 to 5 seconds before a relay connects the speaker outputs, to allow internal voltages to stabilize. If a significant dc offset voltage appears at the output, the speakers are also disconnected. Service is restored automatically when the fault is corrected. This system also protects against large infrasonic transients. Tripping the protection, say the instructions, does not silence the receiver, but reduces output to a low level.

Other protective devices include a thermal cut-out, fuses, and a circuit that limits output current into resistive loads under 2 Ω without restricting the drive into 4-Ω or higher impedances, even with reactive loads such as electrostatic speakers.

On the rear of the SAE R9 are the various signal input and output jacks, insulated spring connectors for the speaker outputs, and small binding post terminals for the antenna connections. There is a hinged AM ferrite rod antenna. Three of the four ac outlets are switched.

The SAE R9 is 18¼" W, 17⅝" D, and 5¼" H. It weighs 35 pounds.

Laboratory Measurements. The one-hour preconditioning period at one-third rated power left the top of the SAE R9 only moderately warm. Power output at clipping, with both channels driven at 1 kHz, was 110 watts into 8-Ω loads, 123 watts into 4 Ω, and 166 watts into 2 Ω. The receiver is rated only for 8-Ω operation, so its IHF clipping headroom comes out to 0.85 dB. Short-term power output at clipping, using the tone-burst signal of the IHF dynamic headroom test, was respectively 156 and 168 watts for 4 Ω and 8 Ω. At 2 Ω, dynamic power output measured 0.3 dB *less* than the continuous clipping output. This seems unlikely in fact, and probably results from a less accurate power measurement in the dynamic test (voltage at clipping must be read from an oscilloscope). The IHF dynamic headroom rating (at 8 Ω) is 2.4 dB.

Distortion performance easily met and surpassed its ratings (at least 90 watts per channel to 8-Ω loads from 20 to 20,000 Hz with no more than 0.05% total harmonic distortion). Measurements with 2-Ω loads were complicated somewhat by interruptions due to the thermal circuit breaker, dc fuses, and overcurrent protective systems, but these, along with the data for 4-Ω loads, fell within the primary ratings.

At maximum gain (46 dB), the amplifiers required a high-level (AUX) input of 14.5 mV for a reference output of 1 watt; A-weighted signal-to-noise ratio was 74.7 dB. Through the phono input, sensitivity was 0.21 mV (83 dB overall gain), with a 73.5-dB signal-to-noise ratio. The lowest phono overload level in the 20 to 20,000 Hz range (referred to the equivalent 1,000 Hz levels) was 207 mV. Phono input impedance was 52 kΩ in parallel with 70 pF.

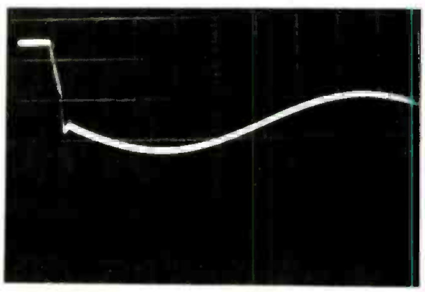
We measured IHF IM distortion using two equal-amplitude input signals at 19 and 20 kHz. Their equivalent peak value corresponded to that of a sine wave output of 90 watts into 8 Ω. The lower third-order distortion product at 18 kHz was at a −70-dB level (0.03%) and the second-order difference tone product at 1 kHz was at a negligible −90 dB (0.003%).

IHF transient overload recovery time was about 20 μs. This was measured with an input signal that gave continuous output of 9 watts at 1 kHz and was increased by 20 dB for 20 ms out of each half second.

Square-wave rise time was 6 μs through the AUX inputs, and the slew rate was 19 volts per μs. IHF slew factor was 5.5, with slew limiting becoming apparent on a "full signal" drive waveform at 110 kHz.

When we drove a rather severe load of 4 Ω in parallel with 3 μF, using a 10-kHz square wave, we observed a couple of cycles of ringing at about 40 kHz, but no sign of instability or protective shutdown, even at full power.

The tone controls had the familiar Baxandall shape, with the bass turnover frequency shifting between 100 and 300 Hz, and the family of treble curves hinged at about 3 kHz. The midrange control effect was greatest



Overload recovery. "Glitch" between clipped waveform at left and sine wave indicating return to normal operation lasts about 20 μs. Horizontal scale is 100 μs per division.

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As a travel fridge the P10 keeps foods and beverages fresh and cold wherever you go. Carry insulin, medical samples, dietetic foods. Great for private planes and golf carts. Photographers use it for films. Mothers...now you can refrigerate baby's formula in your car then heat with the flick of a switch. Powerboaters, just plug it into your boat's cigarette lighter to keep a day's food and drink ice cold without going ashore for ice. With your engine off, you can operate for up to several hours and still start your engine to recharge your battery. "A low battery" indicator warns you when it's time to recharge. With the power off, your P10 keeps everything hot or cold for many hours in its well insulated case.

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MODEL P34 STANDARD RECREATIONAL FRIDGE (see photo above) ~~$169.~~ $139.00 (in Canada ~~$179.~~ $149.00)

Holds over 40 lbs. of food and beverages or 48 pop cans. Refrigerates in air temperature up to 95°F. Rugged ABS case in sand beige colour with dark brown non-corroding latches and handle. Large 34 litre capacity (1.2 cu. ft.) weighs 17 lbs. empty. Ext. 21" L x 16" H x 16" W. Int. 16" L x 12" H x 11-1/2 W. Operates on 12 volts DC with supplied power cord or with optional 12 VDC/110 VAC power adaptor.

The P34 is our standard portable refrigerator. This new, improved model has a non-adjustable solid-state thermostat which keeps your food at normal refrigeration temperature even in 95° weather. It holds more than three times as much as the P10. Fits into any boat, van, camper or car back seat. Plugs into car lighter receptacle, refrigerates over 40 lbs. of food (no space wasted by ice) yet it draws no more power than the P10.

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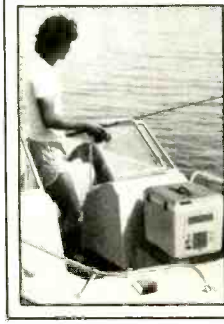

The same size, colour, weight and capacity as the P34 *but* includes food warming features (up to 125°F), fully adjustable temperature control (you can even dial wine cooling temps.) and low battery warning indicator tells you when to recharge. Refrigerates in air temperatures up to 95°F. Or keeps hot foods hot at the flick of a switch...great for fall hunting, camping, boating and winter ice fishing, skiing and snowmobiling.

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ENV3

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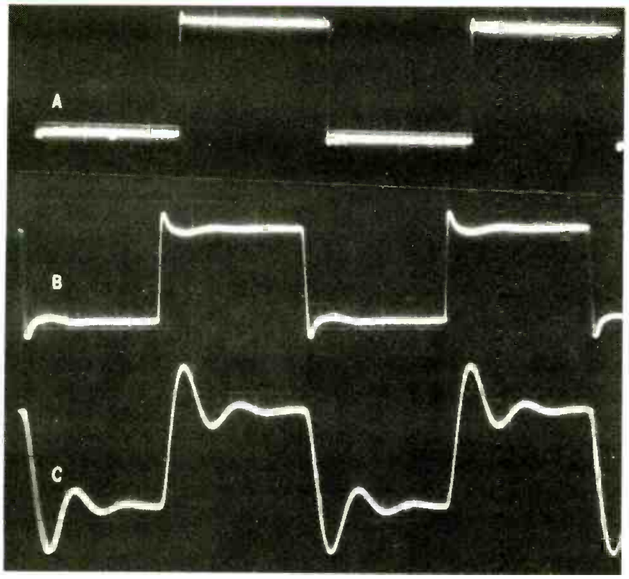

Trace A shows input square wave with frequency of 10 kHz. Trace B shows output waveform across 4-Ω resistor; C shows waveform across 4-Ω resistor in parallel with 3-μF capacitor.

between 1 and 2 kHz, with a range of about ±10 dB. Loudness compensation boosted both low and high frequencies, and the low-cut filter had its −3-dB response at 30 Hz.

RIAA phono equalization was within ±0.5 dB of the ideal curve from 20 to 20,000 Hz. The phono preamplifier of the R9 uses a low-noise IC, apparently an "op amp," that completely isolates the equalization components from the cartridge input. As a result, phono response was identical whether measured through the inductance of a cartridge or from a resistive source.

The FM tuner had a mono IHF usable sensitivity of 11 dBf (1.9 μV) and a stereo sensitivity of 17 dBf (4 μV). There was no stereo switching threshold, so that weak signal stereo reception was limited only by noise and distortion. Mono and stereo 50 dB quieting sensitivities were respectively 13.8 dBf (2.7 μV) and 36.6 dBf (37 μV.)

The FM distortion at 65 dBf (1,000 μV) input was 0.17% in mono and 0.2% in stereo. The respective noise levels were −74 dB and −68.5 dB. An IHF-IM distortion measurement of the tuner, using 14 and 15 kHz tones of equal amplitude and a peak deviation of 75 kHz, revealed equal third-order distortion products at 13 and 16 kHz at −53 dB (0.2%) and a 1-kHz second-order component at −46 dB (0.5%), 100% modulation.

FM stereo frequency response was flat within ±0.5 dB from 30 to 5,000 Hz, and rose to +3.7 dB at 15 kHz. Lacking a schematic, we could not judge whether this was the result of an incorrect multiplex filter response, or an error in the FM de-emphasis time constant (both channels measured alike). Any "brightness" resulting from this response would probably not be audible except in direct comparison to another tuner. (We did not hear it in regular listening.) Stereo channel separation was 40 dB in the midrange, 26.5 dB at 30 Hz, and 31 dB at 15 kHz.

FM capture ratio was 1.25 dB at 45 dBf (100 μV) input; AM rejection was 61 dB at 65 dBf. Image rejection of the varactor-tuned front end was an exceptional 97 dB. Alternate channel selectivity—about 64 dB—was adequate though not especially large, and was associated with a highly asymmetrical i-f response. The asymmetry was also observed in the adjacent-channel selectivity data, which averaged 9.1 dB.

Muting threshold was 10.3 dBf (1.8 μV). In the signal-seeking mode, it was 15.5 dBf or 3.2 μV). Leakage of the 19-kHz pilot was at a −59-dB level, and the tuner hum was a very low −75 dB. AM tuner frequency response was very restricted, about ±3 dB from 45 to 1,500 Hz and down 6 dB at about 2.5 kHz.

User Comment. We were favorably impressed by the fact that the SAE R9, whose performance is specified with exceptional thoroughness, met most of the ratings we checked. The only notable exception was FM tuner response. Overall, this is not only a very fine receiver "on paper," but it lives up to its promise in use.

Unfortunately, the instruction manual falls short of the standard set by the receiver. Descriptions of the digital tuning modes were particularly inadequate.

In SCAN, it was very difficult to cover a large part of the FM band and stop on or next to the desired frequency. The tuning always seemed to overshoot the mark by a couple of channels. In this receiver, we find synthesized tuning less convenient than the old-fashioned analog variety.

The power and tuning indicators worked very well, and the multipath display was one of the best of its type we have used. Antenna orientation for minimum length of the bar display always gave good FM reception. Location of the POWER button (hidden by the VOLUME knob) and the fact that it looks like all the other buttons on the panel, can result in some confusion.

We discovered one bothersome aspect of the R9's behavior when we switched between the AM and FM modes. There was a loud transient noise burst that could be, at best, startling, and at worst dangerous to one's speakers. Of course, if you, like many people, rarely listen to AM, the problem is not all that serious. More to the point, SAE indicates that the difficulty arises when, after the switch is made, the tuner section comes out of muting while still seeking a station. SAE advises that future production will have a slower unmuting action.

Happily, the actual operation of the SAE R9 left little to be desired. It is certainly one of the most complete receivers we have seen, able to interface with almost any other components an advanced audiophile might wish to use. FM tuner and audio performance are absoultely first rate, and the power amplifiers are impressively stable with loads that often elicit misbehavior from other units. —Julian Hirsch

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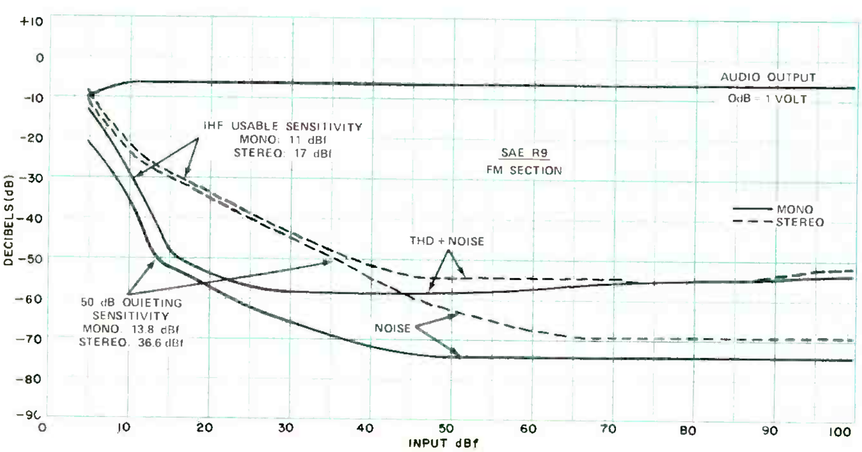

Noise and sensitivity curves for FM section of the SAE R9 receiver.

Audiophile Recordings

By Harold A. Rodgers
Executive Editor

J.S. BACH: ***Three Keyboard Concertos—in D minor, BWV 1056, in A Major, BWV 1055, in F minor, BWV 1056.*** András Schiff, Piano; George Malcolm conducting the English Chamber Orchestra. Denon PCM OX-7182-ND. While it has been reasonably well established by now that there is nothing musicologically incorrect about playing Bach keyboard concertos on the piano, the result, in this recording anyway, seems less than totally satisfying. It seems overwhelmingly probable that Bach would have used a harpsichord (there weren't many pianos available to him) and that he would have had that sound in his mind when composing.

The problem as I hear it is that the main formants of the harpsichord lie higher in the spectrum than those of the piano, and the tones of the former die out more rapidly. This makes the harpsichord sound more transparent and lets the accompanying instruments be heard. A few pianists, notably Gould and Tureck, manage to minimize the piano's masking tendency, but Shiff, unfortunately, does not, and thereby obscures some of the contrapuntal texture. Another possibility is that the manner in which the performance was miked made the piano too prominent, even though favoring the string sections might have been more appropriate. The unfortunate balance, whatever its cause, is the sole notable blemish on this disc. Pressing quality and recorded sound—as well as tempos, phrasing, and dynamics—seem to be right in the ballpark.

TCHAIKOVSKY: ***Symphony No. 4 in F minor, Op. 36.*** Lorin Maazel conducting the Cleveland Orchestra. Telarc 10047. This recording, digitally mastered of course, is in every way up to Telarc's usual standard of production. There is a great sense of transparency, a good hall sound, and a pressing essentially free of defects. The orchestral playing is neat and precise, though perhaps excessively so, giving the overall interpretation a somewhat analytic cast. One is tempted to conclude that in avoiding the lush overromanticism to which Tchaikovsky is often subject, this performance has leaned too far the other way and comes up just a bit dry, especially in the second movement. On the other hand, the scherzo and final allegro fairly bristle with energy and contrast. Maazel apparently lets the music stand on its own structure, leaving programmatic influences well in the background.

In Concert/Montreux '79. Joe Beck, Bob Brookmeyer, Jon Faddis, Richard Davis with Bingo Miki and The Inner Galaxy Orchestra of Japan. Gryphon G-913. In a note from its producer on the jacket of this album, it is billed as a collector's item, a claim that is pretty well justified if you're a lover of jazz. Considering the restrictions on microphone placement and mixing inherent in a live recording situation, the engineers have done a phenomenal job. The pressing, unfortunately, does not seem to be up to the same standard, as the sample we received was marred by an unseemly number of minor ticks.

Musically, the album is first-rate. The Inner Galaxy Orchestra is a very pleasant exception to the tendency that many Japanese orchestras have of playing jazz just a little too neatly. The soloists do a fine job, with Jon Faddis—whose tone might be the envy of any Bach clarino player—a special standout. ◇

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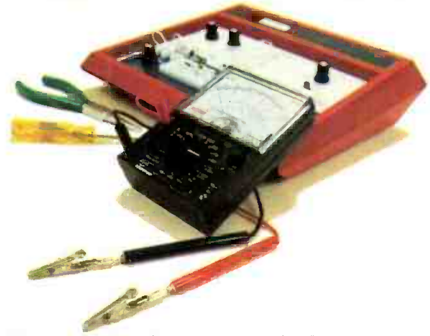

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Popular Electronics Tests

Panasonic's PV-1400 Video Cassette Recorder

THE Panasonic PV-1400 video cassette recorder (of which our sample is the first to enter the U.S.) brings with it an interesting array of features. It incorporates a 14-day programmable timer that can be set for seven programs daily. In addition, an eighth program can operate once a week at any time and will not erase itself. The clock has a 60-minute backup battery (for power outages) that is kept on trickle charge.

Other niceties include soft-touch controls (now standard in the Panasonic line) and automatic rewind at the end of record or play. There is also "cue and review," a neat little picture search system that runs at 9× normal speed. In addition, there is an automatic back-up of a few frames in the pause mode to eliminate gaps in the program. The price for the whole package is $1,295.

The heart of all this control flexibility is a powerful little microprocessor. Each switch, when closed, signals the processor to initiate one of various actions, which are executed by integrated circuits, discrete devices, motors, servo systems, modulators, and demodulators under its control. The vocabulary of commands consists of eject, rewind, stop, fast forward, play, record, audio dub, pause, forward and reverse search, VCR/TV viewing selection, timer operations, channel selection, and power on/off; not to mention external memory on/off, counter, SP (standard play), LP (long play), and SLP (super long play) selections.

A push-to-open flap on the front conceals switches for selecting clock, normal, program, and check; day, hour, and minute; and dim/bright for the green clock readout. Beneath the flap and front apron is the remote-control plug by which forward and reverse search, pause, and channel change can be executed. On the lower left side are video, audio, and microphone inputs, as well as a camera/tuner switch, and the usual thumbwheel for fine adjustment of tape speed. Tiny rectangular red lamps identify all important functions on the front panel, including the dew sensor lamp and camera connection. Channel tuning and aft are under a plastic flap in the right top, and cassette load is at the left. Although this equipment doesn't have viewable fast scan or pause modes, it really does just about everything else you could want.

On the rear panel are uhf/vhf inputs and outputs, as well as video and audio out jacks, plus the usual Channel 3/4 selective switching. There is an unswitched ac-line outlet that can provide up to 300 watts.

(Continued on page 32)

This unit has highly worthwhile, although not obvious, internal advantages over its predecessors. For instance, both head and tape cylinders now use direct-drive motors—for better stability and more compactness—and there are three solenoids, one for play, one for pressure roller, and another for fast forward. In the transport, a separate motor whose speed is directly changed for the LP and SLP speeds powers tape takeup. There is also a loading motor for the tape.

If a tape isn't loaded into the recorder, or if the stop tape tab is missing and there is an unattended recording program under way, the timer/record LED will flash to indicate an error. If no program is entered, the timer/record LED will not light.

According to Panasonic, there are 10 protective sensors throughout the machine, with two of special importance—a Hall-effect integrated circuit that senses the absence of rotation of the supply reel and an LED indicator and cadmium disulfide (CDS) cell that sense takeup problems and cause the transport to halt. Also, synchrolock is maintained during que and reverse, even with noise bars in the 9× forward and 9× reverse speeds. Furthermore, the LP speed now has a channel through a half-line horizontal delay system that keeps the machine synclocked and picture stable during forward and reverse search. Normal servolock takes over in the SLP mode.

". . . a deluxe piece of equipment, responsive to your slightest command."

Lab Tests. Initially revealing tests were made on this equipment in the two modes of operation with outputs deliberately taken from two separate sources to see what, if any, differences were apparent. As usual, multiburst from a specially modifed Sencore VA48 generator was used as a signal source.

In the record mode via Ch. 4 (Fig. 1), the top trace shows VCR response through a 10:1 low-capacitance probe connected to the synchronous video detector of a full 4-MHz broadband TV receiver. The bottom waveform is that of the *video* output of the player/recorder itself. Signals enter from the source through Ch. 4 and are passed to the recorder.

The top trace shows both the 3.02- and 3.56-MHz third and fourth multiburst bars at about half amplitude or 6 dB down (voltage). In the lower trace, directly out of the VCR's video output without modulator or tuner and TV demodulating stages, 4 MHz shows at less than 6 dB down, and the multiburst between 0.75 and 3.56 MHz maintains virtually the full amplitude.

In the playback mode via Ch. 4 (Fig. 2), signal amplitudes drop rapidly as this VCR processes luminance and chroma signals, and the end result—both through the TV and pure video output—are rather less than sensational, delivering hardly more

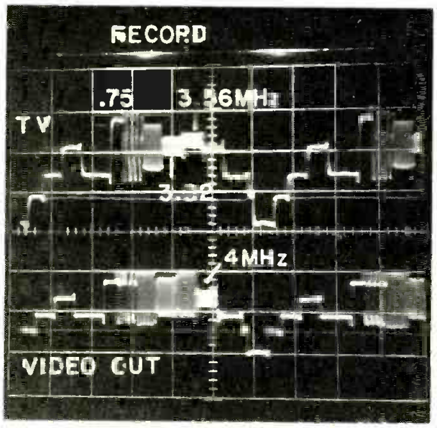

Fig. 1. Video output (lower trace) shows full 4-MHz record bandwidth.

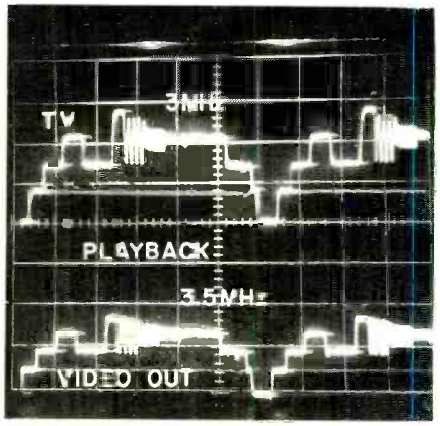

Fig. 4. Overall response may be usable to as much as 3.5 MHz.

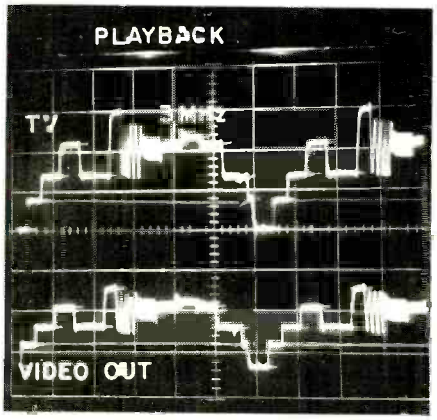

Fig. 2. In playback mode, signal amplitudes drop rapidly as VCR processes luminance and chroma.

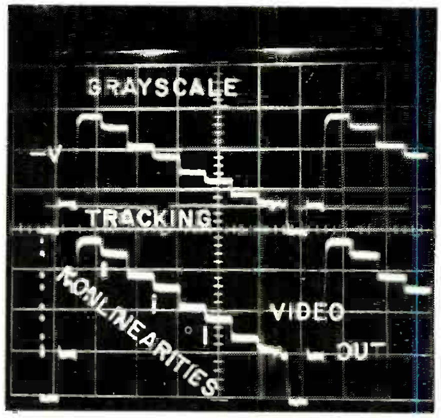

Fig. 5. Grayscale tracking reveals that eight steps are somewhat erratic though horizontal portions are fairly even.

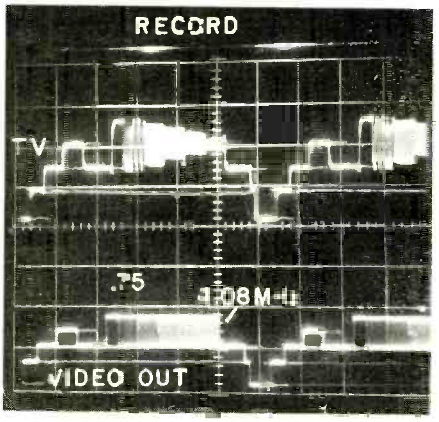

Fig. 3. There are substantial differences in recording and some subtle differences during playback.

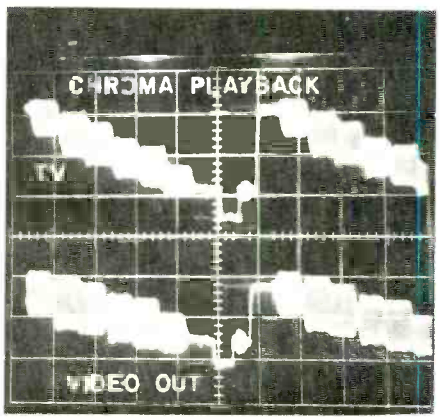

Fig. 6. Chroma tracking between TV receiver and recorder's video output are very similar.

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Up until now the sound quality of mini-speakers was exactly what you probably imagined... minimal. Minimal bass response. Minimal power handling capacity. Minimal definition.

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MS650 MINI-SPEAKER ADC A BSR COMPANY

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than 3 MHz. Overshoots prominently identify the nonexistent 3.56-MHz multiburst bar.

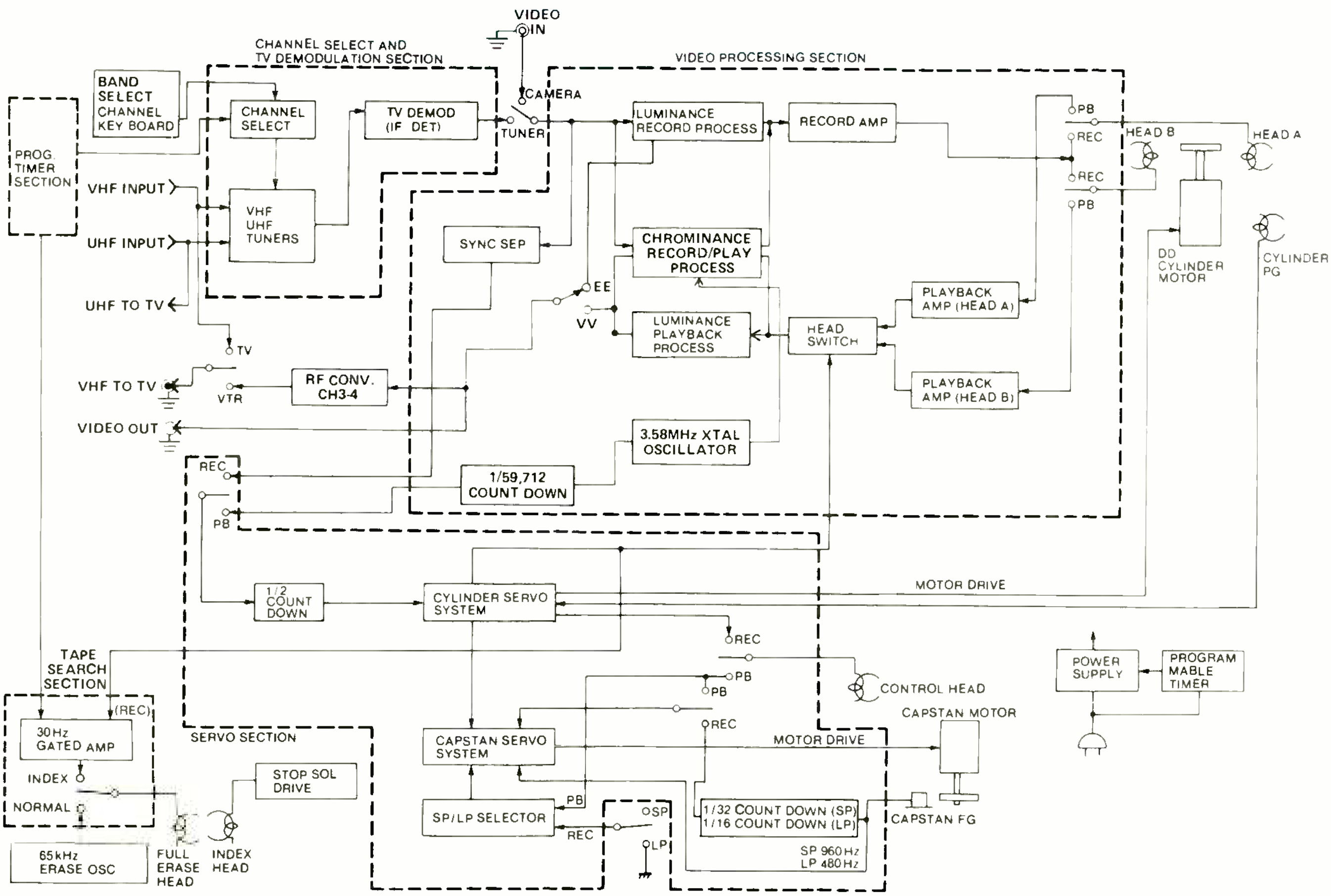
To further test this new VHS recorder we put the same signals at baseband into the video input of the PV-1400, bypassing tuners and demodulators. As you will see in the waveform photograph (Fig. 3), there are substantial differences in recording, and some subtle ones during playback. This would also hold true in record if you were using a TV monitor (without r-f and i-f) as your display device instead of a television receiver. In other words, full bandpass!

When recording through the video input jack, the response in the lower trace at the video output is a maximum 4.08 MHz with no loss of amplitude and excellent staircase linearity. This amounts to little more than straight channel passage through the PV-1400. (In the upper trace, you'll see some dropoff in the amplitudes of this multiburst information through the TV, but most of it's there, and the receiver has proven its 4-MHz capability at the video detector.)

In playback through the video jack (Fig. 4), overall response does extend beyond 3.02 MHz and may be usable to as much as 3.5 MHz. This suggests that video inputs and outputs offer considerably greater bandpass than the various tuners, i-f strips, and modulator/demodulators. This lesson should not be lost on those who want best resolution and definition in the picture, although the operator would have to use a *good* camera or some other straight video wideband device to take advantage of it. The upper trace shows a signal that has passed through the TV receiver.

As for grayscale tracking (Fig. 5), the eight steps of the B&K-Precision NTSC generator, which are supposed to be identical in amplitude, are actually somewhat erratic. All horizontal step portions are pretty much the same, however, even in the video output (lower trace). The receiver waveform at the top dutifully follows all

WHAT A VHS RECORDER LOOKS LIKE INSIDE



The tuner section supplies i-f amplifiers and video detector with broadcast information. Sync is taken off after the video input for any camera-pure composite video (baseband) that might be used for servo-system countdown. Video and chroma are converted to frequency modulation for the video output, the Ch. 3/4 r-f converter, and/or the recording amplifier and heads. Heads A and B are rotated at a constant 1800 rpm by the direct-drive cylinder motor, while the tape is moved at standard or long-play speed by the capstan motor.

Playback uses the same heads as does record. Head outputs are amplified and switched alternately depending on which is in contact with the tape. Video is reconverted from FM to AM, with chroma heterodyned from 629 kHz to 3.58 MHz once again. Taped results can be viewed through any slave television receiver on Ch. 3 or 4, or through the VCR's video output at baseband. If this is a re-recording, the 65- (or 67-) kHz erase head aligns the tape's magnetic field before the new recording and electronically wipes it clean.

There are various capstan control countdowns for standard and long play, with servo control feedback and frequency comparison. During operation, 60-Hz vertical sync pulses are divided in half so that 30-Hz control pulses reach the control head and are recorded on the tape's lateral control track. The stop solenoid actually removes some dc power from the machine and stops it completely when ac power is interrupted or when the interaction of two or more events could cause damage.

When this occurs, all front-panel controls are reset to off. The PV-1400 has four heads instead of two. The larger pair gives better performance at the slower speeds, adequately covering the two diagonal tape tracks that represent two 262.5-line fields of information and constitute a single frame. There are 30 frames recorded or played each second.

Audio is processed in standard TV FM, with the same 65-67-kHz frequency that erases previous magnetic video *and* audio recordings, providing recording bias. ◇

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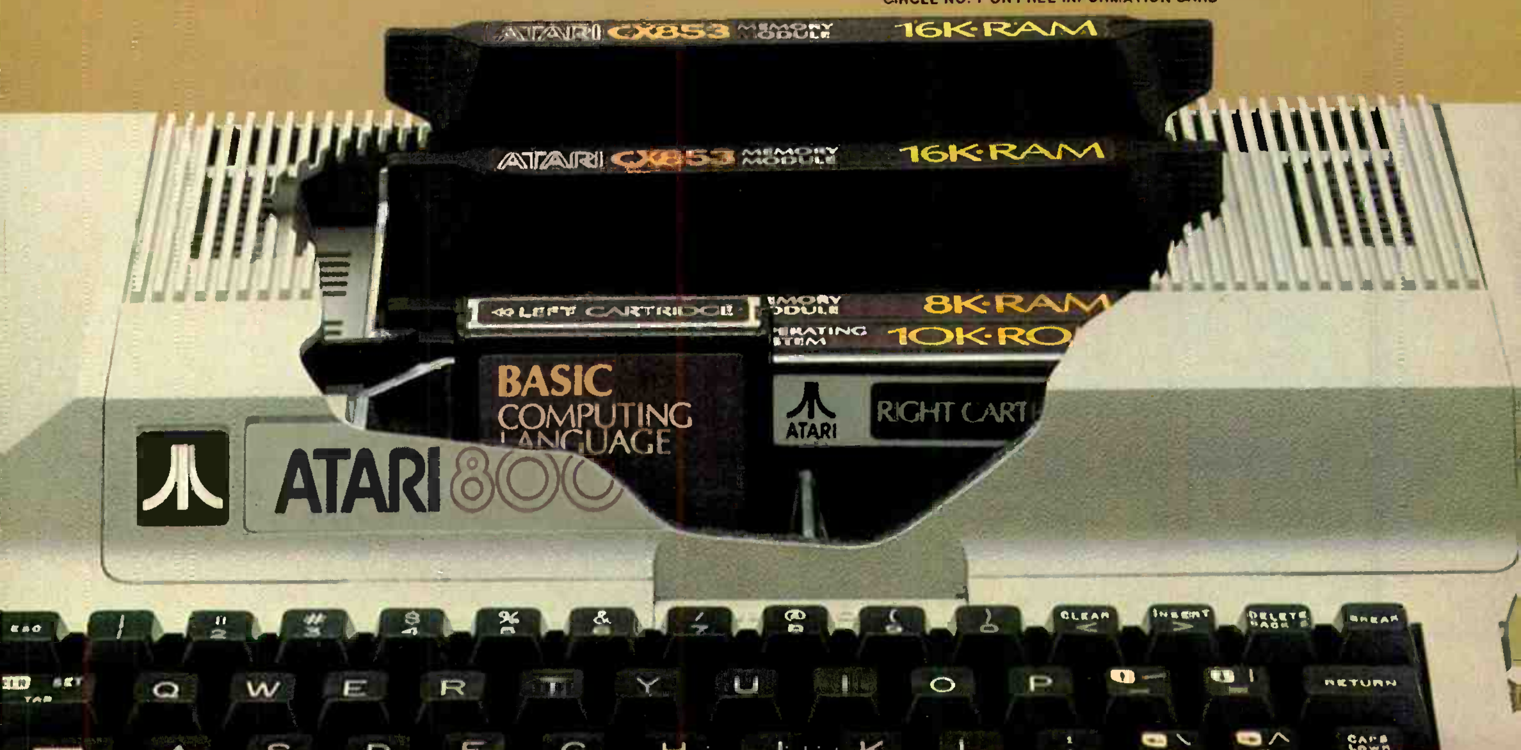

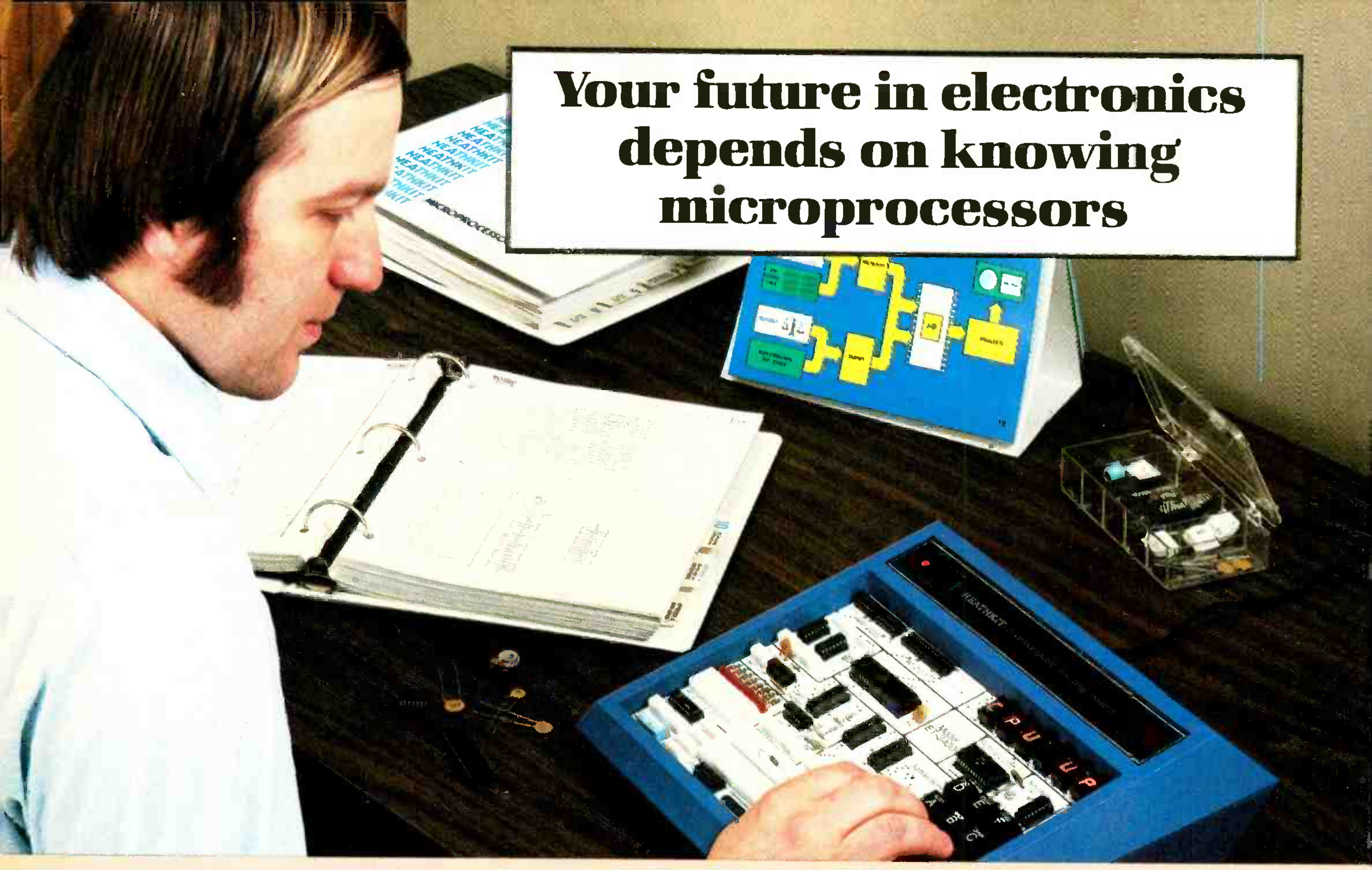

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ED-140

the video-signal discrepancies of the lower trace.

In analyzing such distortion, remember that the grayscale here begins at blanking, next to the horizontal sync pulse, and extends upward to peak white until it reaches full-range modulation, or 100 IRE (Institute of Radio Engineers) units. Nonlinear staircases originate from quadrature distortion, itself caused by nonlinear diode-type envelope video detectors. These often generate color-subcarrier second harmonics, as well as errors in differential gain. The latter will produce, in aggravated instances, cross-modulation between chroma and luminance, usually seen as a modulated staircase. Normally, it is a product of apl, or average picture level, that relates principally to the brightness of each scene, and often results in actual image displacement. Here, the problems are not severe, but they do have a modest effect on the video output and overall chroma information.

Chroma tracking (Fig. 6) at the receiver (top trace) and from the player/recorder's video output (bottom trace) are very similar in most respects with a fairly squared-off horizontal sync pulse (denoting no low-frequency rolloff) and a sort of egg-shaped burst riding on the back porch of the adjoining horizontal blanking

MODEL PV-1400 VITAL STATISTICS

Tape speeds and recording times:	2 hr at 1.33 in./s 4 hr at 0.66 in./s 6 hr at 0.44 in./s
Ac power requirements:	42 W (record) 45 W (play)
Video bandpass (−3 dB):	3 MHz (average)
Audio bandpass (−3 dB):	100 to 7000 Hz
Weight:	27 lb
Dimensions:	19" × 14" × 5 3/8"

Notes: Plays and records at power inputs between 105 and 130 volts ac.
All tests made in SP mode.

pulse. Note, however, that all six color bars from both sources appear somewhat indistinct, without well-defined edges and normal impulse separation. This is due to traditional noise found in many VCRs and contributes to picture degradation. The cause could be poor tape, but more likely it arises in the electronics of the playback mechanism that restore chroma from its "beatdown" narrowband 629-kHz condition to the usual 3.58-MHz center frequency for video and receiver outputs.

Comments. Is this a good machine? Considering the constant evolution in video cassette recorders, of course it is! You don't have a somewhat imperfect stop frame for individual picture viewing and some other fancy gee-gaws, but there is relief from mechanical switches, a clock that keeps time during power outages, lights to tell what's going on and why, and, overall, a convenient and deluxe piece of equipment, responsive to your slightest command.

Furthermore, its appearance is more than attractive, and the silver-walnut coloring will match many of the television receivers on the market this Fall. Do you actually need 14 days of recording time? Perhaps not now, but in the future when you're taping instructions or shopping information from the cable or late-night broadcasts, this large time span might become quite handy. —*Stan Prentiss*

CIRCLE NO. 102 ON FREE INFORMATION CARD

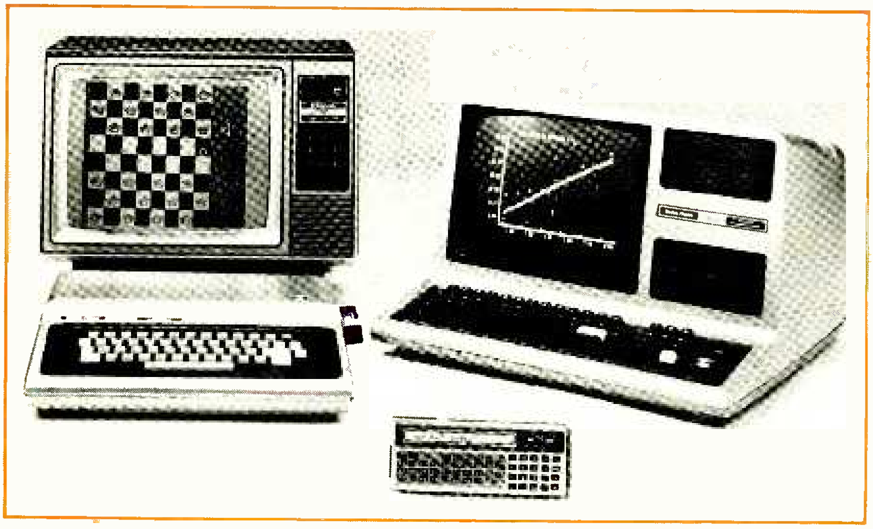
Computer Bits

By Carl Warren

Radio Shack Shows Surprises

FOR more than a year now, a number of industry pundits have conjectured about what the Fort Worth, TX-based Radio Shack would introduce as its next generation microcomputer system. Everything from the mythical TRS-90, which was to be a machine based on 16-bit technology, to a machine costing less than $500 was conjectured. The less-than-$500 machine was introduced (PE Oct 1980) in the form of a timesharing terminal. It has, however, been reintroduced as a color system called the TRS-80 Color computer.

This unit is the basic Videotex® machine I discussed last month, and has application cartridges that add value in the form of games or useful household programs. Yes, the unit is programmable, too, and has a version of Microsoft BASIC written specifically for the MC-6809 microprocessor. The TRS-80 Color computer, is aimed at the low-end user market.



Left to right are Radio Shack's TRS-80 Color Computer, the hand-held Pocket Computer, and the TRS-80 Model III.

The color unit isn't all that Radio Shack is offering for the early 80s though. Supporting the idea of computers for the consumer, the Fort Worth marketers have introduced the TRS-80 Pocket Computer. This $249 hand-held unit, uses a liquid-crystal 24-character display, incorporates a Level I-type BASIC, and is programmable. As an added feature, one can purchase a cassette interface for $49 and either load software tapes from Radio Shack or make your own. Initially, Radio Shack is offering eight application tapes ranging from real estate to personal finance. The software tapes are priced from $14.95 for a math drill to $24.95 for the engineering packages.

Those of you who are expecting the demise of the TRS-80 Model I can guess again. The original Model I is still available and being manufactured! However, owing to FCC requirements, it is being carefully evaluated for continued manufacture, though it will be supported for as long as necessary. The unit that is designed to supplant the Model I is the Model III. This model is basically the same computer as Model I, but with some twists in the packaging.

The Model III is a Z80 system with integrated keyboard, CRT, memory and expansion facilities. This design upgrades from the add-on bailing wire structure of the Model I. The Model III is base-priced at $699 for a 4K RAM, Level I BASIC system. A full-blown, 32K RAM, double-density (175K bytes per disk) dual integrated disks, and Model III BASIC goes for $2495. The Model III has the same display format (64 × 16) as the Model I, and is designed for any Model I software (using a conversion program). Radio Shack officials see Model III as the ideal machine for the small office that needs strong computing capability for less than $5000.

Even though Radio Shack has broadened its computer market with these introductions, it is also strongly supporting the Model II introduced last year. To enhance the Model II and the other units, they have developed, in conjunction with other unnamed companies, printers that support everything from general data processing to plotting.

The plotting printer is possibly the most exciting entrant. The printer/plotter is priced at $1460 and is designed to interface directly to either the Models I, II, or III computer systems. The plotter/printer uses a pen system, thus eliminating ribbons, and prints caps and lower case.

North Below the Border. Recently, I had the good fortune to visit the magic makers at Microsoft in Bellevue, Washington. Vern Raburn squired me around the growing, yet crowded headquarters of the dynamic software house. He let me view some new developments they are working on, specifically on the system side of the house. That's where they build BASIC, FORTRAN, and other high-level languages. One product, UNIX, a very high-level operating system from Bell Labs, is being revised for microcomputers by Microsoft and adapted to their product structure. This is an extremely powerful O/S and might change the whole picture of microcomputer data processing in the very near future.

Vern is president of the Consumer Products Division of Microsoft, and as such is responsible for the development and marketing of application software and products such as the Z80 card I talked about in the August issue. The application software products sold by the division include items like a typing tutor, an adventure game, and an editor. Vern explained that most of the products are being developed for the Apple and TRS-80, with some plans to support units like the Heath H8 and H89.

Color Next Important Step. While I was visiting Microsoft, I attended the SIGGRAPH conference held in Seattle. This is where manufacturers of graphics machines show their wares. This year color was the name of the game, with companies demonstrating terminals with as many as 4000 displayable hues.

Now these aren't the machines you buy for the home; but they are used by companies like Boeing for computer-aided design, and range in price from $20,000 on up.

Apple was there in full force, dem-

Write and run programs–the very first night–even if you've never used a computer before!

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ELF II connects directly to the video input of your TV set, without any additional hardware. Or, with an $8.95 RF modulator (see coupon below), you can connect ELF II to your TV's antenna terminals instead.

ELF II has been designed to play all the video games you want, including a fascinating new target/missile gun game that was developed specifically for ELF II. But games are only the icing on the cake. The real value of ELF II is that it gives you a chance to write machine language programs–and machine language is the fundamental language of all computers. Of course, machine language is only a starting point. You can also program ELF II with assembly language and tiny BASIC. But ELF II's machine language capability gives you a chance to develop a working knowledge of computers that you can't get from running only pre-recorded tape cassettes.

ELF II Gives You The Power To Make Things Happen!

Expanded, ELF II can give you more power to make things happen in the real world than heavily advertised home computers that sell for a lot more money. Thanks to an ongoing committment to develop the RCA 1802 for home computer use, the ELF II products–being introduced by Netronics–keep you right on the outer fringe of today's small computer technology. It's a perfect computer for engineering, business, industrial, scientific and personal applications.

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The incredible ELF II Light Pen lets you write or draw anything you want on a TV screen with just a wave of the "magic wand." Netronics has also introduced the ELF II Color Graphics & Music System–more breakthroughs that ELF II owners were the first to enjoy!

ELF II Tiny BASIC

Ultimately, ELF II understands only machine language–the fundamental coding required by all computers. But, to simplify your relationship with ELF II, we've introduced an **ELF II Tiny BASIC** that makes communicating with ELF II a breeze.

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ELF II's **Disassembler** takes machine code programs and produces assembly language source listings. This helps you understand the programs you are working with and improve them when required.

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By Netronics

ASCII/BAUDOT, STAND ALONE

Computer Terminal

COMPLETE FOR ONLY . . . $149.95

The Netronics ASCII/BAUDOT Computer Terminal Kit is a microprocessor-controlled, stand alone keyboard/terminal requring no computer memory or software. It allows the use of either a 64 or 32 character by 16 line professional display format with selectable baud rate, RS232-C or 20 ma. output, full cursor control and 75 ohm composite video output.

The keyboard follows the standard typewriter configuration and generates the entire 128 character ASCII upper/lower case set with 96 printable characters. Features include onboard regulators, selectable parity, shift lock key, alpha lock jumper, a drive capability of one TTY load, and the ability to mate directly with almost any computer, including the new Explorer/85 and ELF products by Netronics.

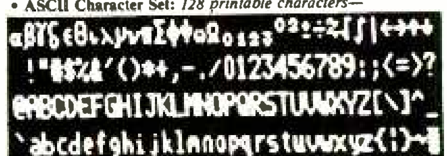
The Computer Terminal requires no I/O mapping and includes 1k of memory, character generator, 2 key rollover, processor controlled cursor control, parallel ASCII/BAUDOT to serial conversion and serial to video processing—fully crystal controlled for superb accuracy. PC boards are the highest quality glass epoxy for the ultimate in reliability and long life.

VIDEO DISPLAY SPECIFICATIONS

The heart of the Netronics Computer Terminal is the microprocessor-controlled Netronics Video Display Board (VID) which allows the terminal to utilize either a parallel ASCII or BAUDOT signal source. The VID converts the parallel data to serial data which is then formatted to either RS232-C or 20 ma. current loop output, which can be connected to the serial I/O on your computer or other interface, i.e., Modem.

When connected to a computer, the computer must echo the character received. This data is received by the VID which processes the information, converting to data to video suitable to be displayed on a TV set (using an RF modulator) or on a video monitor. The VID generates the cursor, horizontal and vertical sync pulses and performs the housekeeping relative to which character and where it is to be displayed on the screen.

Video Output: *1.5 P/P into 75 ohm (EIA RS-170)* • **Baud Rate:** *110 and 300 ASCII* • **Outputs:** *RS232-C or 20 ma. current loop* • **ASCII Character Set:** *128 printable characters—*



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

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☐ **Deluxe Steel Cabinet** for Netronics Keyboard/Terminal in Blue/Black Finish, **$19.95** plus $2.50 postage and handling.

☐ **Video Display Board Kit** alone (less keyboard), **$89.95** plus $3 postage & handling.

☐ **12" Video Monitor** (10 MHz bandwidth) fully assembled and tested, **$139.95** plus $5 postage and handling.

☐ **RF Modulator Kit** (to use your TV set for a monitor), **$8.95** postpaid.

☐ **5 amp Power Supply Kit In Deluxe Steel Cabinet** (±8VDC @ 5 amps, plus 6-8 VAC), **$39.95** plus $2 postage & handling.

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onstrating that they have color and graphics capability in the same plane as many of the "high-end" manufacturers. Reinforcing the strength of Apple was ABW Corp. of Ann Arbor, MI. This company demonstrated a device called Teksim®, which is a read-only-memory (ROM) that plugs into the Apple computer. The $475 device makes use of the Apple's high-resolution plotting capabilities to emulate a Tektronix 4010-type graphics terminal, but with color.

To place this in perspective for you, the Tektronix line of graphics terminals are those that virtually every company tries to equal. The Tek terminals are of the monochrome type, but exhibit various degrees of gray scale and high resolutions. Consequently, a device that permits emulation of a Tex terminal, on a raster scan system such as an Apple, is definitely an achievement.

There is a caveat, though. The device is only valuable if you can use it. I don't recommend buying the Teksim just to buy it, but if you are doing computer graphics on the Apple, and need the enhanced functions that Teksim provides, then by all means add it to your system.

Following this philosophy of purposeful products is Godbout electronics. Bill's latest entry into the S-100 world is called Spectrum®. It is a board designed to give you color graphics capability for less than $400. It can fit into any memory location you have available and delivers composite NTSC video. Although Godbout doesn't tout it, the board is capable of 2D transforms and simulated motion. Bill sees the Spectrum as an ideal board for use in process-control systems—specifically those controlled by an S-100 bus computer system.

MORE INFORMATION

For additional information about products and services mentioned here, contact the companies directly.

ABW Corporation
Box M1047
Ann Arbor, MI 48106
313-971-9364

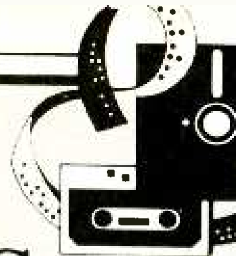
Dave Nutting Assoc.
527 West Golf Rd.
Arlington Hts, IL 60005
312-956-0710

Godbout Electronics
Bldg. 725, Oakland Airport
Oakland, CA 94614
415-562-0636

Microsoft, Consumer Products Div.
10800 NE 8th St., Suite 507
Bellevue, WA 98004
204-454-1315

Radio Shack
1800 One Tandy Center
Box 17180
Forth Worth, TX 76102
817-390-3700

I was under the impression that the Bally microcomputer system was no longer in existence, but at SIGGRAPH, Dave Nutting Assoc. was demonstrating a Bally with their Grafix image editor. This software was powerful and worked well with digitizer tablets and light pens. Nutting did have a machine called the UV1 ZGrass University Machine that is Z80 based and can work in a time-sharing environment. They quote a price of $2395, but like many machines of this type it all depends on options. I don't know the price of the Bally or even if it was for sale. If you're interested, you might contact the company directly. ◇

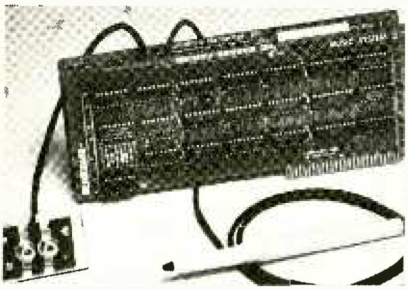


Computer Sources

By Leslie Solomon
Senior Technical Editor

Hardware

Apple Music. The MusicSystem is designed for Apple II computers and produces 16 voices including the generation of the sounds of real musical



instruments. The accompanying Editor program permits graphical input of sheet music using standard music notation. The Player utility permits polyphonic performance of musical compositions. Stereo output is provided. Address: Mountain Computer Inc., 300 Harvey West Blvd., Santa Cruz, CA 95060 (Tel: 408-429-8600).

S-100 APU. The MemTech Arithmetic Processing Unit interface features floating-point multiply performed in 56 microseconds, 41 trig and exponential functions, and automatic floating point normalization and error codes. It is jumperable as any pair of I/O ports on an S-100 bus. It provides a considerable speedup for both FORTRAN and BASIC. $390 (multiply in 84 μs), $460 (multiply in 56 μs). Address: MemTech Co., 4891 Clairemont Mesa Blvd., San Diego, CA 92117 (Tel: 714–292–1219).

Cryptograph. The Cryptographic Primer Kit includes an RS-232 Interface Cryptographic Board that attaches to the RS-232 port of a computer and accepts 300 baud data. The user inputs the 64-bit cryptographic key from the terminal. The board contains the WD2000IF implementation of the NBS Data Encryption Standard. A Cryptographic Primer that describes the software implementaion, an assembly manual, and the book "Codebreakers" by David Kahn are included with the kit. $395. Address: Western Digital, 3128 Redhill Ave., Newport Beach, CA 92663 (Tel: 714–557–3550).

AIM-65 Enclosure. Made from high-strength ABS plastic, this enclosure for the AIM-65 computer comes with mounting hardware, wire, and switches, and is ready for assembly. All parts are precut and drilled. Room is left for two additional boards. $49.95 plus $2.50 shipping/handling. Address: Don-El Enterprises, 3261 Michigan Ave., Costa Mesa, CA 92626 (Tel: 714–546–7481).

SS-50 Double Density. The DCB-4 Disk Master is an SS-50 bus double-density controller board that allows 336K bytes of storage on a single minifloppy, and is capable of handling up to four 5¼" or 8" drives simultaneously. It includes DOS-68B or 69D, is fully compatible with hard-disk systems, and allows users to select either single- or double-sided operation, single or double density data, stepping rate, 35- or 40-track operation, etc. It occupies only 16 bytes of memory space and can read/write a single sector by itself. An on-board buffer allows full interrupt capability and once data has been initiated, no further processor time is required. $449. Address: Smoke Signal Broadcasting, 31336 Via Colinas, Westlake Village, CA 91361 (Tel: 213–889–9340).

TRS-80 to 488 Bus. The Model 488-80B Interface Adaptor allows any TRS-80 Model I having 16K of RAM and level 2 BASIC to be used as a GPIB-488 controller. The machine-language program provided with the device interacts with Level 2, Level 3, or disk BASIC. $225. Address: Scientific Engineering Labs., 11 Neil Drive, Old Bethpage, NY 11804 (Tel: 516–694–3205).

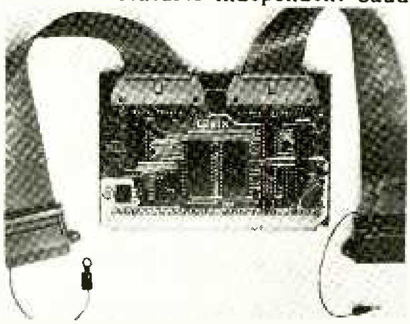
S-100 I/O Ports. The Model 4P4S Parallel-Serial I/O board combines four parallel bi-directional data ports with full handshaking and interrupt control. In addition, there are four serial RS-232 I/O ports and room for prototyping. The board is mapped as 16 consecutive I/O ports and will work with any Z80, 8080, 6800, 6802, 6809, 6502, or 8085 IEEE standard S-100 products. $199. Address: MicroDaSys, Box 36215, Los Angeles, CA 90036 (Tel: 213–731–0876).

WH89 CP/M. This plug-in modification for the Heath Z89/WH89 makes it possible to use CP/M as well as HDOS. Up to two additional disk drives can be added to the modified computer allowing a total capacity of 306K of storage. The modification kit with CP/M 1.4 Operating System and documentation is $249. Address: Magnolia Microsystems, 2812 Thorndyke Ave. West, Seattle, WA 98199 (Tel: 206–285–7266).

Apple Light Pen. The Lipson Light Pen connects to an Apple II game paddle connector and uses a cadmium-selenide cell for light detection. This allows the measurement of varying intensities of light. Besides a 48-page manual, a number of integer and Applesoft BASIC programs are included to make use of the high-resolution graphics, sound, and color. $24.95. Progressive Software, POB 273, Plymouth Mtg., PA 19462.

Atari Printer Interface. This Parallel Printer Interface can be used with the Atari 400 or 800 computers and connects via the front-panel controller jacks. The board is small enough so that it does not interfere with normal keyboard operations and a three-foot ribbon cable connects to the printer. A short machine language program directs all LPRINT outputs to the printer interface. The interface works with BASIC, DOS, and Assembler/Debug. $69.95. Address: Macrotronics Inc., 1125 Golden State Blvd., Suite G, Turlock, CA 95380 (Tel: 209-667-2888).

SS50 I/O Ports. The GIMIX 2 Port Serial ISO board has two independent RS-232 compatible I/O ports with handshaking on a single 30-pin board. It features independent baud



rate and interrupt for each port and uses the 6850 ACIA. The board is compatible with both the SS50 (4 addresses per slot) and the SS50C (16 addresses per slot). $128.43 less cables. The GIMIX 8 Port Serial I/O board has eight independent RS-232 ports with handshaking on a single 50-pin board. It features selectable baud rate for each port, extended address decoding for SS50C, selectable interrupts, and also uses the 6850 ACIA. $318.46. Address: GIMIX Inc., 1337 W. 37th Pl., Chicago, IL 60609 (Tel: 312-927-5510).

PROM Programmer. The PP-2532 TMS2532 EPROM programmer is a complete programming package that connects, via a 4-foot ribbon cable, to

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A financial VP in Massachusetts is cutting the time it takes to prepare month-end reports from three days to three hours.

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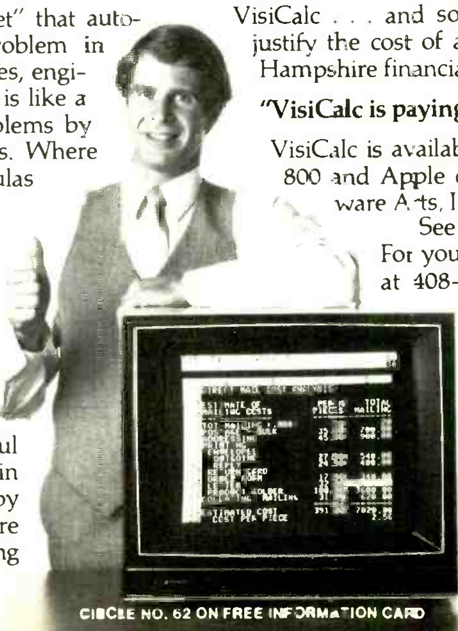
"VisiCalc is paying for itself over and over."

VisiCalc is available for 32k Commodore PET/CBM, Atari 800 and Apple disk systems. VisiCalc is written by Software Arts, Inc.

See VisiCalc at your Personal Software dealer. For your dealer's name, call Personal Software Inc. at 408-745-7841, or write 1330 Bordeaux Drive, Sunnyvale, CA 94086.

While there, see our other Productivity Series software: Desktop Plan and CCA Data Management System. They're like time on your hands and money in the bank.



PERSONAL SOFTWARE

Commodore is a registered trademark of Commodore Business Machines Inc., Atari is a registered trademark of Atari Inc., Apple is a registered trademark of Apple Computer Inc.

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any read-only PROM socket. Data is sent via the eight lower address lines to the programmer. No additional power supplies are required, and all timing and control sequences are handled by the programmer. Each programmer comes with an internal dc-to-dc switching regulator and a zero-insertion-force socket. $295. Address: Oliver Advanced Engineering, Inc., 676 West Wilson Ave., Glendale, CA 91203 (Tel: 213–240–0080).

Software

Statistical Analysis for TRS-80. For Level II or disk BASIC, this package consists of 13 programs. Ten describe data sets and conduct statistical data analysis, two are utility programs for preparing, updating, and listing data files, and one aids in the selection of data samples. Program names include Tape Data Files, Disk Data Files, Random Sample, Descriptive Statistics, Histogram, Frequency Distribution, Analysis of Variance, T-Test for Matched Pairs, Correlation and Linear Regression, Multiple Linear Regression, Time Series Analysis (two), and Chi Squared Analysis. Available at Radio Shack Computer Stores for $39.95.

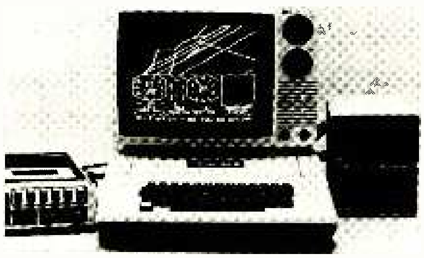
BASIC Precompiler. EZ-CODER is a BASIC precompiler that can be used with a North Star system. It features a self-documenting BASIC, allows mnemonic variables of arbitrary length, and tables for line references. Complete cross-referencing of all variables, labels, and user-defined functions are permitted. Source files are created using a built-in text editor. The precompiler produces North Star compatible code for use with North Star BASIC. $79. Address: Demerco Industries, Box 2396, Van Nuys, CA 91404.

Altair CP/M. Used by the Altair 8800 and MITS 3202 disk systems, this approach takes full advantage of the 300K plus capacity per diskette with no changes to the hardware. The use of CP/M allows languages such as C, COBOL, FORTRAN, PASCAL, etc., to be run immediately. Address: Lifeboat Associates, 2248 Broadway, New York, NY 10024 (Tel: 212-580-0082).

Extended Z80 Operations. The PDS Z80/8080 assembly language development system has been extended to include an additional 96 Z80 operations heretofore undisclosed. These implement four additional byte registers by allowing access to the two halves of the index registers. The PDS includes a relocating macro assembler, interactive editor/assembler, trace debug/monitor, text editor, linkage editor, and a relocating loader. $99 for North Star, or CP/M on 8-inch soft sector or 5-inch 10- or 16-hard-sector diskette. Address: Allen Ashley, 395 Sierra Madre Villa, Pasadena, CA 91107 (Tel: 213-793-5748).

Language Teacher. Featuring French, Spanish, German and Italian, the Language Teacher operates from a TRS-80 Model I disk system. The drill-learning format features language-to-English and vice versa and offers hundreds of word combinations, phrases and verb conjugation forms to challenge the student. It also allows print-out of multiple-choice tests and has a full quiz diagnostic routine. $19.95. Address: Acorn Software Products Inc., 634 North Carolina Ave., S.E., Washington, DC 20003 (Tel: 202-544-4259).

Flight Simulation. The A2-FS1 (Apple II) and T80-FS1 (TRS-80) are visual flight simulators that offer a real-time, 3D, "out of the window" view of the flight. The view is updated



three times per second. The viewed panel contains all the instruments required under Part 91 of the FAA Regulations for visual flight. It also includes a stall warning, turn indicator, radar screen, ammo indicator, and control position indicators. Other (keyboard) controls include throttle, brakes, bomb drop, machine guns, high-low world, and declare war. An airborne battle game is included. Requires 16K of RAM. Cassette is $25, diskette is $33.50. Address: Sub Logic, Box V, Savoy, IL 61874 (Tel: 217-359-8482).

6800/6809 DOS. The FLEX Disk Operating System for 6800 and 6809 systems supports such features as dynamic filespace allocation, random and sequential file accessing, user startup facility, user environment control, English error messages, and over 20 disk operation commands. It requires a 256-byte soft-sectored diskette, and includes an editor and assembler. $150. Address: Technical Systems Consultants, Inc., Box 2570, West Lafayette, IN 47906 (Tel: 317-463-2502).

Accounts Receivable. ACCT-M2 for the TRS-80 consists of five programs for almost any small business. The user can specify parameters such as company name and address, late charge policy, etc. It can sort customers by name, and you can add, inquiry, delete, and adjust transactions and customer information. Transaction can be paid or unpaid invoice, credit, debit or payment. Subcommands allow search, display, print, and updating of records. Order entry allows multiple items to be entered and an invoice can be printed if desired. Many other customer related functions are also included. Special features include form input, live keyboard, double-precision arithmetic, fast SHELL sort, audit log, error trapping formatted date and numeric output, I/.O buffering and blocking and a number of management options. $149. Address: Micro Architect, 96 Dothan St., Arlington, MA 02174.

British PASCAL. Available on IBM 3740 format 5" or 8" diskettes to run under CP/M, this is a full standard PASCAL, and uses as little as 32K to run. With linker and relocatable files, the package can handle complex problems. This PASCAL was developed in Great Britain. Address: Transam Components Ltd., 12 Chapel St., London, NW1 5DH, Eng.

Utilities. DISK FIX is a general-purpose disk utility for MITS/Pertec disks that allows any sector of an unmounted diskette to be examined, edited or rewritten. It will copy an entire diskette in less than two minutes. Check sums for each track assure data reliability. It requires an 8080, 32K of memory, floppy-disk drive (two drives for DISKCOPY). $95. SELECT/MWP provides for copying selected records from a mini-word processing name-and-address file to a new file as determined by the operator. Requires an 8080/Z80 with 48K and disk. Uses CP/M. $95. TX/RX (transmit-receive) provides computer-to-computer communication for 8080/Z80 machines at up to 19,200 baud. The receiver is capable of continuous unattended operation and the transmitter operates in the batch mode. Uses CP/M. $195. Address: The Software Store, 706 Chippewa Square, Marquette, MI 49855 (Tel: 906-228-7622).

OSI Sort. BPSort is a high-speed disk file sort utility for Ohio Scientific OS-65U operating system. It is written in assembly language and uses a Shell-Metzner sorting algorithm. $124. Address: BPS, 322 W. 57th St., New York, NY 10019 (Tel: 212-765-0815).

Courtesy RCA

PHONOGRAPH PLAYBACK

It's better than you think!

The vinyl disc, being seriously challenged by new technologies, is still a strong competitor

BY THE DISCWASHER RESEARCH STAFF*

THE vinyl-disc playback system (VPS)—the phonograph record and the components used to manufacture and play it—stands challenged by newer technologies. Therefore, understanding its strengths and weaknesses looms great in importance. How good is the system? How long can the disc be expected to last? How can its original quality be preserved? Can the overall system be significantly improved?

On the basis of research findings so far, the VPS can be said to have the ability to store and redeliver on home high-fidelity equipment with a quality surpassing that of all other systems extant or projected at this time—including digital. For example, certain well-pressed audiophile discs have noise floors of about −76 dB re RIAA zero VU. Adding to this the +12 dB or so headroom that most high-quality phono cartridges can successfully track gives a peak S/N ratio of 88 dB. Not only does this exceed the 84-85 dB claimed by a projected 14-bit digital disc playback system, it rivals the 90 dB claimed for digital tape systems.

A normal European pressing was found to contain recoverable modulations on the order of 0.434 nanometer, about $1/450$ the wavelength of violet light. The recorded signal, in this case, was the 19th harmonic of a 900-Hz violin tone (17.1 kHz), at about −70 dB. A normally produced disc of U.S. manufacture was found to have a residual noise level of −68 to 70 dB, for a total dynamic range of about 80 dB.

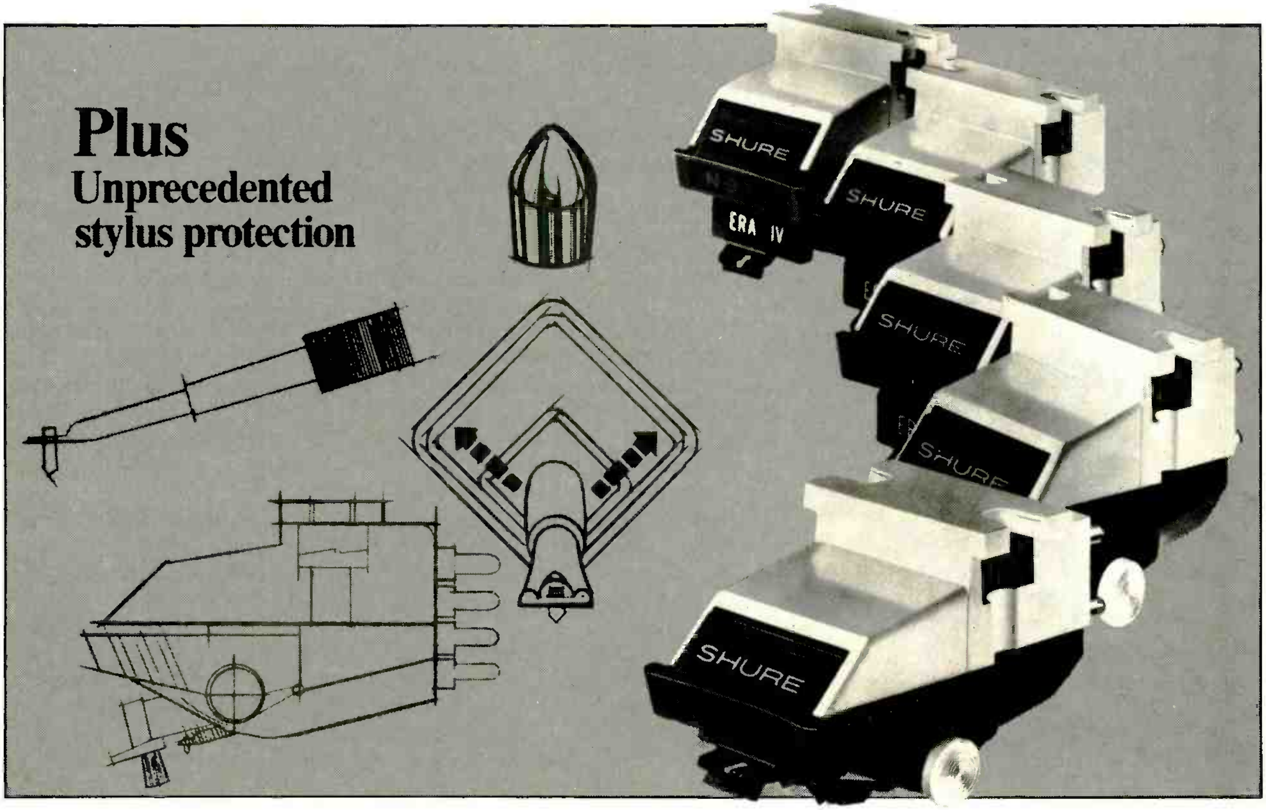
It may seem surprising that a stylus can sense such fine low-amplitude modulation when its very passage through the groove deforms the vinyl by a much greater amount, typically 250 nanometers. Perhaps even more surprisingly, the modulation is durable and withstands many passes of the stylus. But vinyl is, in fact, quite elastic and readily returns to its original shape, provided that the contact pressure is not too great. The stylus is in much the same situation as the legendary princess who could feel a pea through a thick layer of mattresses.

Interestingly, a digital recorder does not do a very precise job of capturing low-level signals either. A 16-bit system with a 50-kHz sampling rate would catch slightly less than 3 samples per cycle of the 17.1-kHz violin harmonic mentioned earlier. Because of its low level, the tone would be encoded to only a 3-bit accuracy, placing it perilously close to the level of quantizing noise, which has a far more annoying spectrum than ordinary white noise.

Bandwidth is another area in which

*B. R. Maier, R. D. Fay, J. R. Again, B. A. Hutchins, R. L. Pruitt, & J. M. Risch

fact: five new Shure Cartridges feature the technological breakthroughs of the V15 Type IV



the M97 Era IV Series phono cartridges

Model	Stylus Configuration	Tip Tracking Force	Applications
M97HE	Nude Hyperelliptical	¾ to 1½ grams	Highest fidelity where light tracking forces are essential.
M97ED	Nude Biradial (Elliptical)	¾ to 1½ grams	
M97GD	Nude Spherical	¾ to 1½ grams	
M97EJ	Biradial (Elliptical)	1½ to 3 grams	Where slightly heavier tracking forces are required.
M97B	Spherical	1½ to 3 grams	
78 rpm Stylus for all M97's	Biradial (Elliptical)	1½ to 3 grams	For 78 rpm records.

Shure has written a new chapter in the history of affordable hi-fi by making the space-age technological breakthroughs of the incomparable V15 Type IV available in a *complete line* of high-performance, moderately-priced cartridges: the M97 Era IV Series Phono Cartridges, available with five different interchangeable stylus configurations to fit every system and every budget.

The critically acclaimed V15 Type IV is the cartridge that astonished audiophiles with such vanguard features as the Dynamic Stabilizer—which simultaneously overcomes record-warp caused problems, provides electrostatic neutralization of the record surface, and effectively removes dust and lint from the record—and, the unique telescoped stylus assembly which results in lower effective stylus mass and dramatically improved trackability.

Each of these features . . . and more . . . has been incorporated in the five cartridges in the M97 Series—there is even an M97 cartridge that offers the low distortion Hyperelliptical stylus! What's more, every M97 cartridge features a unique lateral deflection assembly, called the SIDE-GUARD, which responds to side thrusts on the stylus by withdrawing the entire stylus shank and tip safely into the stylus housing before it can bend.

NEW! M97 Series Era IV Phono Cartridges . . .
Five new invitations to the new era in hi-fi.

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Manufacturers of high fidelity components, microphones, sound systems and related circuitry.

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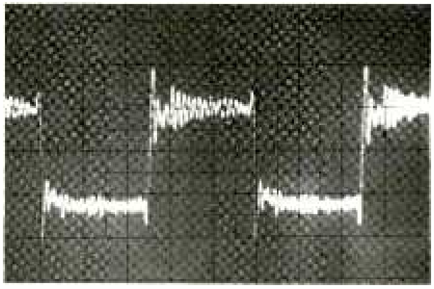
the VPS excels. Digital systems are rigidly limited to signals whose frequencies are less that one-half the sampling rate. At present, the maximum sampling rate that can be provided at reasonable cost appears to be 50 kHz. This limits practical signal bandwidth to about 22 kHz or less, depending on how complicated a low-pass filter is used. The VPS, on the other hand, is known to possess a bandwidth on the order of 45 kHz. While few human beings can hear anything above 15 to 25 kHz, depending on the individual, there is some evidence that trained listeners sense the absence of such frequencies if the audition period is sufficiently long. Studies showing that listeners do not miss anything above 15 kHz have used relatively short auditions.



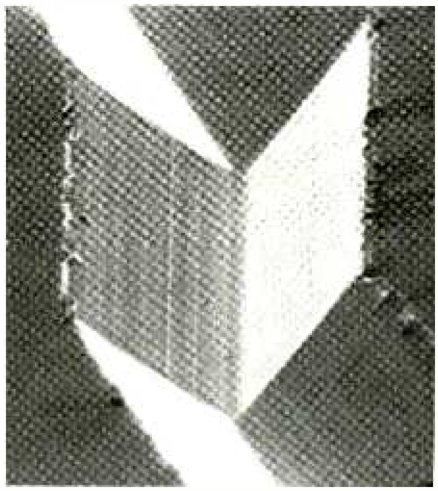


Fig. 1. Oscilloscope trace (above) of cartridge output from a 1-kHz square-wave band of a CBS STR-112 test record. "Ringing" at 41 kHz is evident. Fig. 2. (right) shows an electron micrograph of the test record groove. Note how the ripples in the groove correspond to the "ringing" signal observed in Fig. 1.

Weakness of the VPS. Like any information-storage system, the VPS can allow errors to occur. First, it is not certain the groove cut into the master disc will correspond exactly to the information to be preserved. Second, the modulation cut into the master may not be accurately duplicated through all the manufacturing stages leading to the final pressing. Third, the playback equipment may misbehave and not trace the modulation accurately, or, if it accomplishes that successfully, fail to translate it into a correct electric signal. In general, there are more of the errors of the third category.

Playback discrepancies can be perceived as changes in distortion and also as losses of low-level signals. According to previous literature, playback problems can be attributed to tracing distortion, poor stylus scanning radius, incorrect stylus rake angle (SRA) or vertical tracking angle (VTA), poor stylus/groove interface, and characteristic electromechanical properties of a particular cartridge, such as resonances.

Problems of the playback equipment are usually evaluated by means of test records containing known signals that can be examined via distortion analysis or an oscilloscope after they have been played by the cartridge. It is extremely important to know whether any given cartridge output corresponds to the recorded modulation or is an artifact of the playback process. Research has shown that test records often suffer from inaccuracies in frequency response. (See Stereo Scene, December, 1979.) It was decided, therefore, to "fingerprint" the various test records by analyzing the high-frequency spectra of recorded sine and square waves.

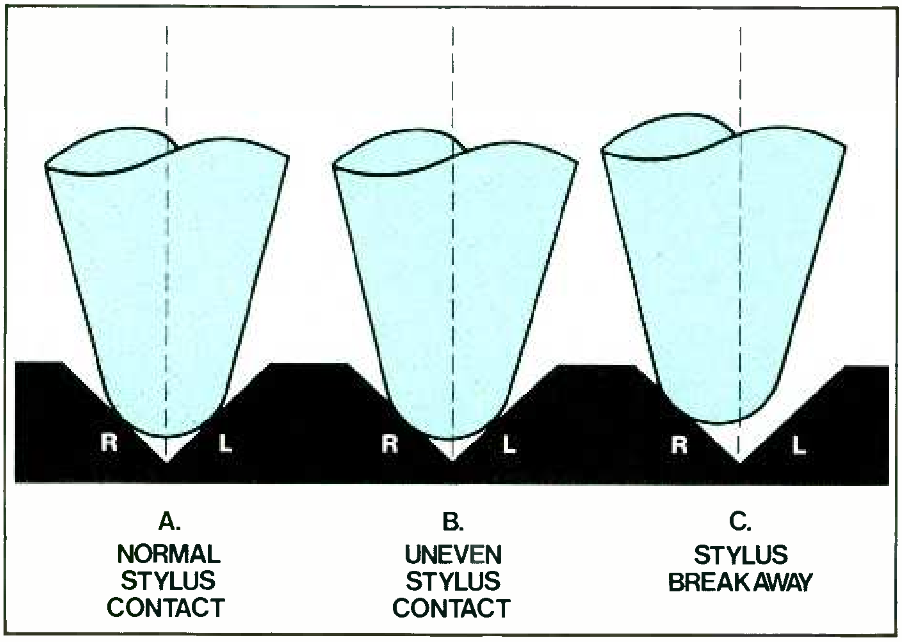


Fig. 3. Varying conditions of contact between stylus and record groove. In soft mistrack (B), stylus force is unevenly distributed between groove walls.

Fig. 1 shows an oscilloscope trace of a cartridge playing a 1-kHz square wave from a CBS STR-112 test record. The trace shows a disruption at 41 kHz, consisting of a characteristic "ringing" that many magazine reviewers have attributed to resonances in cartridges they have tested over the past 10 years. To examine this hypothesis, the disc was played at a speed different from the standard 33⅓ rpm. If the ringing were an artifact of the cartridge, its frequency would remain fixed; if recorded onto the disc, its frequency would change in proportion to the difference in speed.

As the frequency did change, it was concluded that the "ringing" was cut into the disc and the cartridge that reproduced it was actually outperforming one that did not. Subsequent examination of the groove walls by electron microscopy showed the ringing signal clearly. Note how the ripples at the beginning and end of the flat portion of the square wave shown in Fig. 2 correspond to the large displacements in the oscilloscope trace. This ringing is a characteristic of the Westrex lathe cutting system used in the production of the CBS STR-112 test record! Test records of other manufacture with square waves show no such ringing.

Another classic misrepresentation of the actual VPS occurs in state-of-the-art playback testing procedures. Most audiophiles know that mistracking should be avoided like the plague. Mistracking, however, is not always a brittle, total disruption of playback events, but may be a gradual nonlinear occurrence. Such "soft mistracking" (Fig. 3) can occur on many passages of a record. Spectrum analysis of soft mistracking shows a low-level series of harmonics generated at multiples of the fundamental frequency. These are a result of reduction rather than total loss of stylus groove contact. The most frequent cause of soft mistracking is incorrect compensation for skating force and mild record warps.

Experiments using a spectrum analyzer on a test record with an IM distortion band (a 4-kHz test tone modulated by a 400-Hz tone) provided some interesting results. Sideband frequencies spaced 400 Hz apart on either side of the 4-kHz peak are true IM distortion. Heavily mistracked IM signals produce additional peaks at 400-Hz intervals which appear under spectrum analysis as a "picket fence" of spikes. These spikes (Fig. 4) have been incorrectly termed IM distortion. Actually, it can be shown that these picket-fence side bands are not IM at all, but mistracking of the 400-Hz test tone. These spikes precisely mask and accentuate the true IM sideband products and explain how mistracking has been previously confused with IM distortion. Theoretical models of the oscillographic data of this mistracking event can be developed. A mathematical model based on the velocity-related output of a Denon DL-303 moving-coil cartridge with verification using a Stax CP-X condenser cartridge that directly interprets stylus displacement led to the conclusion that the picket fence of Fig. 4 may occur as a stylus encounters a highly modulated groove.

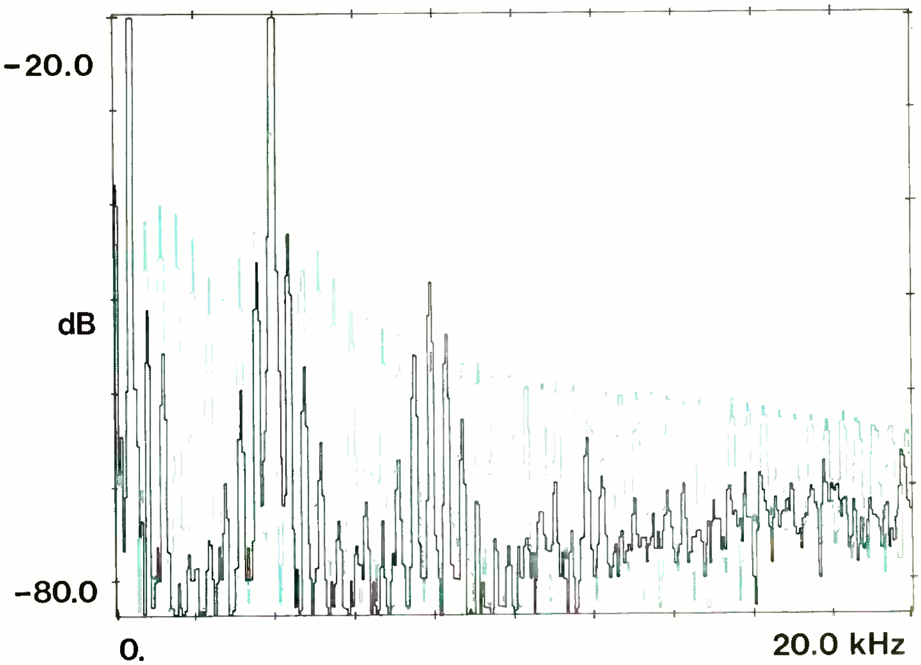


Fig. 4. Spectrum analysis of 4-kHz test tone with a 400-Hz modulation which forms a picket fence of spikes shown in color.

Figure 5 is a drawing of a monophonic sine-wave groove. The mechanical impedance of the cartridge (stiffness) causes the stylus to ride up the groove wall (A) as the stylus tries to make a "tight turn." Progressively, the stylus loses pressure with the opposite groove wall (B) until a total loss of contact occurs. The stylus tip rides up on the wall until the vertical tracking force (VTF) catches up with the eccentric inertial condition, and the stylus literally slams back down into the groove, recontacting both walls (C).

A European test record with high-velocity 300-Hz bands was played 850 times under the conditons of mistracking. The scanning electron microscope clearly shows the path where the stylus rides up one channel and scores it (Fig. 6). Research has shown that the best way to reduce this type of mistracking is to play a given cartridge at the high end of the manufacturer's recommended VTF. This does not increase record wear within the measurement capability of our systems. Correctly setting the anti-skate of a turntable/tonearm system for VTF and groove modulation is very important. A system to accurately make this type of adjustment in the home environment is under development.

The Myth of the Vertical Tracking Angle (VTA). Commonly accepted knowledge about the VPS holds the vertical tracking angle (VTA) between the cartridge/cantilever pivot point and the record (with stylus contact as the angle apex) to be extremely critical in accurate and low distortion playback. (See

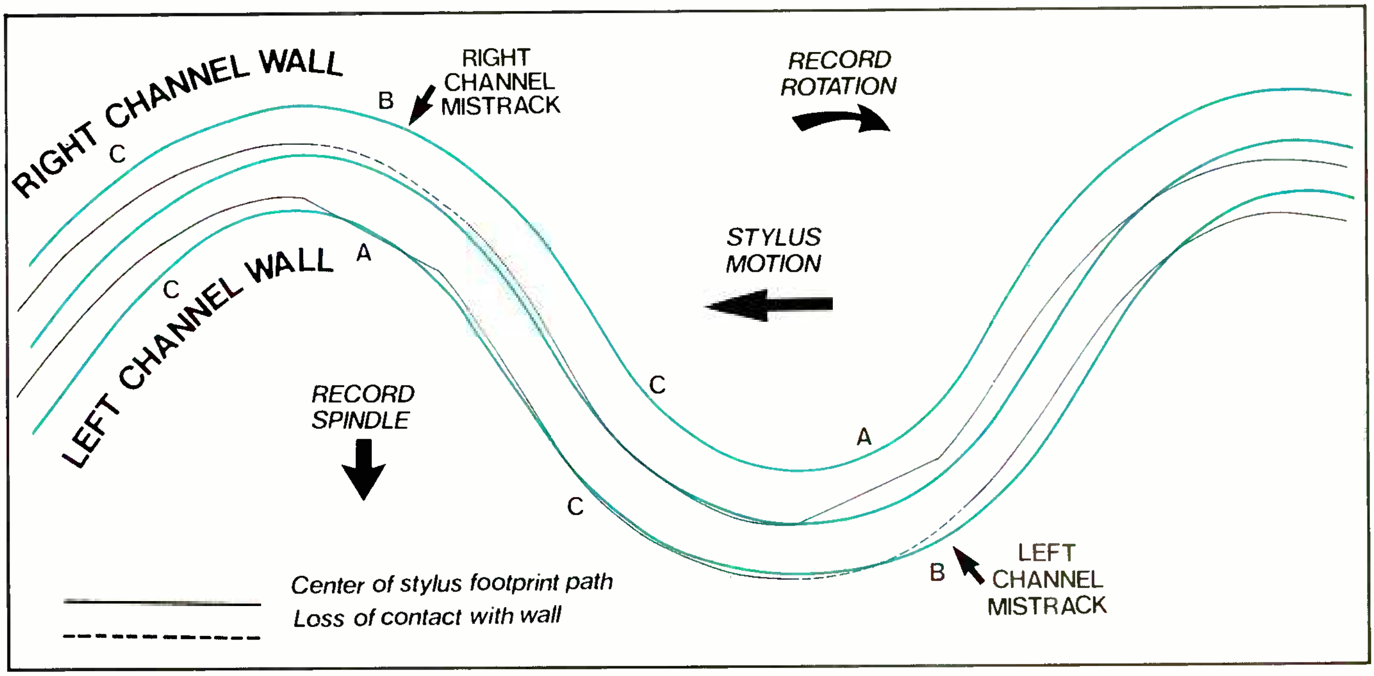


Fig. 5. Mistracking of a monophonic sine-wave groove.

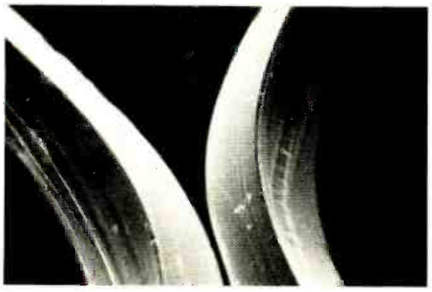


Fig. 6. Electron micrograph of a mistracked groove shows ruts caused by errant stylus.

Fig. 7.) Specifically, the VTA of the playback system must match the corresponding angle of the cutting system. To test this hypothesis, it was determined empirically that VTA within a wide range of visual setups was not measurably significant with respect to distortion. Yet it seemed audible at smaller angle differences. Note that four degrees of change in VTA give a visually startling slant to a tonearm, but within plus or minus three degrees (significant visual differences) measured distortion was not dramatically increased.

Since the playback stylus chip (and cutting stylus of the mastering lathe) are fixed to their respective cantilevers or arms, stylus rake angle (SRA) is irrevocably connected to VTA, and the two are often confused. SRA is actually an independent specification, representing the vertical contact profile of the stylus as it touches the record groove. Geometry shows, however, that a spherical stylus will have a constant SRA even though VTA may change. Eliptical and shibata type styli, in contrast, show dramatic alterations in SRA when VTA changes. This is because of their contact geometries.

As the table in Fig. 8 shows, a spherical stylus has relatively stable distortion levels as VTA changes in the range of two to four degrees. A similar change in VTA for a shibata-type stylus, however, changes SRA as well, and the data show a larger increase of distortion products. There are indications that some cartridges, because of the distance between system pivot and stylus tip (armature length), cannot maintain correct VTA under any circumstances. Even these cartridges can be shown to have minimum distortion (null) points with proper setup.

These data suggest that SRA may in fact be the important setup dimension. This contention has been supported by taking a shibata type of stylus and physically bending the cantilever such that the cartridge VTA is grossly (±5 degrees) out of alignment, while the SRA remains correct. This odd condition produced data not significantly different from that obtained for a correctly aligned shibata.

The conclusions support the idea that VTA may be customarily overemphasized as a parameter of audio quality in the VPS. SRA alone, on the other hand, is extremely critical by both listening tests and distortion measurements.

Communications with the manufacturers and engineers of cutting lathe systems indicate that the cutting stylus carves the record with a vertical contact profile "tipped" slightly forward (away from the tonearm) pivot by one or two degrees. Thus the SRA of the cutting system is 92 degrees, with a VTA of 16 to 20 degrees. Critical matching alignment of playback-stylus SRA results in audible improvement in the VPS. A procedure to allow SRA alignment to be performed easily in the home is under development. Such alignment is possible now, but it is difficult.

Prospects for the VPS. It is a matter of historical record that the VPS has fulfilled virtually all of the demands made on it, in particular, those for extended playing time and stereo capability. In addition, it has withstood the challenges posed first by open-reel tape and later by the cassette medium. Research into the nature of the VPS leads to the surprising conclusion that, with carefully manufactured software and critical alignment of playback equipment, it can compete successfully even with digital recording systems. In such a contest, the cost-effectiveness of the VPS is undoubtedly one of its strong advantages. ◇

VTA	Conical stylus	Shibata stylus
0°*	0.67%	0.43%
+4°	0.71% (app. 1 dB inc.)	0.75% (app. 5 dB inc.)
+8°	1.05% (app. 2½ dB inc.)	1.19% (app. 9 dB inc.)

*Arbitrary reference

Fig. 8. Distortion levels for spherical and shibata styli as the vertical tracking angle is varied.

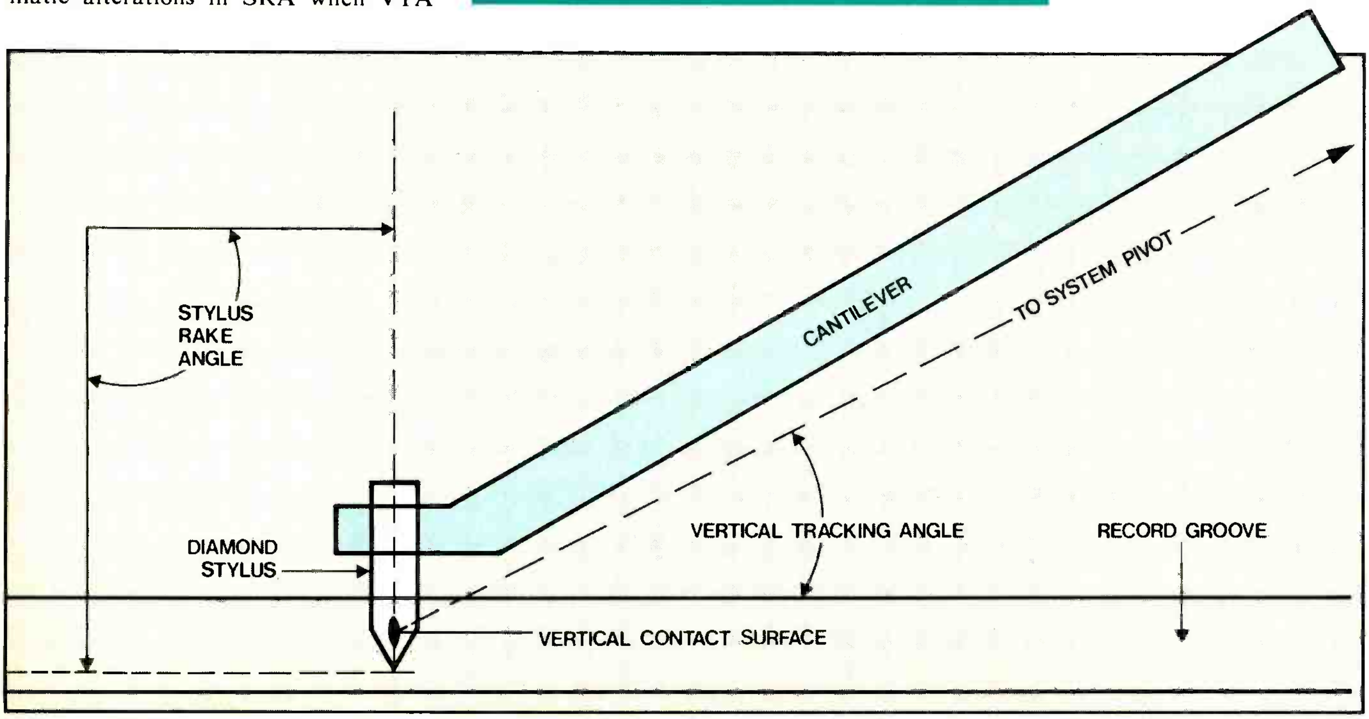


Fig. 7. Though in a fixed relation for any one cartridge, stylus rake and vertical tracking angles are independent.

Basics of COMPUTER DISK SYSTEMS

An introductory look at this ubiquitous mass-storage technique

BY LESLIE SOLOMON
Senior Technical Editor

FOR large-capacity data storage with fast program access and retrieval, no present computer peripheral can beat the magnetic disk medium. A typical, moderately priced, floppy-disk system can *randomly* access stored data in no more than a few seconds and can load it into a computer at an extremely high rate. (Hard-disk systems are even faster.) In both these respects it outperforms cassette tape systems handily. For example, a typical 5¼″ disk system operates at 15.6K bytes/second, an 8″ drive works at 31K bytes/second, while a typical cassette system uses a leisurely 150 bytes/second. Also, in a disk system, most operations are automatic, while with a cassette system, the operator has to manually perform all operations. The cassette medium's sole advantage is very low cost.

The Floppy-Disk System. Three elements make up the floppy-disk system: the flexible diskette on which data is stored; the mechanical disk-drive element; and the electronic controller that interfaces the disk drive to the computer. Let's take a close look at each:

Floppy Diskette. This is the "medium" onto which data is recorded (written) and from which data is played back (read). It consists of a durable, thin, flexible ("flexible," translated into computer jargon, becomes "floppy") plastic disk coated on both sides with a layer of magnetic oxide similar to that used on audio recording tapes. The magnetic medium (the actual "diskette") is sealed into a durable and somewhat less flexible plastic jacket that protects and lubricates it as it rotates.

A large hole in the center of the jacket exposes a smaller circular hole in the magnetic medium, which allows the motor-driven spindle in the drive mechanism to mechanically hold and rotate the diskette against the read/write head. Rotational speed is usually 360 rpm for both 5¼" and 8" (the two sizes available) systems.

Data is stored as magnetic flux changes in circular "tracks" that are concentric with the center of the diskette. In all, there are from 35 to 77 tracks on a 5¼" diskette and up to 154 tracks on an 8" diskette. Tracks are subdivided into "sectors," each of which can contain 256 to 1024 bytes of data. In a hard-sectored diskette, there are typically 10 to 16 sectors on a 5¼" diskette and 15 to 30 sectors on an 8" diskette.

Access of the read/write head medium is through a slot in the jacket. (See Fig. 1). A small circular hole through the jacket is used by the index/sector detector. When a diskette is installed in the drive, a photoelectric detector "looks" through this hole and detects the start of a sector on the diskette when a corresponding hole (or holes, in the case of a hard-sectored disk) is aligned with the index hole in the jacket. Having detected the hole in the diskette, the computer can locate all sectors.

The write-protect notch, always located along an edge of the protective jacket, is sensed by either a photoelectric device or a mechanical switch. Covering this notch on a 5¼" diskette suppresses write operations and protects the recorded data against overwriting. When the notch is open, write operations to the diskette are allowed. The reverse is true of 8" diskettes: writing is suppressed when the notch is open, and permitted when it is covered. However, some manufacturers use nonstandard write-protect systems. Consult the instruction manual if in doubt. Some diskettes have very small notches on one edge; these are for jacket strain relief and should not be confused with the actual write-protect notch.

Disk Drive. A basic approach to the mechanics of disk-system operation is illustrated in Fig. 2. When the front door of the disk drive is closed, the drive spindle is forced through the hole in the diskette against a stop located above the diskette. A belt connects the spindle to its drive motor. When the diskette is firmly seated on the spindle, a signal from the computer to the disk system's control logic starts the drive motor, which then rotates the diskette. Meanwhile, the write-protect detector will have determined whether or not the diskette can be written to and so inform the read/write logic. Additionally, the index/sector sensor will have detected the correct starting location for the upcoming *write* or *read*.

When the *start* signal is received by the control logic, the head is mechanically stepped to the correct track, where it makes direct contact with the magnetic oxide on the diskette. A pressure pad on the opposite side of the diskette, in line with the head, maintains intimate contact between head and diskette. Most manufacturers include a front-panel LED that glows to indicate when the disk drive is operating. Also, in most cases, you will hear a click or grinding sound as the positioning mechanism moves the head to the correct track.

Once the disk drive goes into operation and the sensors have done their job, the head "seeks" the correct track and sector and reads the requested data. This data is passed to the read/write logic, where it is processed for use by the computer.

When all operations are completed, the head automatically lifts from the surface of the diskette and the front-panel LED extinguishes. Then, opening the front door of the drive allows the diskette to be removed from the drive spindle. A darkened LED is not a reliable indicator that all operations have been completed. The drive may simply be pausing between steps and may restart at any time. Only when the "prompt" symbol appears on-screen is it safe to open the drive door and remove the diskette.

Disk Controller. Each manufacturer supplies a DOS (disk operating system) that is unique to each single- and multiple-drive system. In most cases, a disk controller takes the form of a plug-in card that interfaces with a computer. A typical DOS, usually in ROM, will contain enough commands to allow flexible use of a diskette. Though basically similar, DOSes vary in the additional convenience functions that they provide.

Some DOS operations are also used in disk BASICs, which are specialized versions of this popular high-level language specifically written with disk manipulations in mind. A disk BASIC is usually written for a particular DOS or disk system and may or may not work with other disk systems. There may also be a slight difference in syntax used for the same command in DOS or BASIC. In multiple-drive systems, each drive is assigned an identifying code so that it can be "called" to provide data from its diskette.

A well-written DOS with a large number of commands is a programmer's best friend. It enables access to hundreds of thousands of data bytes that need not occupy the relatively sparse amount of RAM usually found in a small computer. Bear in mind that an eight-bit microcomputer can conventionally address 65,536 bytes of memory, and not all of this can be RAM, since operating utilities such as ROM, video plug-ins, and other elements take up

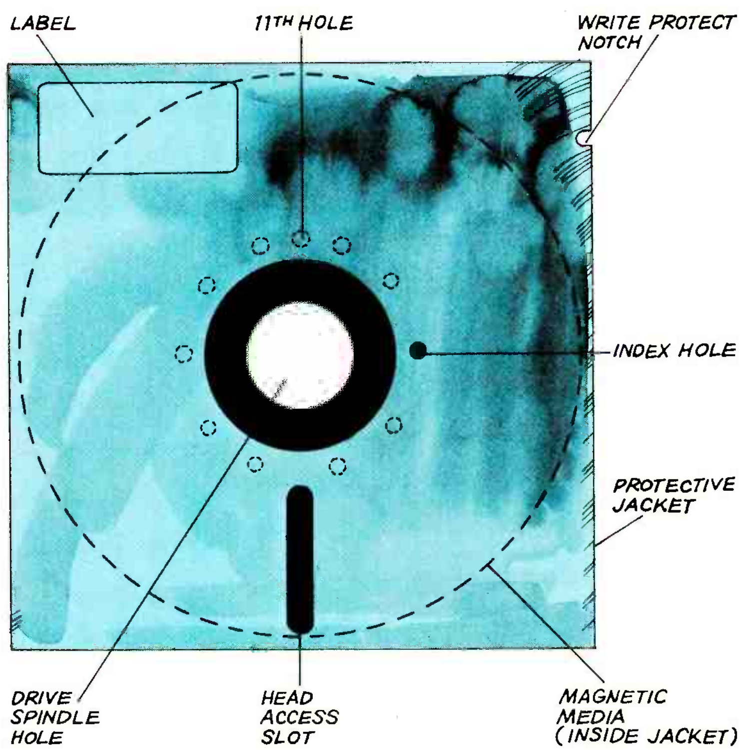


Fig. 1. Configurations of a 5¼" (above) and 8" (opposite) diskettes as used in small computers, with makeup of a diskette at far right.

space in the address field. A well-written DOS can function efficiently with as little as 16K bytes of RAM.

Soft and Hard Sectoring. In general, there are two mutually incompatible types of track sectoring used in modern diskettes. Physical differences make it easy to determine whether a given diskette is hard- or soft-sectored. Soft-sectored diskettes have only one index hole. Hard-sectored diskettes, on the other hand, nominally have 10 or 16 holes. In reality, they have 11 or 17 holes; the extra hole, centered between two of the "official" holes, tells the computer that the next hole identifies the start of sector 0. Each hole thereafter identifies the start of a sector. Circuits in the disk controller detect the shorter space between the index hole and the hole following it and reset the counter to 0.

On a soft-sectored diskette, the DOS creates sectors on an *ad hoc* basis. Conceivably, the entire disk could be a single sector.

To determine the type of sectoring used in a given computer, check either the instruction manual or the diskette itself. If you wish to examine the diskette, hold it by its protective jacket. Being careful to avoid touching the magnetic medium through the head-access slot or bending the diskette, use a slender nonmagnetic tool to lift the jacket away from the diskette through the large center hole. Look into the opening, and count the number of indexing holes. If there is only one hole, the diskette is soft-sectored. If there are 11 or 17 holes, it is hard-sectored. Make a note of the number of holes used in your diskettes.

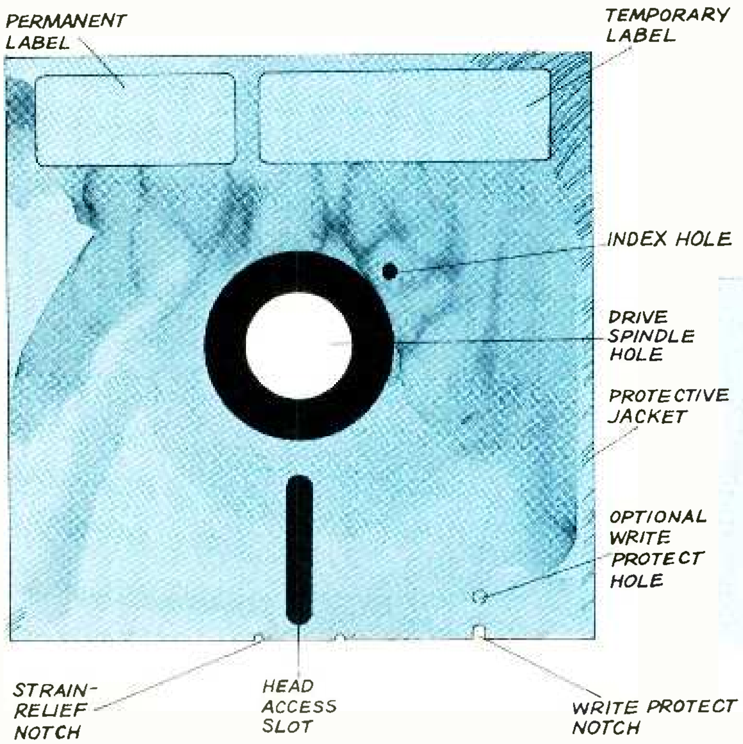
In most cases, the manufacturer's label on the diskette's jacket will inform you of the diskette's formatting. For example, Verbatim uses the following three-digit code prefix: 525 for a 5¼" single-sided diskette; 550 for a 5¼" double-sided, double-density diskette; and 577 for a 5¼" single-sided, double-density diskette. These are followed by a two-digit suffix: −01, −10, or −16, which identify soft-sectoring and 10- and 16-hole hard-sectoring, respectively. Hence a diskette with a 525-10 code is a 5¼" single-sided, 10-hole hard-sectored diskette.

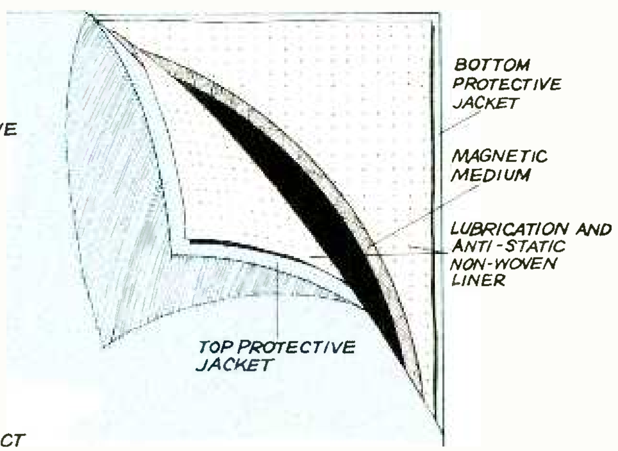
To increase the amount of data that can be stored on a diskette, manufacturers have gone to "double-density" (twice the number of bits per track), "double-sided" (recording the disk on both sides), and "quad-density" (a combination of the above) schemes. All have their advantages, but they can present some problems. For example, because there is no standard for double-density systems, such diskettes often cannot be interchanged. In double-sided systems, there is a read/write head on both sides of the diskette, each acting as a "pressure pad" for the other. This can exert too much pressure, damage the medium, and cause rapid head wear. New drives do not have this problem.

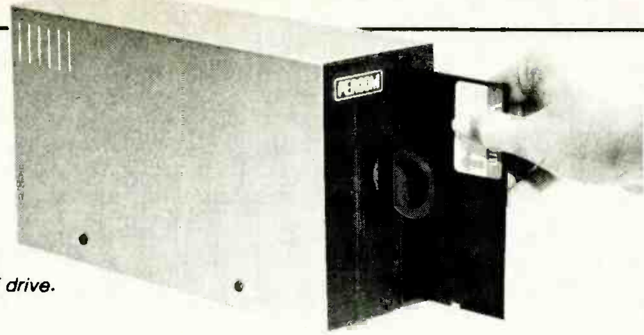
Generally speaking, a disk controller designed for a double-density system can read either single- or double-density diskettes with appropriate hardware or software changes. However, a single-density controller cannot read double-density diskettes.

Since a diskette is coated on both sides with magnetic oxide, there is yet another approach to increasing storage capacity. You can punch an index hole and write-protect notch through the diskette's jacket and make the "other" side of the diskette available for data storage. Bear in mind, though, that in a single-headed drive, the head is backed up by a pressure pad. If this pad becomes contaminated with oxide or particulate matter, it can destroy the soft oxide on both sides of the diskette.

More Details. Data in a disk system is written onto the diskette using a form of frequency modulation (FM), wherein a single data pulse (0 or 1) is written so that it is centered between clock pulses. The presence of a flux transition indicates a binary 1, its absence a binary 0. Double density is achieved by using a modulation technique called modified







Diskette is installed with notch up or down depending on make of drive.

FM (MFM) or modified-modified FM (M^2FM). Here, a double-frequency write oscillator is used to maintain the same flux changes per inch. Thus, a bit cell in MFM/M^2FM is only half that used in FM. The data-transfer rate is doubled, since a 1:1 relationship exists between the flux changes and bits per inch (2:1 in FM).

In M^2FM, clock bits are written at the beginning of each cell if there is no data bit written into the previous cell and if there will be no data bit written into the present cell. Since a double-density bit cell may not have a clock pulse at its beginning, data separation is more complex and prone to errors.

Transfer rate is the speed at which requested data can be moved from the diskette to the computer. Look out here for the "numbers game," though, since a system that can transfer at 250,000 *bits* per second is *not* the same as one that can transfer 250,000 *bytes* per second.

Error rates in the typical diskette system have been estimated to be one per 10^8 bits during read operations for soft-sectored diskettes; one per 10^{11} bits during read for hard-sectored diskettes; and one per 10^6 bits during seek.

Life of a diskette is estimated to be about two years under "normal-use" conditions. One manufacturer (Shugart) claims a life of 2 million passes on any one track. A track is considered to be worn when its output signal voltage falls by 20% from its original level.

Estimated MTBF (mean time before failure) in the typical disk system is approximately 8000 hours. Component design life is usually estimated conservatively at five years.

Selecting a Disk System. Before you buy a disk system, determine what you intend to do with your computer. If your computer will be used as a game "player" or for experimenting, learning computer techniques, or anything else that does not require extensive number/data "crunching," a single 5¼" drive will probably suffice. But if you want a really large-capacity mass storage, you may need a multiple-drive system.

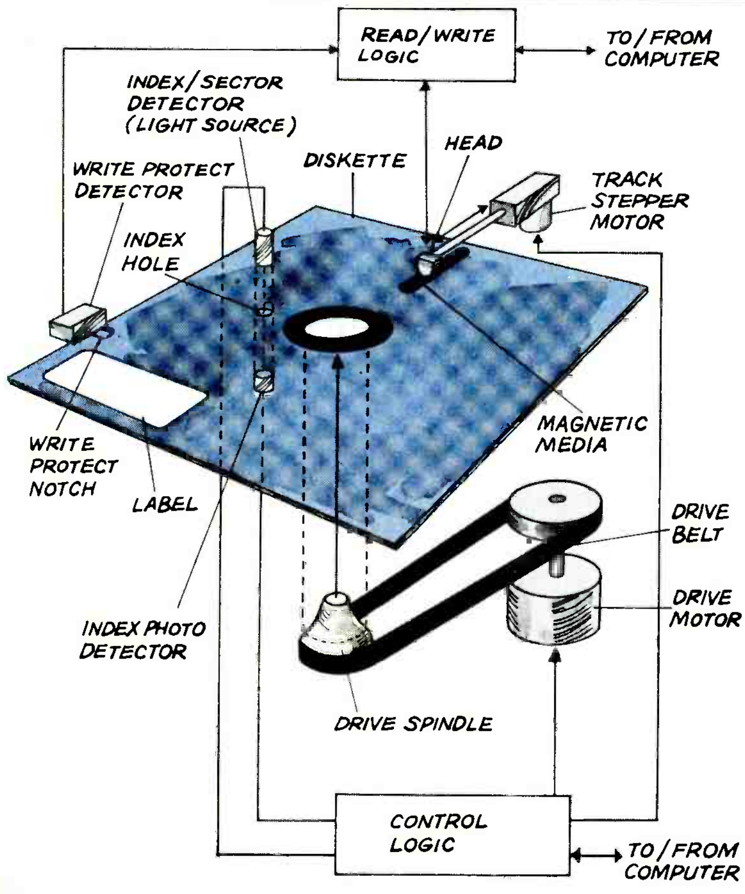


Fig. 2. Basic electronics and mechanical design of a typical floppy diskette system. In this view, the diskette is assumed to be installed and ready to go.

Mass storage requirements will also dictate the choice between 5¼" and 8" drives. (An 8" diskette can hold twice as much data as a 5¼" diskette at less than twice the cost.) Note that you never really have *all* the available disk space for program-data storage. Some is reserved for formatting (file names, headers, etc.).

If your data demands range into millions of bytes (megabytes), a "hard-disk" system may be your most economical alternative. Bear in mind, however, that you will have to back up the data on the hard disk with one or more floppy-disk drives, just in case the hard disk suddenly "loses" a megabyte of data.

In most cases, a single disk controller board and DOS can handle up to three drives. This allows you to add drives to a minimal system as you need and can afford them.

There is no hard and fast rule that can guide you in selecting the "best" disk system for a particular computer but there are some basics to be observed. Most important is that the electronics and DOS or high-level language provided with the disk system must be compatible with your computer. The DOS, BASIC, assembler, and any other software features supplied on the disk system's diskette must be able to call your particular computer's keyboard, video display, printer, etc. Unless you are very experienced in using software, you will find it extremely difficult to integrate a "strange" DOS or language into your computer's routines.

Make sure that any software you require is available for the disk system you select. While on the subject of software, it is important to note that not all CP/Ms (a popular, "universal" DOS) are as insensitive to hardware as claimed. If you should have single-density drives and obtain double-density-formatted CP/M, the disk cannot be read, and CP/M will not run. So, *before* you buy a given CP/M, make certain it will run in your system.

Access time (the time taken to move the head to a desired track) can sometimes be important. Long waiting times, even though measured in milliseconds, can interfere with some sophisticated software or may nullify its advantages. It is also crucial that the disk system be compatible on the hardware level. The North Star hard-sectored system, for example, achieves high transfer by outputting data on the *address* bus. Naturally, it requires a special interface.

The Future. There is little doubt that the hard-disk ("Winchester-drive") system is the wave of the future for low-cost multimegabyte mass storage. What makes the hard-disk different from the floppy-disk medium is that the former allows no physical access to the disk and read/write head(s), which are hermetically sealed in a protective enclosure. Hermetic sealing is necessary because the read/write head literally "flies" a minute distance above the rapidly rotating (3600 rpm) surface of the magnetic disk. If any particulate matter, even microdust, were to get between disk and head, catastrophic disk damage would almost certainly result.

The hard-disk drive employs a very precise mechanism in which tolerances are extremely tight. Track density, therefore is vastly increased, making it possible for the disk to store considerably more information than is possible with floppy disks.

Although hard-disk systems appear to be very expensive, they are actually much less expensive than floppy disks and RAMs on a cost-per-byte basis. In a typical 5¼" floppy-disk system, average per-byte cost is 0.002¢, while an "inexpensive" 64K byte RAM system's typical per-byte cost is 0.006¢. Now contrast these figures with the 0.0002¢ per byte cost for a 26-megabyte hard-disk system that sells for $5000.

Hard disks come in a variety of sizes, ranging from 5¼" to 14". The latest on the market is Shugart's Model ST506, which offers 6.38 megabytes unformatted (5 megabytes formatted) storage capacity on 612 tracks and four read/write heads at a suggested retail price of $1000. With a per-byte cost of only 0.0002¢, the ST506 may well signify the start of a trend in low-end hard-disk systems for the small-computer system owner.

At present, no industry standard exists for the computer/disk interface. However, because of the large market share garnered by Shugart Associates, this company's Model SA1000 hard-disk system has become the *de facto* standard used by low-cost hard-disk system manufacturers. (This trend is similar to the "standard" set by the MITS S-100 bus for eight-bit microcomputers.) It is more than likely that the SA1000 interface will soon be modified to handle any floppy-disk drives that may be used to back up the data on the hard disk.

Whether or not prices for hard-disk systems will drop as dramatically as the prices for computer systems in general is difficult to foretell. But even if prices remain the same as they are now and more hard-disk systems come on the low-end market, many computer owners are likely to move up to the hard disk, especially if they already have minifloppy systems that can plug directly into the hard-disk system for backup. ◇

FRAGILE—HANDLE WITH CARE

Because the magnetic oxide on floppy diskettes is relatively soft and very thin, it can easily be damaged unless special care is exercised during handling, use, and storage. For this reason, we have drawn up a list of 10 things to avoid. Here they are:

- *Don't touch the magnetic-oxide surface on the diskette, especially around the head-access slot in the jacket. Body oils in fingerprints can permanently destroy data.*
- *Don't leave a diskette lying around where it can collect dust, dirt, and other contamination. Even a tiny dust particle passing between head and diskette will scratch the oxide medium. Always return each diskette to its storage envelope.*
- *Don't smoke when you are handling diskettes (or when you are operating your computer, for that matter). Airborne smoke and ash particles have a habit of collecting on diskettes and ruining them.*
- *Don't write on a label that is already on a diskette with a ballpoint pen. Transmitted pressure from the pen's point can easily damage the oxide surface on the diskette. If you cannot write out your labels off the diskette, use only a soft felt-tipped pen and very little pressure.*
- *Don't erase a label while it is on a diskette. No matter how careful you are, eraser and paper particles are almost certain to contaminate the diskette.*
- *Don't force a diskette into a disk drive or its storage envelope. If you encounter resistance, back out and try again.*
- *Don't bend or fold a diskette. If you do, tiny pieces of oxide will flake away and render the diskette useless.*
- *Don't store diskettes in locations where temperatures are likely to rise beyond 110° F or where there is danger of stray magnetic fields.*
- *Don't store diskettes lying flat and on top of each other. Like phonograph records, store them vertically, in dust-tight containers.*
- *Don't power up or power down a disk system with a diskette in the drive. If you do, stray magnetic fields generated by the drive's motors may alter the data on the diskette making it incorrect.*

If you follow these rules religiously and keep everything scrupulously clean, you should obtain the maximum operating life from every diskette you own.

9K RAM (8K user available), 14K BASIC interpreter operating system ROM.

User-programmable, in both BASIC and MC6800 machine language.

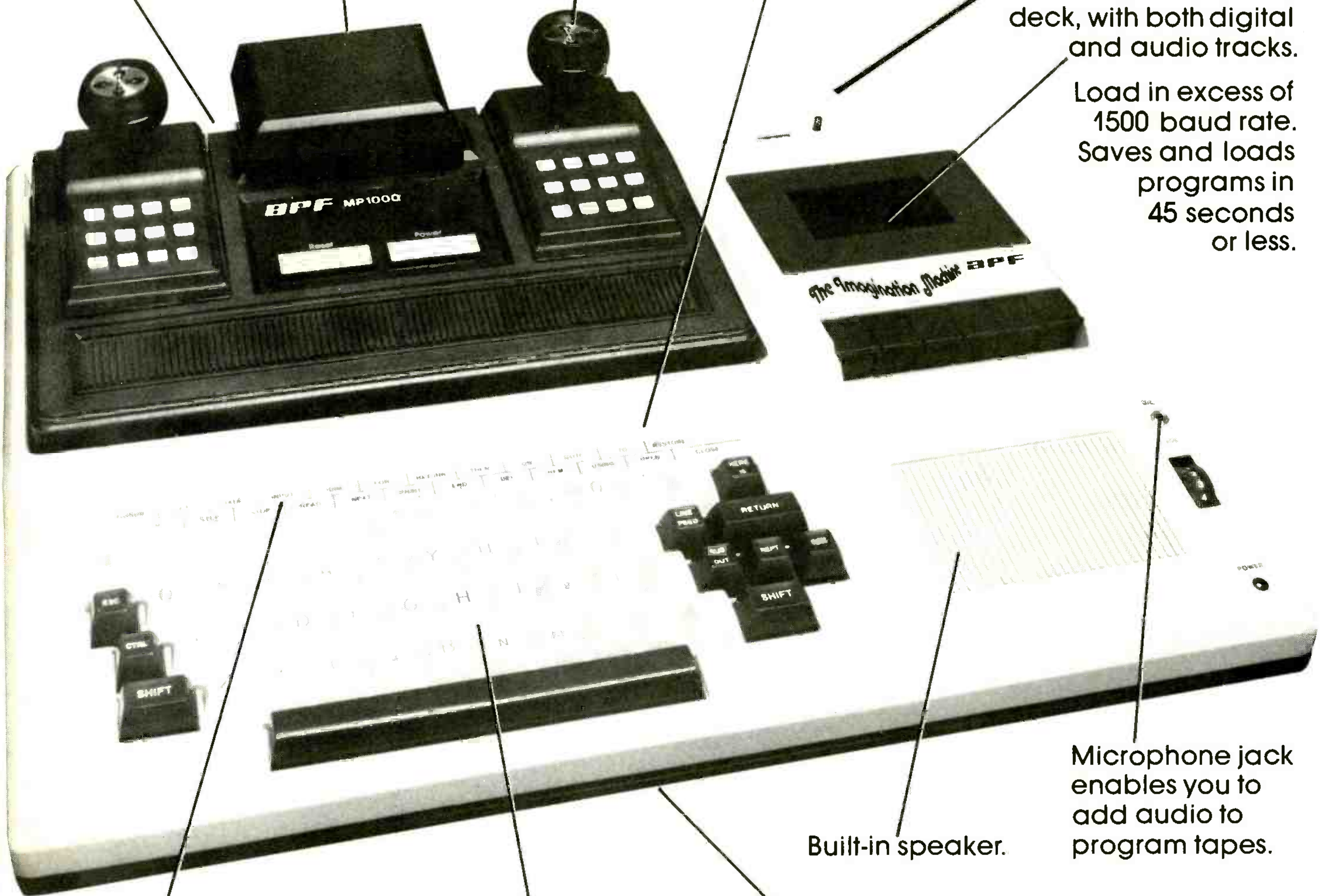
Built-in RF modulator.

Built-in sound synthesizer.

Two built-in game controllers, with joysticks and numeric keypads.

Built-in cassette deck, with both digital and audio tracks.

Load in excess of 1500 baud rate. Saves and loads programs in 45 seconds or less.



Microphone jack enables you to add audio to program tapes.

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Full, standard, 53-key typewriter keyboard.

High resolution picture on your TV screen, in 8 colors.

256 x 192 graphics mode.

All that computer for $599.

The Imagination Machine, the personal computer from APF Electronics.

The Imagination Machine is more personal computer than you'd expect at $599.

The Imagination Machine is a superbly designed, expandable, user-programmable computer system . . . at $599.

No other personal computer on the market can touch it, at that price.

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First of all, The Imagination Machine has 9K RAM and 14K BASIC-IN-ROM. A full 53-key professional, typewriter keyboard. A high-resolution picture on your TV set, in eight colors. Fast loading (1500+ baud rate), built-in dual-track cassette deck, for APF's digitally recorded tape programs. Built-in sound synthesizer. And, even a built-in RF modulator, which is a $40 option on other computer systems.

All that, plus user-programmability.

We know sophisticated users aren't going to be satisfied forever using preprogrammed software. (Even though we offer a large library of educational, entertainment, home and business management programs.) So, we made The Imagination Machine user programmable, in both BASIC and MC6800 machine language. To simplify matters, we've just developed the first and only BASIC TUTOR course on cassette. With it, you can learn to program The Imagination Machine in BASIC, with hands-on training, right at the computer.

Some exceptional features.

The Imagination Machine has several unique features that can help you use your time at the computer more effectively.

For example, it stores programs and data on the same cassette tape. (With other computers, you have to read programs from one tape into the computer, remove the tape, put in another tape and store your data on the new tape.)

Another special feature is The Imagination Machine's unique keyword system, which simplifies BASIC programming. The machine has 24 different programs statements and commands printed at the top of the keyboard. You can enter these 24 into your program without retyping them every time you use them. Instead of typing out "PRINT," for example, you just press two keys and the word appears on the screen. The system helps prevent typing errors and can speed up entering programs.

A third feature is Timed Response Monitoring, which automatically adjusts the computer's pace and level to your own. It makes "tutoring programs," for instance, easier and more interesting to follow.

And then there are The Imagination Machine's three graphic display modes: 1. Alpha numerics, mixed with low-resolution graphics in as many as eight colors. 2. High resolution — up to eight colors — 128 x 192 display. 3. High resolution graphics — up to four colors — with 256 x 192 display.

And expandability.

A personal computer that can't grow along with your growing requirements soon becomes obsolete. So, we designed The Imagination Machine to be expandable. By adding APF's optional "Expansion Box" and interface cartridges, you can hook up any compatible floppy disk or printer, or an additional 8K RAM memory cartridge.

Full mini-floppy system $995.

For small business and professional use, you may require a full mini-floppy system. In that case, order APF's System II. It includes The Imagination Machine, the "Expansion Box," floppy disk interface and 72K-byte, mini-floppy disk drive. All for just $995! No one can come close to that price.

You can't beat our prices or our guarantee.

If you can find a better personal computer system for the money, let us know. In the meantime, we stand by our statement: There is no other personal computer on the market that offers so much for so little. And if you order now, we'll even include our $19.95 APF Technical Reference Manual, with complete schematics, absolutely free.

Order The Imagination Machine directly from APF Electronics, with the assurance that if you are not completely satisfied, you can return it within 30 days of purchase for a complete refund. To order, or to learn the name of the dealer nearest you, call TOLL FREE 1-800-223-1264. New York residents call 212-869-1960. MasterCard and VISA accepted.

Price list:

System I, The Imagination Machine.	$599.
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BB-1. Expansion Box with RS232 cartridge.	$199.95
BB-2. Expansion Box with floppy disk interface cartridge.	$199.95
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RS232 cartridge.	$ 99.95
Floppy-disk interface cartridge.	$149.95
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QUALITY COMPUTER AT A PRICE ANYONE CAN AFFORD

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SERVICE AND WARRANTY

If the unit fails because of factory defect within 90 days of purchase, it will be repaired at no charge for labor and parts - you just send the unit United Parcel prepaid to the Service Center designated and it will be sent back to you promptly United Parcel prepaid! A complete Diagnostic program tape and instructions are available. You can get a Service manual, Cassette alignment tape, Schematics, and parts list plus a Money Saver Service and Warranty Card. Everything you need to check and service your computer.

IT CAN BE EXPANDED AT LOW COST

It is a single board computer. RS232 interface is available at $99.50 for adding printers and telephone modems. A telephone modem allows you to access "MICRONET", "SOURCE" and other data banks. You can also communicate with other computers. It is possible to increase the RAM to 32K and the ROM to 16K. We plan to offer a low priced expander January '81 for basic in ROM and 16K Additional RAM. Our Factory sponsored National Computer Club membership is available to learn from other Owners the Fantastic things you can do with this computer.

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SPECIAL FACTORY PACKAGE PRICE DEAL $399.00

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PART II

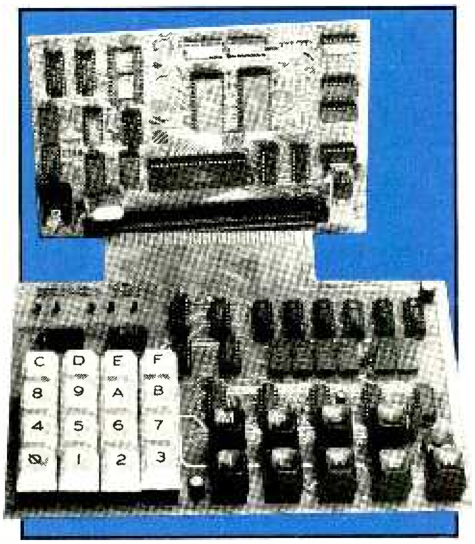
NOW YOU CAN BUILD MICROPROCESSOR PROJECTS USING AN INEXPENSIVE PRODUCT DEVELOPMENT SYSTEM!

BY GEORGE MEYERLE

IN May 1980, our first article on designing with microprocessors, "It's a Whole New Ballgame," showed how, with an understanding of just a few instructions and very modest hardware, one could build a microprocessor-based combination lock. However, to implement more generalized microprocessor product design with confidence, additional skills in programming and with hardware are required. Development of these skills will be the theme of this and future articles.

This article describes the use of input and output ports and how the microprocessor interfaces with peripheral hardware such as random access memory (RAM) and read-only memory (ROM). We will go on to the construction of an 1802 microprocessor product development system. This is an inexpensive system (professional models cost thousands of dollars) that allows the processor to be programmed, tested, and debugged for a particular application. The unique property of this system is that it is contained on two separable circuit boards: the product board and the programming board. The former becomes part of the finished project—whatever that may be; the latter is used to program other product boards.

The product or application board we will describe includes a CPU (central processing unit), a crystal-controlled system clock, 1024 bytes of RAM, 2048 bytes of ROM, one 8-bit input port, one 8-bit output port, address latches and decoding, buffered CPU flag inputs, Q output, INTERRUPT/DMA (direct memory access) request input, a POWER ON CLEAR circuit, and battery backup.



The product board is shown at top, and the programming board below.

The board uses bus connectors to plug in the programming board as well as additional product expansion cards or boards such as additional I/O, memory, A/D. graphics keyboard, cassette I/O, etc. The programming board that we will describe includes a hex keyboard to input programs, six 7-segment displays that show the status of the address and data busses, a variable-speed single-step system used to step through the program, LEDs on the MODE and STATE CODE lines of the CPU to indicate what the processor is doing, and a series of switches to completely control the action of the CPU. Functions include RESET, RUN/EXECUTE, WAIT, LOAD, INPUT and MEMORY PROTECT. (This programming card is not necessary if you already own an Elf II; the product board plugs into an Elf II and can be programmed directly.)

Product Board Operation. The central component of the product board is the microprocessor (CPU), which controls the activities of all the peripherals. For the time being, we will not be concerned with what happens inside the CPU, only with external effects and signals. The following is a description of events and signals present at the CPU during various operations. (See Fig. 1.)

Clock. The clock signal required by the processor is generated by an external oscillator. It is used by the CPU to produce internal and external timing signals needed to control the peripherals as well as to transfer signals and data internally between parts of the CPU.

CPU Mode Control. Two processor mode-control pins completely control the CPU action. They are labelled $\overline{\text{WAIT}}$ and $\overline{\text{CLEAR}}$. The line (vinculum) over the name indicates that a low-logic level (0 volts) at that point will cause the stated effect. To change the CPU mode, we simply have to present the $\overline{\text{CLEAR}}$ and $\overline{\text{WAIT}}$ lines with the logic levels shown in Fig. 2. When we want to put the processor in the RESET mode ($\overline{\text{CLEAR}}$ low, $\overline{\text{WAIT}}$ high) certain internal registers are set to predictable states. It will suffice for the moment to realize that the program counter is set to 0. This insures that when the mode is changed from RESET to RUN or LOAD, the first address issued by the CPU will be 0000. When the CPU is put into the LOAD mode (must be preceded by RESET), it is possible to load a program into memory via the direct-memory access line of the CPU. The

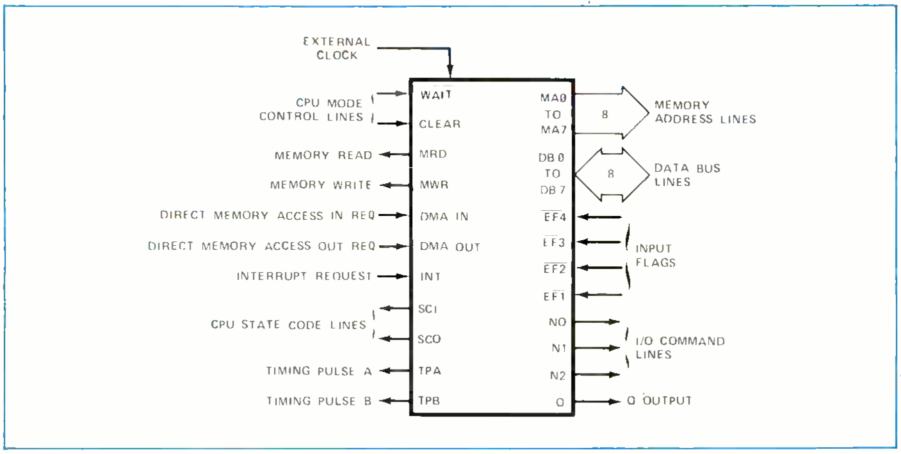


Fig. 1. Events and signals present at the CPU during various functions.

program is loaded directly into memory from the hex keypad during this mode. When the CPU is in the WAIT or PAUSE mode, the internal timing generator does not function. The clock continues to run but it is ignored. Note that the data, address, and other control lines may not have valid data or status in the WAIT mode.

The RUN mode (both CLEAR and WAIT high) may be entered from a PAUSE or RESET mode. Remember that the first machine cycle following a reset to RUN is followed by a memory fetch at address 0000. This is extremely important and simplifies the hardware interface.

State Code Lines. When in RUN, the CPU can perform only one of four types of operations. They are: INSTRUCTION FETCH, also called S0 (S an abbreviation for "state"), EXECUTE, S1, a DIRECT MEMORY ACCESS, S2 or INTERRUPT, S3. Ignoring DMA and interrupt for the moment, we can say that the CPU is simply either fetching instructions or executing them. A FETCH requires one machine cycle (each machine cycle is made up of eight clock pulses). EXECUTE requires one or two machine cycles, two required only during long-branch operations.

The State-Code lines labelled SC1 and SC0 are used to tell the peripherals which type of operation is being performed by the processor. (See Fig. 3.) Note that during FETCH, both SC1 and SC0 are low; during EXECUTE, SC1 is low and SC0 is high.

Timing Pulses. (In addition to the state code lines, there are TIMING PULSE A and B (TPA, TPB). These signal the peripherals when the address, data and I/O COMMAND lines are valid and other internal operations are completed.

MEMORY READ and MEMORY WRITE LINES. These, designated MRD and MWR, are both active with logic low. MRD is present when the processor wants data from the memory. MRD must occur during a FETCH when the processor is reading memory for its next instruction. It must also occur during an OUTPUT execution when the data is being transferred from the memory to an output port, as well as during BRANCH, and other memory read operations. MWR is present only when the processor is writing data into memory. Data may originate in the CPU or from an input port.

CLEAR	WAIT	MODE
L	L	Load
L	H	Reset
H	L	Pause
H	H	Run

Fig. 2. Logic needed to change CPU Mode.

State Type	State Code Lines SC1	SC0
S0 (Fetch)	L	L
S1 (Execute)	L	H
S2 (DMA)	H	L
S3 (Interrupt)	H	H

Fig. 3. State code lines define operation

Input Flags. The input flag lines, EF1, EF2, EF3, EF4 are tested by the microprocessor and often used as single-signal input ports. The flag lines are tested during an EXECUTE. Remember that these lines are *active low.*

Q-Line. The Q-line output can be set high or low by a program instruction. The status of the Q-line can be tested by conditional BRANCH instructions. Q is a single-signal output port and can control relays or other devices.

MEMORY ADDRESS Lines. These eight lines are multiplexed. The high-order eight bits of the 16-bit address are present first; at the end of the TPA the low-order bits are presented. If the system memory is larger than 256 bytes, additional hardware is needed to record (latch) the high-order bits so that all 16 are presented simultaneously to the memory. The trailing edge of the TPA can be used to signal the latch when the high-order addresses are valid.

DATA BUS Lines. These eight-bit-bidirectional lines transfer data between the memory, CPU, and I/O devices.

(Continued on page 64)

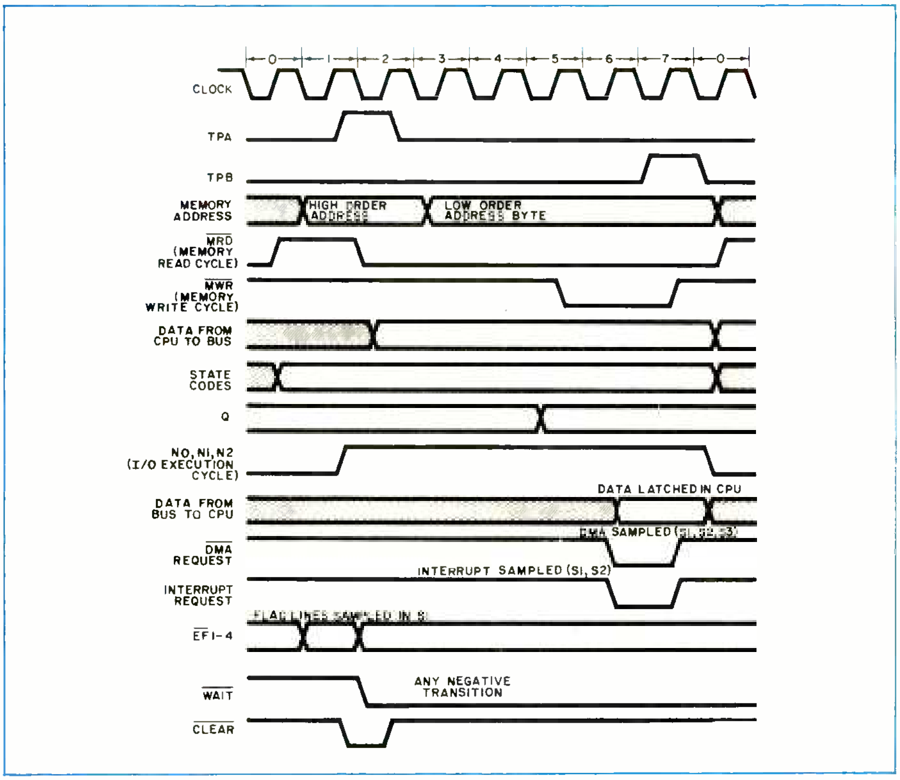


Fig 4. The timing diagram is used to show signal relationships. Shaded areas indicate undefined state when multiple transition may occur.

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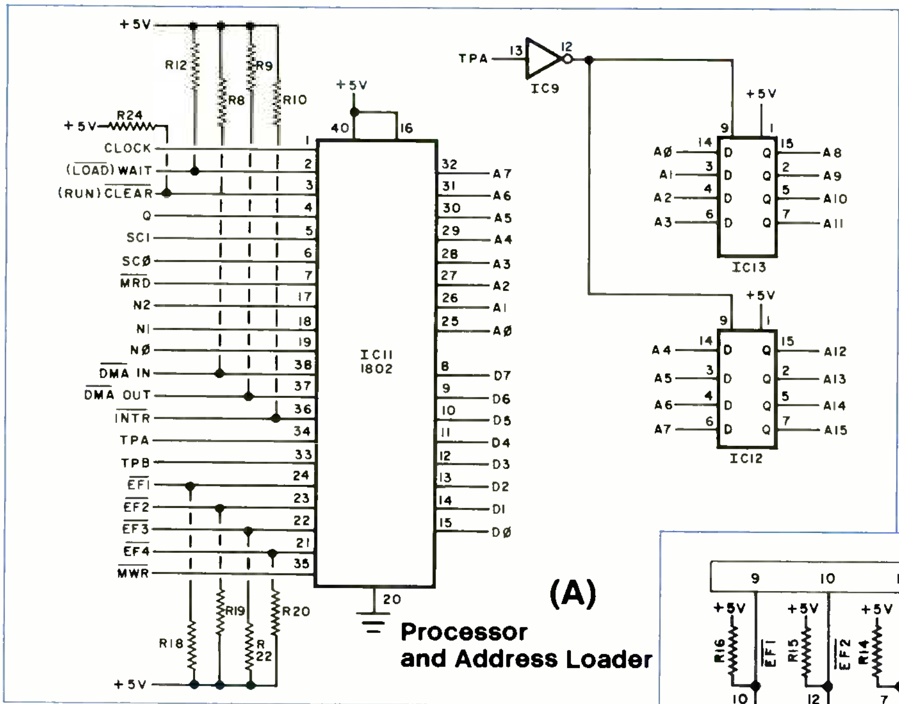
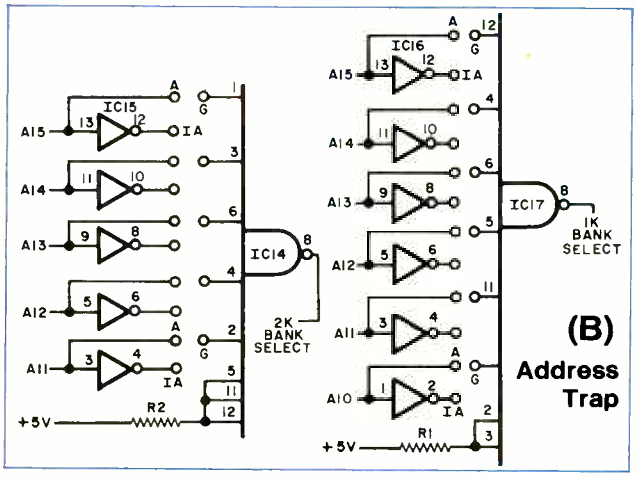
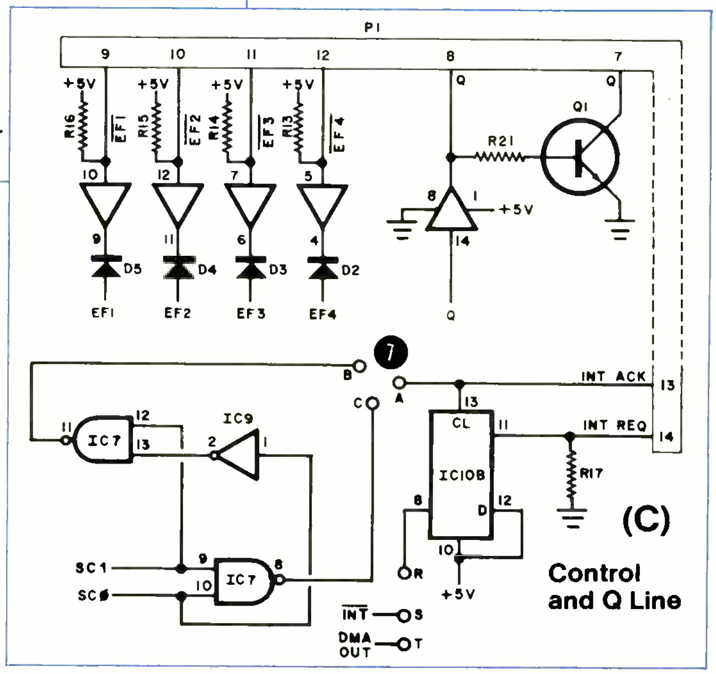
The TPB indicates to the external devices that the data bus is prepared for the transfer.

I/O COMMAND Lines. The input/output command lines, referred to as the N lines, are activated by a program instruction to signal input and output devices, either requesting data from them during an input instruction or sending data to them during an output instruction. The three lines can be decoded into seven separate output signals so that all 14 input/output instructions can be used.

A general timing diagram is shown in Fig. 4. It is not complete, but should give an idea of when transfers occur between the CPU and peripherals. Understanding this timing will enable us to use the







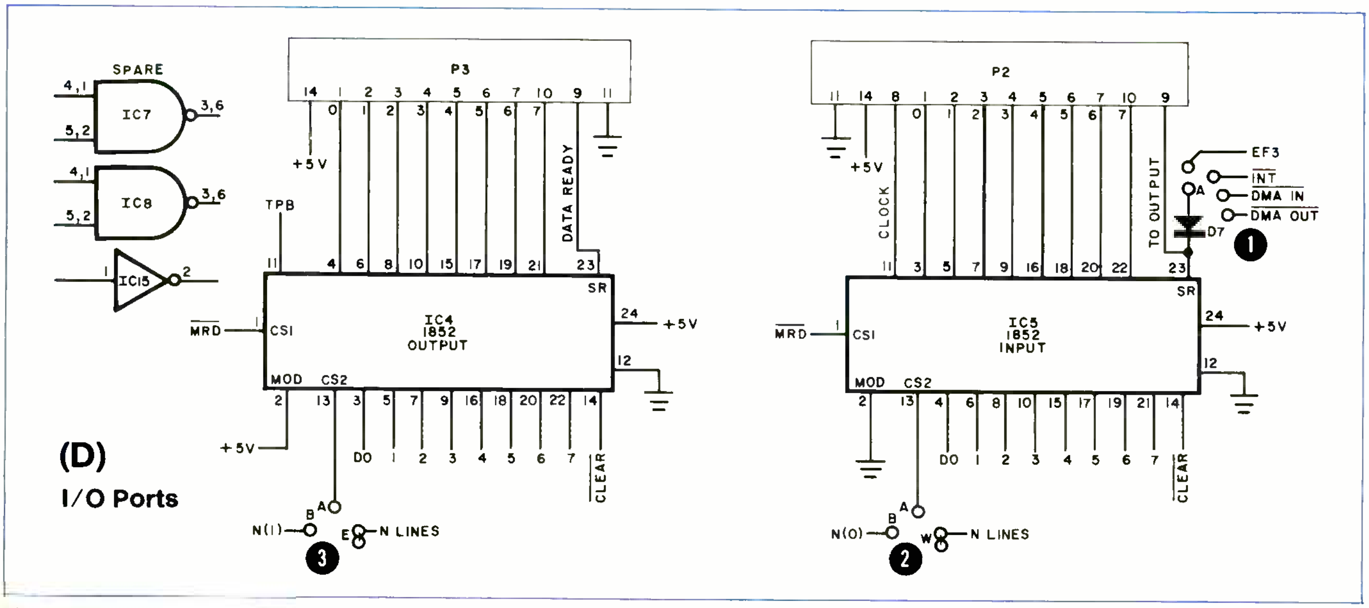
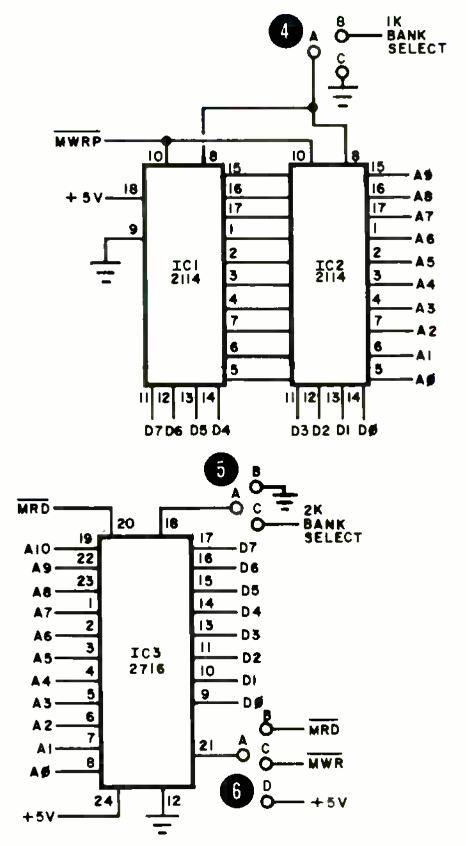
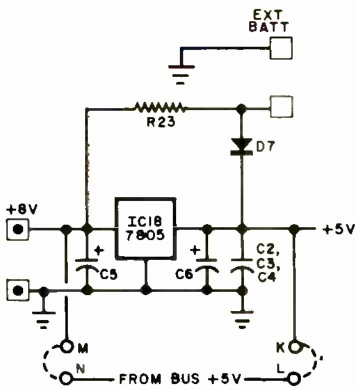


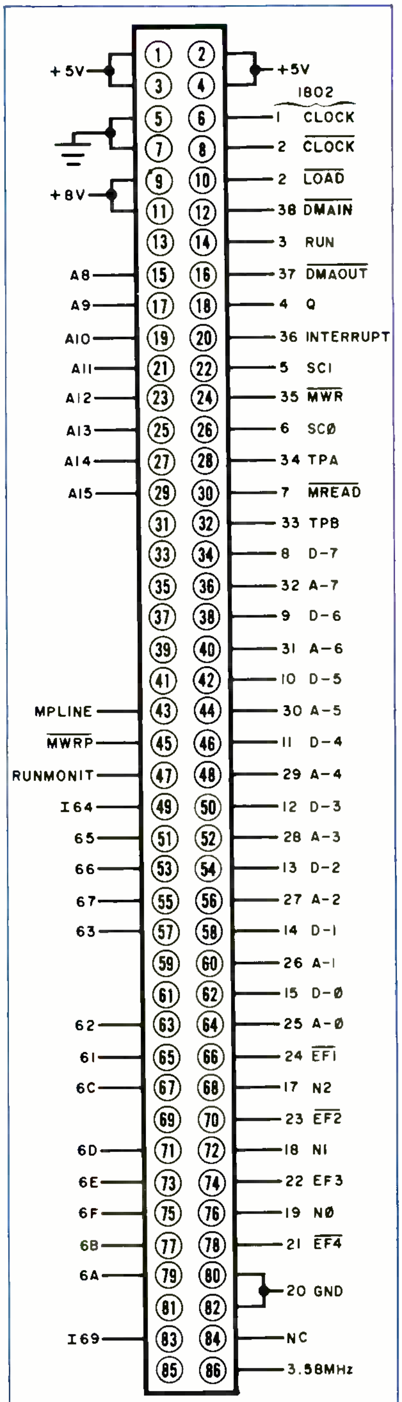
Fig. 5. The various parts of the circuit on the Product Board are shown schematically above and on the opposite page. Numbers in circles indicate jumper pads.



(E) RAM/ROM



Power Supply

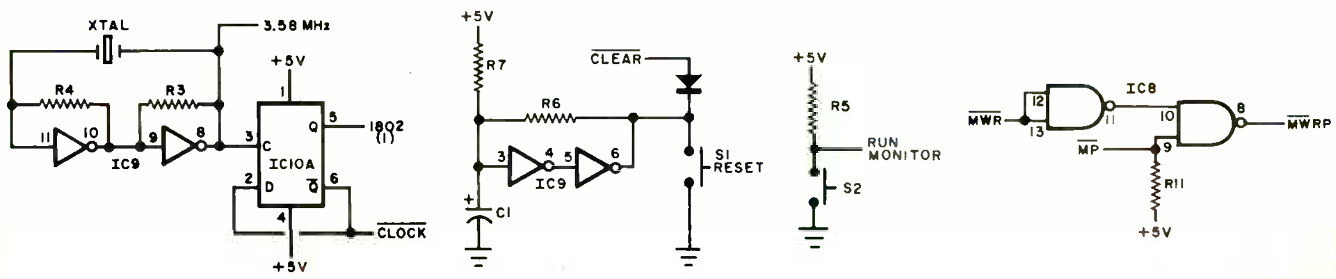


(F) Bus Connector

correct hardware I/O signalling devices. Note the eight clock pulses, 0–7, and the synchronization between them and the signals on the CPU lines. STATE CODES become valid just before the leading edge of TPA and continue valid until the trailing edge of TPB. External hardware is responsible for reading CPU signals during valid periods only. Each machine cycle outputs a 16-bit address of which the high-order eight bits are valid at the trailing edge of TPA and are followed by the low-order eight bits which are valid

PARTS LIST—PRODUCT BOARD

C1—2.2-μF, 16-V electrolytic
C2,C3,C4—0.01-μF, 50-V disc ceramic capacitor
C5,C6—10-μF, 16-V electrolytic
D1 through D6—1N4148 switching diode
D7—1N4001 rectifier
IC1,IC2—2114 random-access memory
IC3—2716 ROM
IC4,IC5—1852 I/O port
IC6—CD4050 hex noninverting buffer
IC7,IC8—74LS00 quad 2-input NAND gate
IC9,IC15,IC16—74LS04 hex inverter
IC10—74LS74 dual D flip-flop
IC11—1802 CPU
IC12,IC13—74LS174 hex D flip-flop
IC14,IC17—74LS30 eight-input NAND gate
IC18—7805 5-volt regulator
Q1—2N4384 transistor
The following, unless otherwise specified, are ¼-watt, 10% tolerance, fixed carbon-composition resistors.
R1,R2,R5,R11,R17—4.7kΩ
R3,R4—1kΩ
R6,R7—100 kΩ
R8,R9,R10,R12,R13,R14,R15,R16,R18, R19,R20,R22,R24—22kΩ
R21—2.2kΩ
R23—47 Ω, ½ W
XTAL1—3.579-MHz quartz crystal
Misc.—Suitably etched and drilled, double-sided printed circuit board with plated-through holes and gold-plated edge-connector contacts; one normally open, momentary-contact pushbutton switch; IC sockets (one 40-pin, three 24-pin, two 18-pin, ten 14-pin) or Molex Solder-cons; three 14-pin DIP headers; heat sink for IC18 measuring 1" × ½" × ⅛" or similar; hookup wire; solder; etc.



(G) Clock Power On Clear Run Memory Protect

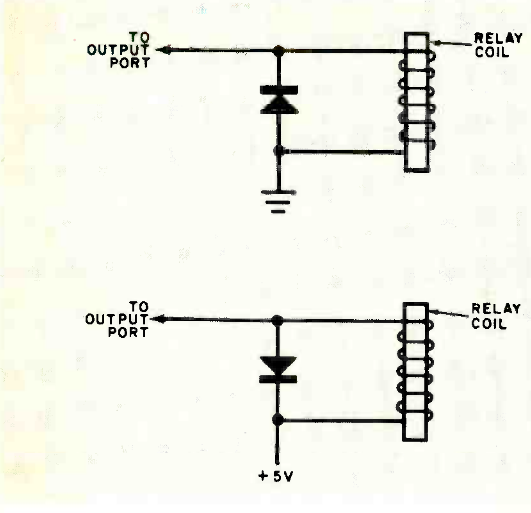


Fig. 6. How to determine load resistances on output ports. In circuit above, minimum relay coil resistance is 2.1 kΩ. The relay is active when the output is high. In the lower circuit, minimum relay resistance is 820Ω. The relay is active when the output is low.

through the trailing edge of TPB. When the CPU reads from the data bus, data is latched into the CPU during TPB. I/O COMMAND lines N0, N1, and N2 are valid from the beginning of TPA to the end of TPB. The CPU tests the flag lines during an S1 cycle; the CPU responds to control signals $\overline{\text{WAIT}}$ and $\overline{\text{CLEAR}}$ during TPA, and samples DMA and INTERRUPT during TPB. Some conditions are valid only during certain types of machine cycles. For example, DMA is sampled only during machine cycles S1, S2, or S3.

Interfacing Memory. Having studied the signals present at the CPU, let's look at the schematic of the product board shown as Figs 5A through 5G. Data, in this case the high-order address bits, are latched into the Q outputs of the flip-flop during a low-to-high transition on the clock input. This low-to-high signal is produced through inversion of TPA

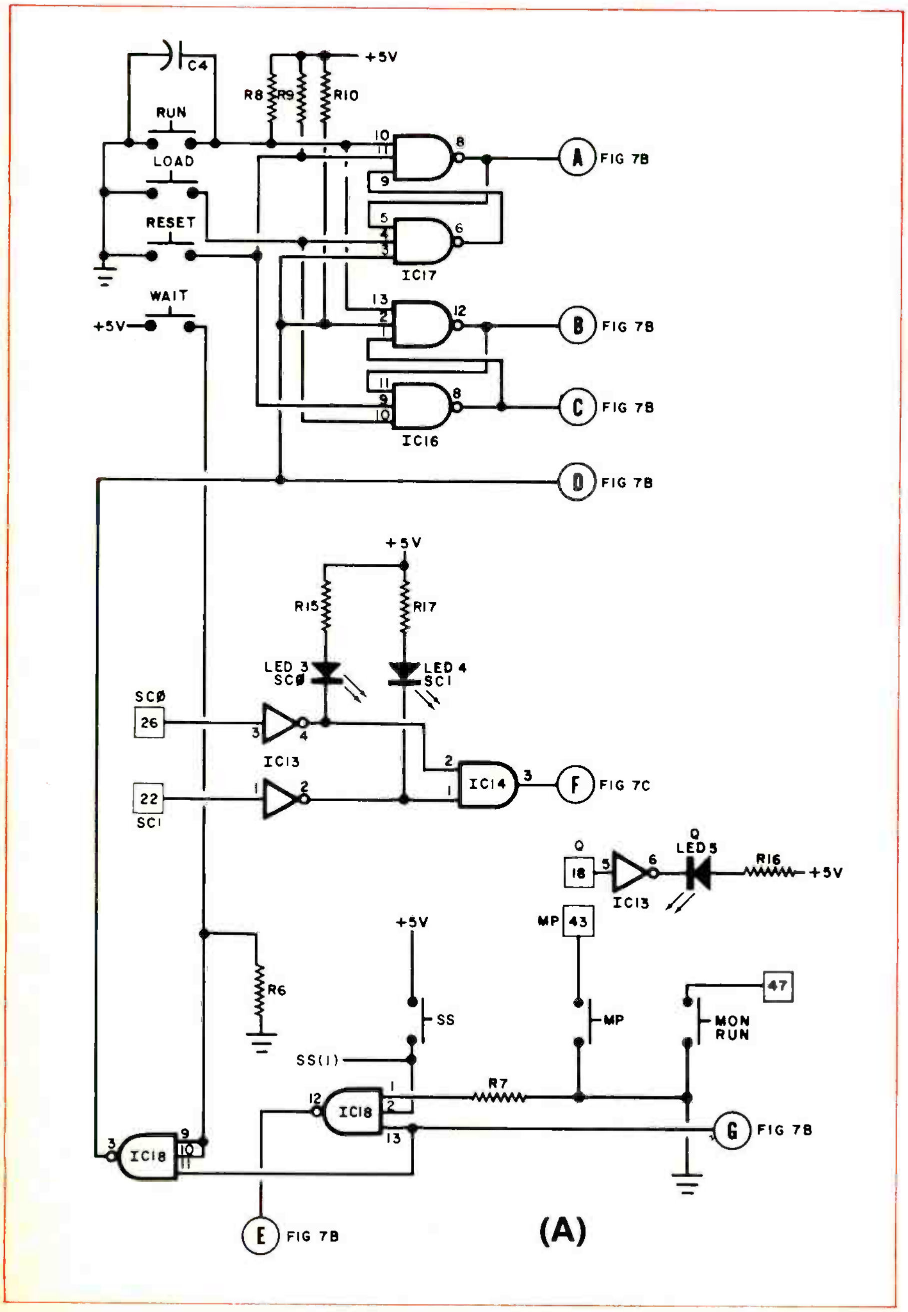
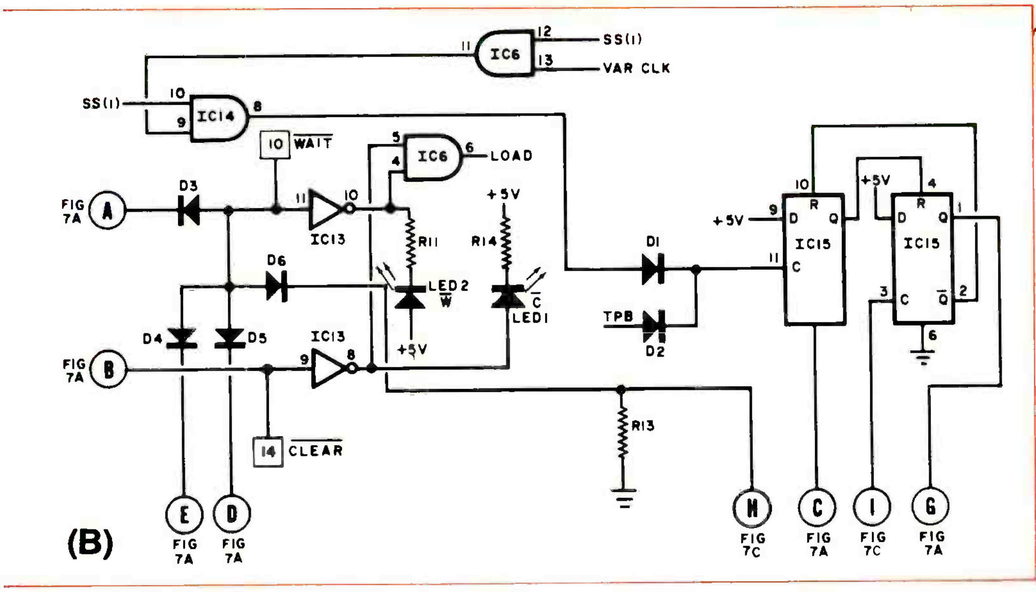


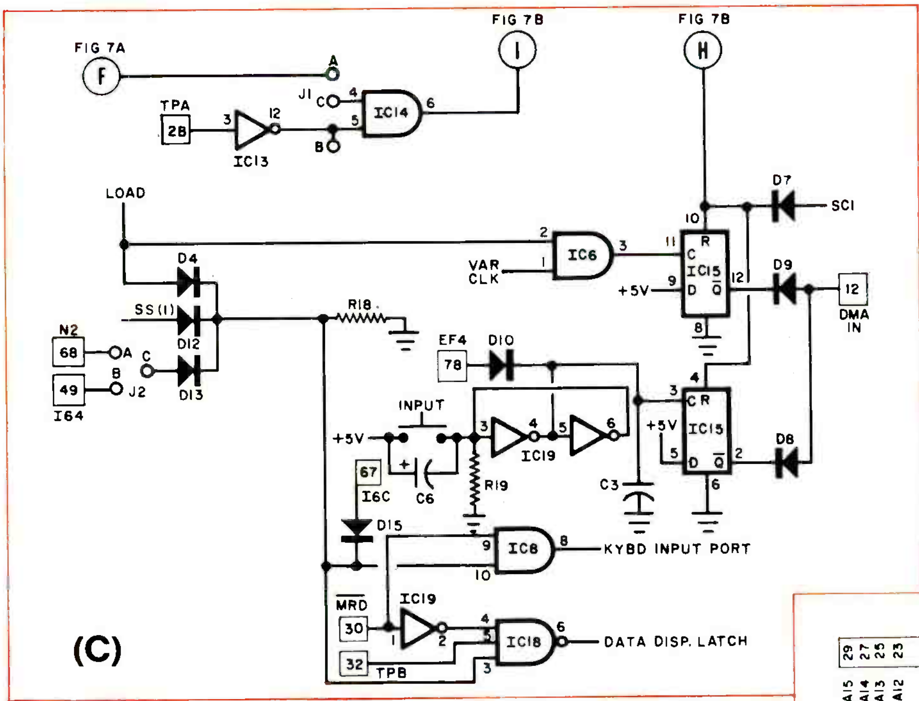
Fig. 7. Programming board circuits (A through F) are shown here and opposite

PARTS LIST—PROGRAMMING BOARD

C1,C5—1-μF, 16-V electrolytic
C2,C3—0.15-μF Mylar capacitor
C4—2.2-μF, 16-V electrolytic
C6,C7—22-μF, 16-V electrolytic
C8—0.1-μF disc ceramic capacitor
D1 through D13,D15—1N4148 switching diode
D14—1N4001 rectifier
DIS1 through DIS6—Common-cathode, seven-segment LED display
IC1—74C923 CMOS 20-key encoder
IC2—74C173 CMOS TRI-STATE quad D flip-flop
IC3,IC4—CD4016 quad bilateral switch
IC5,IC15—CD4013 dual D flip-flop
IC6,IC14—74LS08 quad 2-input AND gate
IC7 through IC12—MD 4368 hexadecimal-to-seven-segment decoder
IC13,IC19—74LS04 hex inverter
IC16,IC17,IC18—74LS10 triple 3-input NAND gate
LED1 through LED5—Red light-emitting diode (HP5082 or equivalent)
The following, unless otherwise specified, are ¼-watt, 10% tolerance, fixed carbon composition resistors.
R1—15 Ω, ½ W
R2,R6,R7 through R10,R18,R19—4.7kΩ
R3—1-MΩ, linear-taper trimmer potentiometer
R4—22kΩ
R5—1 MΩ
R11,R14 through R17—470 Ω
R12—200 Ω
R13—47kΩ
Misc.—Suitably etched and drilled, double-sided printed circuit board with plated-through holes and gold-plated edge-connector contacts; 86-contact edge connector with gold-plated contacts; 22 normally open, momentary-contact pushbutton switches (this includes those comprising the hexadecimal keypad); two spdt toggle switches; IC sockets (seven 16-pin, eleven 14-pin) or Molex Soldercons; suitable hardware; hookup wire; solder; etc.



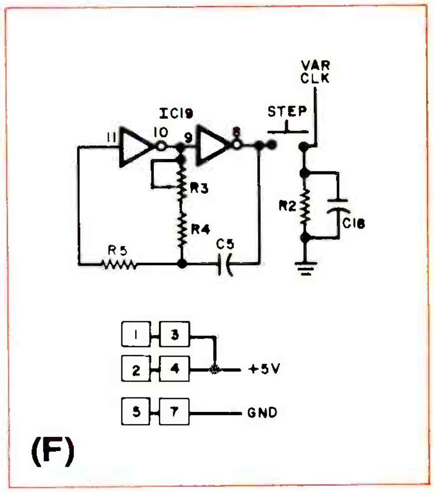
(B)



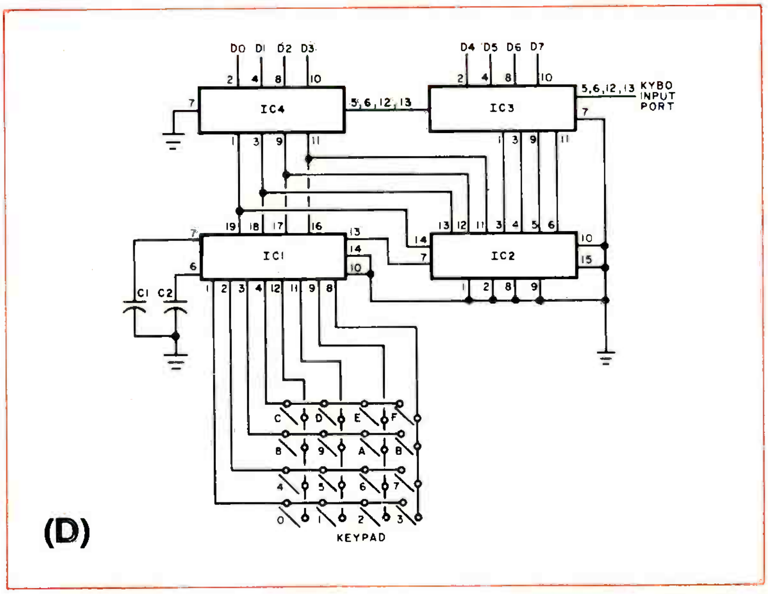
(C)

by *IC9*. The high-order address lines A8 to A15 are therefore present at the Q outputs of *IC12* and *IC13*. Now, with the full 16-bit address present on the memory address bus, we can look at how the RAM *IC1* and *IC2* and ROM *IC3* are actually addressed. RAM *IC1* and *IC2* contain 1,024 different memory cells or addresses; while ROM *IC3* contains 2,048 different cells. The CPU is capable of addressing 65,536 different cells or addresses. To uniquely position our blocks of memory in the 65,536 address field, we must decode the upper address lines. If we want to address a RAM (*IC1* or *IC2* for example), we need 10 address lines, A0 through A9 ($2^{10} = 1024$). Note that on the 2114s, pin 8 is a chip-select line, active when low. The pin, when active, connects the memory cells to the data bus.

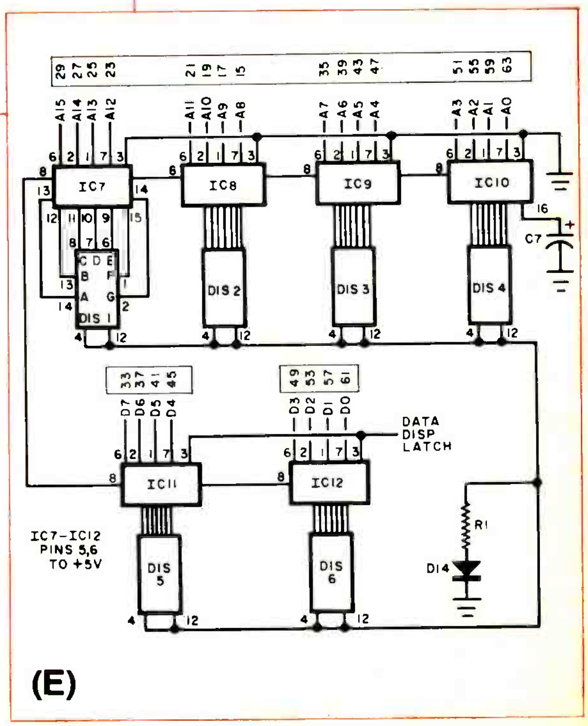
The 1,024 block could be addressed in any of 64 different blocks in the 65,536



(F)



(D)



(E)

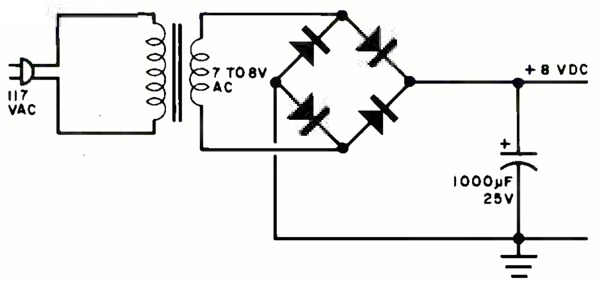


Fig. 8. Use this circuit to connect an 8-volt dc supply to the Product Board.

address field. Address lines A10 through A15 are decoded to select a specific field. If all the inputs to eight-input NAND gate *IC17* are high, the output on pin 8 will be low and the RAM memory will be selected. The six address lines can be connected to the inputs of the NAND gate either directly or through hex inverter *IC16*. The use of inverters at selected address lines allows 64 (2^6) different possible locations for the block of memory.

To determine which address lines require an inverter, write the binary equivalent of the first address in the block of memory. Label the high-order six digits A15 through A10. An inverter must be used at all locations with a 0 binary digit. To locate the memory block at F000 (hex), we would use an inverter on address 11 and connect A12 through A15 directly to the NAND gate. If only one memory block is used and it is to be located at 0000, the chip-select CS line can be grounded and IC's 14, 15, 16, and 17 can be removed.

The same principle is used in the 2K bank-select, using IC14 and *IC15* to locate the position in the memory field for *IC3*.

To finish our discussion on the memory, let's look at the MEMORY READ and MEMORY WRITE lines. *IC1* and *IC2* deposit their data on the bus whenever the CS line is low so there is no need to have the CPU READ signal connected. The MWR (P) is connected to pin 10. When the CHIP SELECT and MWR lines are low, the information on the data bus is copied into the memory cell address. Data flows from *IC3* to the data bus only when both the CS and MRD lines are low. Although the position of *IC3* is principally intended to be filled by a 2716 EPROM (which requires that pin 21 be tied high), a 2K RAM can be used instead by connecting its pin 21 to MWR. If you plan to use a 2K RAM at *IC3*, check the specs carefully for signal requirements. Finally the MEMORY WRITE line, pin 10 (*IC1* and *IC2*), is labelled MWR (P). The P means that the memory can be protected against accidental written data by grounding pin 9 of *IC8*, which prevents MWR from reaching the memory. This line, MP, is also connected to pin 43 on the 86-pin bus.

Interfacing I/O Ports. Integrated circuit *IC5* has pin 1 tied low and acts as an input port. It has eight input lines that can be connected to external equipment via plug *P2*. These inputs, typically, would be connected to the status switches on a robot, alarm system, etc. When the data is valid and to be read, *IC5's* CLOCK line (pin 11) is externally made high. This latches the data into the input side of the port. A high-to-low transition of the CLOCK line causes the input data to be latched into the input port's output register and simultaneously sets the SERVICE REQUEST line, pin 23, low. At this point, the output drivers of *IC5* are disabled and the data is not yet on the bus. The SERVICE REQUEST line of *IC5*, pin 23 can be connected to the CPU flag EF3, INTERRUPT, or DMA. If you use EF3, your program must interrogate EF3 and issue an instruction that results in the transfer of data from the port to a memory location designated by the program, as well as to the D register in the CPU. Actual data transfer takes place when *IC5*'s CS1 and CS2 both go high. This enables the output drivers and puts the data on the bus. At the same time, SERVICE REQUEST is reset. Voltage at the inputs must be in the range of −0.5 to 5.5 volts dc. This is true of all the gates and inputs that we will discuss.

Output port *IC4* is identical to input port *IC5*. Tying pin 2 high converts the chip to its output mode. Data is latched into the port when CS1 is low during a MEMORY READ and CS2 is high during an output instruction, and when TPB is high. Data is immediately transferred to the output lines and is available at plug *P3*. A SERVICE REQUEST pulse is generated by the port after MRD line goes high. This pulse can signal the receiving device that new data is available.

The output lines can be connected to low-current relays or other digital devices. The 1852 will deliver up to 2.3 mA when the output is high or will sink up to 6 mA when the output is low. See Fig. 6 to determine the maximum and minimum resistances that may appear as loads on this port. Input and output commands can be changed by connecting pin 13 to a decoded N line (decoder must be on an expansion board). The output instruction for this board is 61 and the input is 6B. A final detail regarding the I/O ports is pin 14 CLEAR. A low on this line resets the port's registers and the SERVICE REQUEST output.

INTERRUPT/DMA Interface. As shown in the CPU timing diagram, DMA and INTERRUPT lines are only sampled for a short interval by the CPU. Therefore we must hold the request low until the CPU acknowledges that it has been received. This is done by flip-flop *IC10B*. A negative-to-positive pulse at pin 11 (clock) sets pin 8 low. Pin 8 can be connected to either the INT or DMA OUT line on the CPU. If an interrupt is chosen, pin 8 of *IC7* will go low because the STATE CODE lines SC0 and SC1 will both be high. (See Fig. 4.) This will reset *IC10B* and signal the device requesting the interrupt that the CPU has responded. Jumper 7, A to C, must be connected. If *IC10B* pin 8 is connected to DMA OUT, *IC7* pin 11 will go low when the STATE CODE lines indicate that DMA is in progress, again resetting the flip-flop and acknowledging the DMA request via jumper 7, A to B. These examples illustrate the importance of understanding timing diagrams.

To Output Port

0000	OUT 1	61	Output next byte
0002		FF	All 1's
0003	IDL	00	Idle

Fig. 9. Use the program at left to output a byte and the one below to input a byte.

To Input Port

0000	LD1	F8 00 B1	Load 00 in high order Reg. 1
0003	LD1	F8 10 A1	Load 10 in low order Reg. 1
0004	Set X	E1	Set X to
0005	IN3	6B	Input data
0006	Out 4	64	Display it on program board
0007	IDL	00	Idle

POWER ON/CLEAR Circuit. This automatically resets the CPU in the event of a power failure. Its usefulness depends on the retention of data in memory despite power loss, which means that the memory or program memory must be in ROM. When the $\overline{\text{CLEAR}}$ line on the CPU is held low with the WAIT line high, the CPU is reset. This condition is met on a power up because the CLEAR line is held low by *IC9* until *C1* charges. This delay lets the onboard crystal oscillator stabilize before program execution begins.

The crystal clock generator (2 gates of *IC9*) generates a 3.578-MHz square wave. The D-type flip-flop *IC10A* is used to divide the frequency by two. The 1802 clock input is connected to pin 5 of *IC10A*. A $\overline{\text{CLOCK}}$ signal is provided to drive a color video system in an expanded setup.

Buffers and Power Supply. Input and output buffers in *IC6* isolate the external flags and Q lines from the CPU. Buffers are far less costly than CPUs and can serve as protection against voltage transients and short circuits that may occur in the outside world. Additionally, they are capable of sourcing and sinking larger currents than can CPU lines.

The power-supply regulator *Q2* will deliver up to 500 mA dc. The programming board also gets its power from this source. The power requirement of the product board, fully loaded, is 110 mA. An optional NiCd battery pack can be added (four 1.5-volt cells) to power the product board for about 2 hours in the event of a power failure.

Programming Board. The purpose of the programming board is to load a program into the memory on the product board and then test the program and hardware. It can be disconnected from the product board when the programming and testing are complete. The programming board (Figs. 7A through 7F) is connected (via the 86 pin bus) to the CLEAR and WAIT lines on the CPU; therefore it can place the CPU in any of its four modes, displaying the mode selected on *LED1* and *LED2*. Two LEDS (*LED3* and *LED4*) on the STATE CODE lines identify the type of CPU machine cycle in progress.

The hex value of the entire 16-bit address line is displayed on 7-segment displays *DIS1* through *DIS4*. Two 7-segment displays (*DIS5* and *DIS6*) perform the same function for the data bus. Data bus displays are also configured as an output port responding to a 64-output instruction. A hex keyboard is connected to the data bus via two 4116 gates. *IC1* converts the hex value of the key press to its 4-bit binary equivalent. When a second key is pressed, the value

(Continued on page 74)

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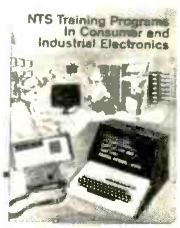

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of the first key is stored in *IC2*. This puts a full 8-bit number on the input side of the 4016 gates *IC3* and *IC4*. If the CPU is in the LOAD mode, pressing the INPUT button will load the binary value of the two keys previously pressed into the program memory. This is accomplished by pin 2 of *IC5* pulling the $\overline{\text{DMA IN}}$ line low, causing the contents of the data bus to be directly loaded into the memory location specified by the register 0 in the CPU. The CPU will acknowledge the $\overline{\text{DMA}}$ by issuing a high on SC1. This is used to reset flip-flop *IC5*. The INPUT switch is also connected to the $\overline{\text{EF4}}$ line.

The hex keyboard also can be used to input data during a program. It is configured to respond to a 6C instruction. The RUN, LOAD and RESET buttons are connected to three NAND gates of *IC17*. These gates are flip-flops that apply the appropriate logic levels to the $\overline{\text{CLEAR}}$ and $\overline{\text{WAIT}}$ lines which control the CPU mode. The WAIT switch will cause the CPU to pause. It is arranged so that the pause will only occur between TPA and TPB to insure that valid data and addresses are displayed when the WAIT is issued. The single-step mode allows the operator to execute the program one step at a time, observing the STATE CODES, Q line, data and address lines, as well as the action taken by external relays and components, etc. Jumper *J1* can select the stopping point during the single-step mode. If *J1* is connected A to C, then the program will stop only in a FETCH cycle. If *J1* is connected B to C, the stopping point will be each machine cycle at the trailing edge of TPB. You may want to try this initially to get a better understanding of the CPU operation. However, eventually you will probably connect *J1* to HALT only in the FETCH mode.

Remember to consult the timing diagrams to interpret the contents and meaning of the ADDRESS and DATA bus signals.

Slow-Step Clock. Formed from *IC19*, the speed of the stepping or toggling clock is controlled by *R3*. Hold the STEP toggle button depressed, and adjust *R3* for the clock speed desired.

Test Procedure. To test the combination of the product and programming boards, install the six 1K bank-select jumpers (IA to G). This will locate the 1K memory at 0000 hex. Connect the input ports so that jumper 1 connects from terminal A to $\overline{\text{EF3}}$ and jumper 2 between A and B, selecting instruction 61. Connect the output port jumper 3 A to B, the 1K memory-select jumper 4 A to B. Jumpers 5, 6 and 7 are not required at this time. Install the following jumpers on the programming board: *J1* A to C, *J2* B to C. Now connect an 8-volt dc supply between the 8-volt input and ground on the product board. Use the circuit shown in Fig. 8. Apply the power with no ICs installed. Check the output of the 7805 regulator *Q2* on the product board. The voltage should be +5 volts, ±5%. If not, correct the problem before proceeding.

Remove the power, install the ICs, and plug the programming board into the product board. If you are using an Elf II to program the product board, remove the 1802, 2102's and the 1861 video chip. (The 1861 will interfere with the I/O port allocation unless you use your giant board to reallocate I/O instructions to IC4 and IC5 on the product board.

When power is applied, the 7-segment displays should light up. With the latching switches up, press the RESET button. The RESET LED should be on, as well as SC0, PAUSE, SC1 and Q LEDs should be off. Press the LOAD button. The RESET LED should go off. Enter a 7 on the hex keyboard, followed by a B, then depress the INPUT button. The display should read 0000 7B, indicating that a 7B is located at memory location 0000. Now input 7A, followed by a 3A and 00. The display should read 0003 00. This program first turns the Q light on, then turns it off and BRANCHES back to the beginning, running in a loop.

Now press RESET, followed by the EXECUTE RUN button. Both the RESET and PAUSE lights should go on, indicating that both the $\overline{\text{WAIT}}$ and $\overline{\text{CLEAR}}$ lines on the CPU are high or that the CPU is in the RUN mode. The Q light should glow. It is being turned on and off by the program. Now press the WAIT button. The PAUSE light should stay on, the RESET go off. The program can now stop at any point in the loop. Remember, it stops in any machine cycle, so it may stop in a FETCH or EXECUTE.

Depress E again. The program will start up where it left off. Try it a few times, noting that the program stops only at address 0000 through 0003 and that the Q, SC0 and SC1 LEDs may or may not be on. Try to estimate where the CPU has stopped. Now depress the S (STEP) button. Then depress E, holding the T (TOGGLE) button down. Rotate *R3* until you can follow the program.

Note that the addresses displayed are one step ahead of the action on the data bus display and the Q LED. This is because the SINGLE-STEP stops at the beginning of a FETCH, while the DATA display and the Q LED are indicating the previous machine EXECUTE cycle. Refer to Fig. 4 and follow the timing diagram through the single-step mode.

To examine memory, press RESET, LOAD and P (Memory Protect). Remember to release the SINGLE-STEP button. Now, pressing INPUT will allow you to step through your program. Pressing and holding the TOGGLE button will allow you to review it at a rate determined by *R3*. The M button is not used at this time. Provisions have been made to add a system monitor which will be activated with this button. To test the I/O ports, write a small program such as those in Fig. 9 using them.

Construction. Assembly of the development system is basically straightforward, but because of the complexity of the circuitry, use of pc boards is virtually a necessity. The boards are double-sided and very difficult to make, and their purchase is recommended. Because of their size, the foil patterns are not given here. The patterns and component layout guides may be obtained by sending a self-addressed 8-inch by 10-inch envelope with two units of postage to Editorial, Dept. MP, Popular Electronics, One Park Ave., New York, NY 10016. Several of the ICs are MOS devices and require the standard handling precautions.

Once you have assembled and checked out your development system, you will be well on the way to proficiency in designing with microprocessors. The scope of projects you can design and build is limited only by your imagination and ingenuity. Considering the vast possibilities offered by microprocessors, you may want to order a supply of several of the product boards. ◇

PARTS AND KIT AVAILABILITY

The following items are available from Netronics Research and Development, Ltd., 333 Litchfield Road, New Milford, CT 06776: complete Product Board kit including all components appearing in Product Board parts list, $59.95; complete Programming Board kit including all components appearing in Programming Board parts list, $79.95. The following are also available individually: Product Board printed-circuit board only, $25.00; Programming Board printed-circuit board only, $29.00; 86-contact edge connector with gold-plated contacts only, $5.70; 8-volt power supply including plug-in transformer/bridge rectifier/filter capacitor assembly, $8.95. Postage, handling and insurance charges for U.S.A. orders: complete Product Board kit, $2.00; complete Programming Board kit, $2.00; Product Board pc board only, $1.50; Programming Board pc board only, $1.50; 86-contact edge connector only, $0.50; 8-volt power supply, $0.80. Connecticut residents, add state sales tax. Toll-free telephone number for ordering purposes: 1-800-243-7428.

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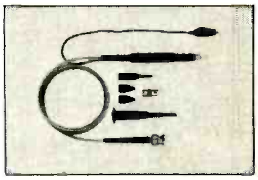

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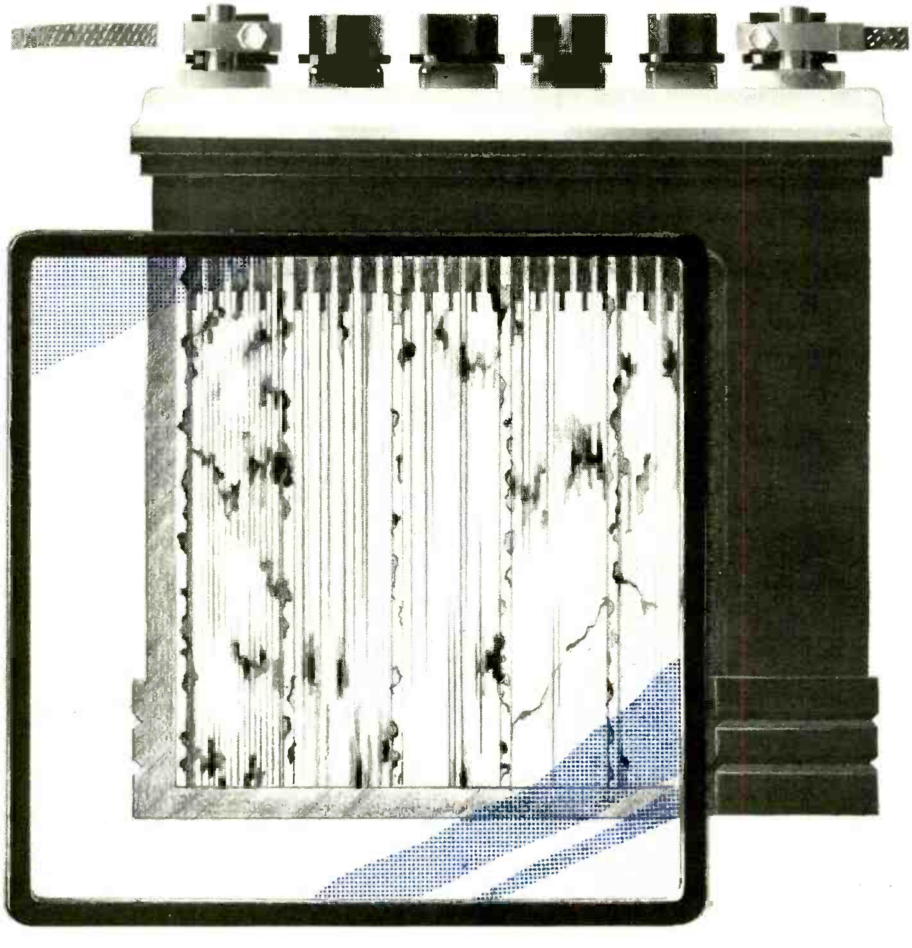
INEXPENSIVE AUTO BATTERY TESTER

BY HANK OLSON

Simulates 200-ampere starter-motor load



AN AUTOMOTIVE battery works very hard, especially when cranking the engine, and if you have a plethora of electrically operated accessories that often draw more power than the unaided alternator can deliver, it may not have a full charge to work with. Even a battery that loafs most of the time may age to the point where it can no longer start the engine on a cold day, so it's a good idea to check your battery's health now and then.

Numerous tests can be made on a battery, and all of them give some indication of its condition. But none is as conclusive as checking its performance under load. To do that you need a professional battery tester, an inexpensive version of which you can build, as described in this article.

The Circuit. The battery tester, shown schematically in Fig. 1, assumes the test current to be 200 amperes at 12 volts. (To determine appropriate load current, refer to the box.) Using Ohm's Law and assuming a 12-volt battery, you can readily see that load resistor *R2*'s value would have to be a very low 0.06 ohm ($R = E/I$ = 12 volts/200 amperes = 0.06 ohm). Furthermore, its power rating would have to be a whopping 2400 watts ($P = IE$ = 200 amperes × 12 volts = 2400 watts). Clearly, you're not going to find a resistor with these ratings in your local electronics parts store. Fortunately, however, you can fabricate your own power resistor from available inexpensive materials.

Continuing with our example of 12 volts and 200 amperes, you'll need about 12 feet of ½-inch wide, 0.025-inch thick steel banding strap (used to cinch wooden packing cases) to fabricate *R2*. Connect the strap in series with an ammeter that can handle at least 2.5 amperes across a variable power supply capable of delivering up to 1 volt at more than 2 amperes. Adjust the power supply for a 2-A output and measure the voltage across the load. If it is over 0.12 volt, trim the strap until it equals 0.12 V.

Turn off the power supply and disconnect the test setup. You've now determined the length of steel strap to use for a 0.06-ohm load resistor. (You can use the same test setup to determine the length needed for any other battery voltage/power ratings simply by changing the voltage or/and current to the appropriate values in the formulas that are provided in the box.)

You're not likely to find a switch that can handle 200 amperes in an electronic parts store, but a conventional 12-volt automotive starter solenoid (*K1* in Fig. 1) will fill your need. Operating current for the solenoid is controlled by normally open pushbutton switch *S1*.

Meter *M1*, resistors *R3* through *R6*,

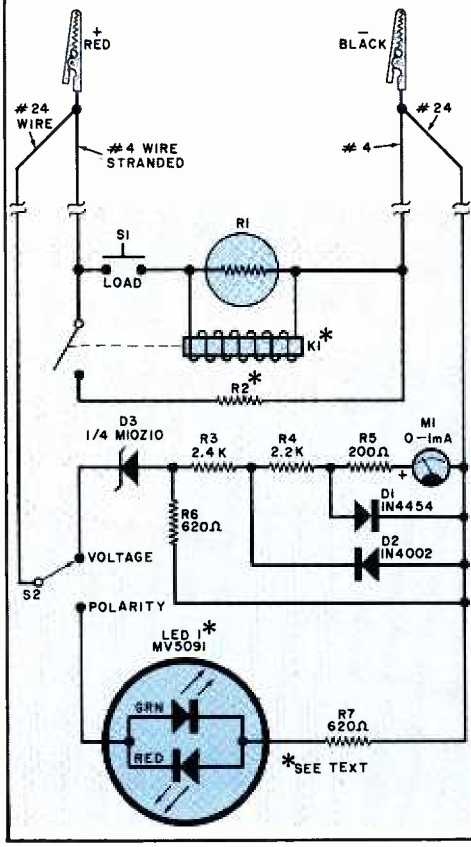


Fig. 1. In the circuit, a standard starter solenoid and contact are used instead of a switch.

PARTS LIST

D1—1N4454 diode
D2—1N4002 diode
D3—10-volt zener (Motorola 1/4 M10Z10 or similar)
K1—12-volt automotive starter solenoid
LED1—Two-color LED (Monsanto MV5091 or similar; see text)
M1—0-1-mA meter movement
R1—Thyrite varistor for solenoid
R2—See text
R3—2.4-kΩ, ½-W, 5% resistor
R4—2.2-kΩ, ½-W, 5% resistor
R5—200-Ω, ½-W, 5% resistor
R6, R7—620-Ω, ½-W, 10% resistor
S1—Normally open pushbutton switch
S2—Spdt switch
Misc.—#4 wire cables; suitable Mueller clips or jumper-cable clamps (2); 12 feet steel banding (for R2); ½" steel or aluminum spacers (13); 1" × ½" metal L brackets; ¾" plywood board; 16-gauge sheet aluminum; 6-32 machine screws (1" and ¼" long); large flat No. 6 washers; No. 6 × ½" metal spacers; ¼" machine hardware; assorted terminal strips (see text); ¾"-long round-head wood screws; #24 hookup wire; etc.

and diodes *D1* and *D2* make up a 0-to-6-volt dc voltmeter. When connected in series with 10-volt zener diode *D3*, this meter circuit becomes an expanded-scale 10-to-16-volt dc voltmeter. Diode *D2* protects the meter against reverse polarity, while diode *D1* protects against overvoltage when the meter is connected in proper polarity.

When selector switch *S2* is set to POLARITY, *LED1* glows green if the tester is connected to the battery in proper polarity, red when the connection's polarity is incorrect. Note that Fig. 1 shows and the Parts List specifies an integrated red/green LED assembly for *LED1*. If you wish, you can replace this with discrete red and green LEDs, connecting them into the circuit as shown for the integrated unit.

Construction Hints. As shown in Fig. 2, the best way to mount the steel strapping that makes up the load resistor, *R2*, is on a ¾-inch plywood board, using No. 6 metal—*not* plastic—spacers and machine hardware. Start by drilling a ¼-inch hole spaced ¼-inch in from each end of the strapping.

Next, drill two rows of ⅛-inch holes through the board, spacing the rows about 8 inches apart and the holes within each row about 1 inch apart. Then mount a metal spacer at each hole location with a 6-32 × 1" machine screw, placing a large flat No. 6 washer under the head of each screw. Mount another large flat washer on top of each spacer with a 6-32 × ¼" machine screw.

Mount the starter solenoid at the right rear of the plywood board and fasten one end of the steel strapping to one of its terminals. Then route the strapping back and forth from spacer to spacer. (The washers prevent the strapping from slipping off the spacers.)

Fasten a large L bracket to the free end of the strapping with ¼-inch hardware. Then secure the L bracket and one- and two-lug terminal strips to the wood base with ¾-inch round-head wood screws.

For the front panel, you will need a sheet of 16-gauge aluminum. Trim it to the width of the plywood base. Then, if possible, bend a 90° lip, about 1 inch wide, along the panel's bottom edge (alternatively, use three large L brackets) and drill three or four ⅛-inch holes along the length of the lip to permit mounting the panel to the plywood base.

Machine the panel and mount on it the meter movement, integrated LED assembly (or discrete LEDs), switches, and two three-lug terminal strips. This done, mount the panel to the top front of the plywood base with ¾-inch-long roundhead wood screws.

Wire the circuit as shown in Fig. 1. Note that separate #24 wires are used as voltage sensors and are run in parallel with the large #4 cables that carry the actual current. The #24 wires are used to measure the voltage at the battery before any voltage drops in the cable resulting from the high-current flow through *R3*. When installing the #24 wires, route them along the #4 cables and use either lacing cord or tape to bind wire and cable together. Finish the assembly by attaching large Mueller clips or jumper-cable clamps to the free ends of the #4 cables.

Use. To use the tester, connect the two Mueller clips (or clamps) to the battery/charger system (at the battery's terminals) in the vehicle you wish to test and set *S2* to POLARITY. If the LED glows green, the tester is properly connected, but if the LED glows red, reverse the connections to the battery.

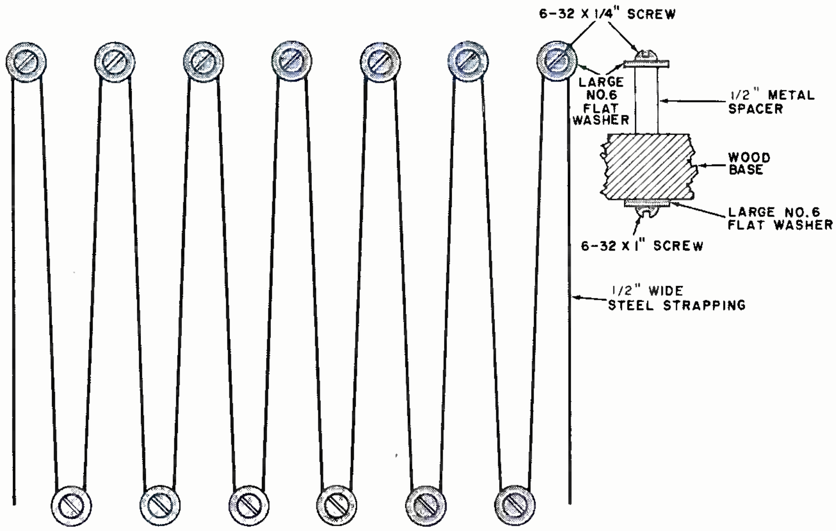


Fig. 2. Using this diagram as a guide and following instructions in the text, you can make up your own load resistor from ½-inch steel banding strap.

battery tester

Now set *S2* to VOLTAGE; the meter should indicate between 10 and 13 volts. Press and hold LOAD switch *S1* for no longer than 5 seconds (the limit because as *R2* heats up, from the current flowing through it, its resistance increases) and note the meter indication. A fully charged battery should indicate 10 volts or more.

Release *S1* but leave *S2* set to VOLTAGE. Start the vehicle's engine. The meter's pointer should now swing up-scale to a point between 13 and 15 volts as the vehicle's charging system comes into play. If you obtain abnormally low readings at any time, try fully recharging the vehicle's battery and repeat the tests. If the condition still persists, the battery is most likely bad.

You should periodically "load test" your vehicle's battery, say, once a month. Regular testing will help you keep track of the battery's condition and can also indicate preventive maintenance steps to keep it delivering maximum current for as long as possible. Periodically clean the battery terminals and connectors and, unless yours is a sealed, "no-maintenance" type, check the liquid level in each cell often and add distilled water where necessary. ◇

SELECTING A LOAD

Battery testers used by professionals have built-in load resistors specifically selected for testing a range of typical automotive battery power-delivery capabilities. As a general rule, load-resistance values are calculated from a simple formula that states that the load resistor should draw half of the battery's maximum current during a voltage measurement. Since automotive batteries are usually rated in watts, rather than current-delivery capability, it is necessary to first convert to current before you can calculate the load resistance.

Using the standard power formula $P = IE$ (P is rated battery power, I is unknown battery current, and E is battery voltage), we obtain $I = E/P$. Now, let's assume the battery is rated at 12 volts and 4800 watts. First, we divide the power rating by 2, obtaining 2400 watts. Plugging these values into the formula, we get $I = P/E$ = 2400 watts/12 volts = 200 amperes.

Now, use Ohm's Law to calculate the resistance of the load: $R = E/I$, where R is load resistance, E is battery voltage, and I is test current (calculated above). Continuing our example, we obtain R = 12 volts/200 amperes, or 0.06 ohm. Therefore, for a typical 12-volt, 4800-watt automotive battery, the load resistance should be 0.06 ohm at 2400 watts.

Using the procedure described above, you can calculate the required load resistor's parameters for any battery voltage/power ratings.

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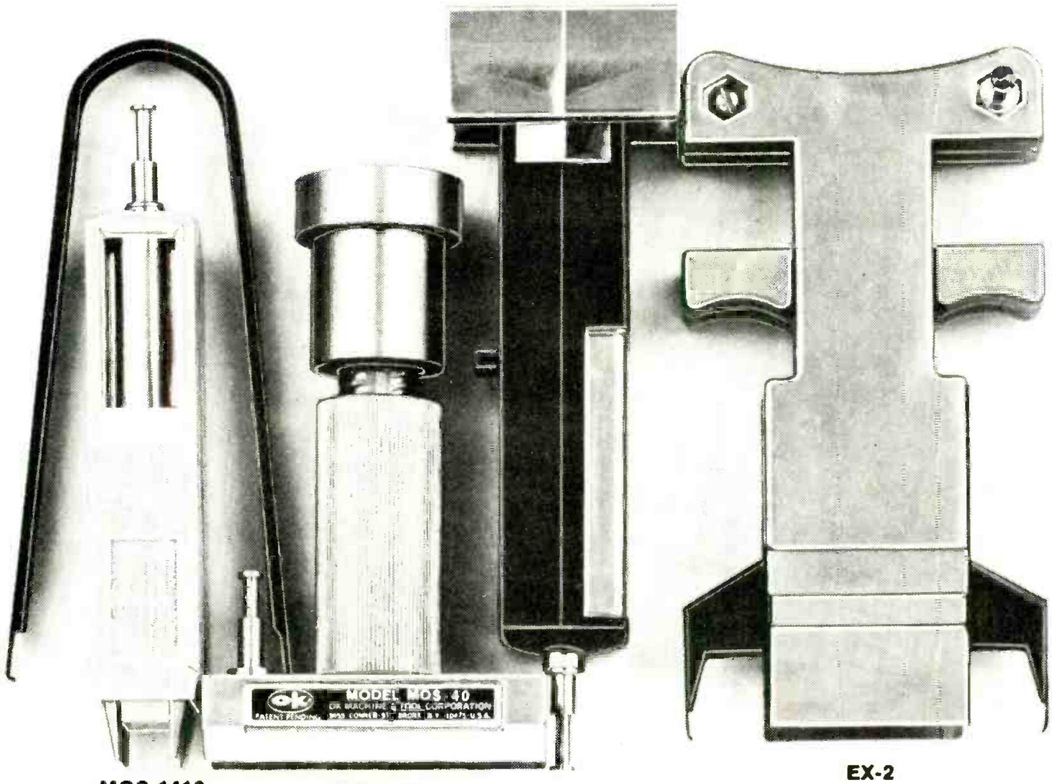

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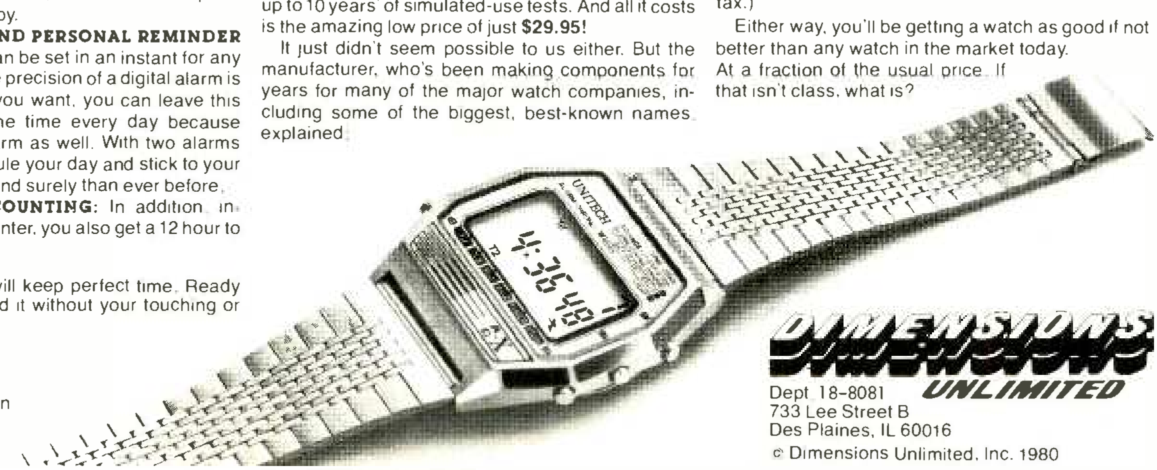

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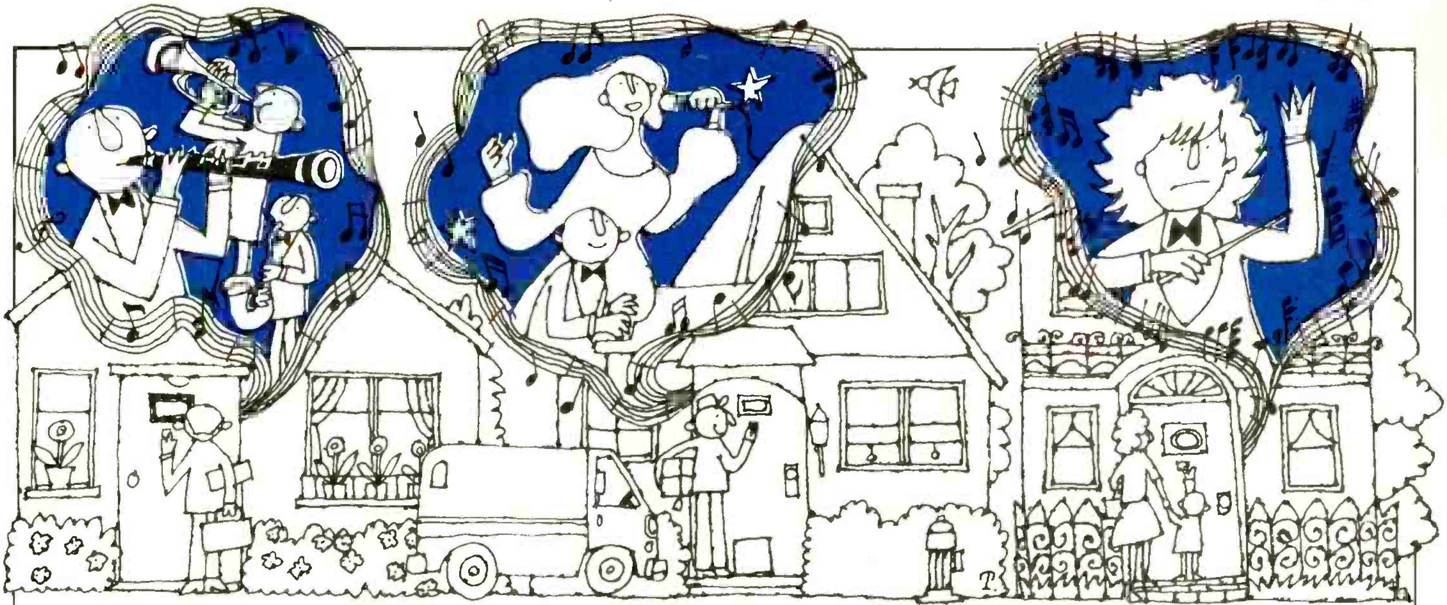


BUILD A SUPER MUSIC MAKER

Using just one microprocessor chip, 25 tunes can be generated—even more if a PROM is added

BY TOM CAUDLE

FOR generating digitally synthesized sequences of musical tones, it's hard to beat a large-scale integration (LSI) chip, such as the General Instrument AY-3-1350 IC. That chip, used in the "Super Music Maker" project described here, is perhaps the most powerful and flexible music synthesizer IC on the market. Actually a microprocessor with a tone-generation program in an internal memory, it stores short segments of 25 popular tunes and three chime sequences, each of which is individually selectable. While this alone makes the AY-3-1350 unusual, there's more. The chip can also address an external, preprogrammed ROM (read-only memory)

(Continued on page 85)

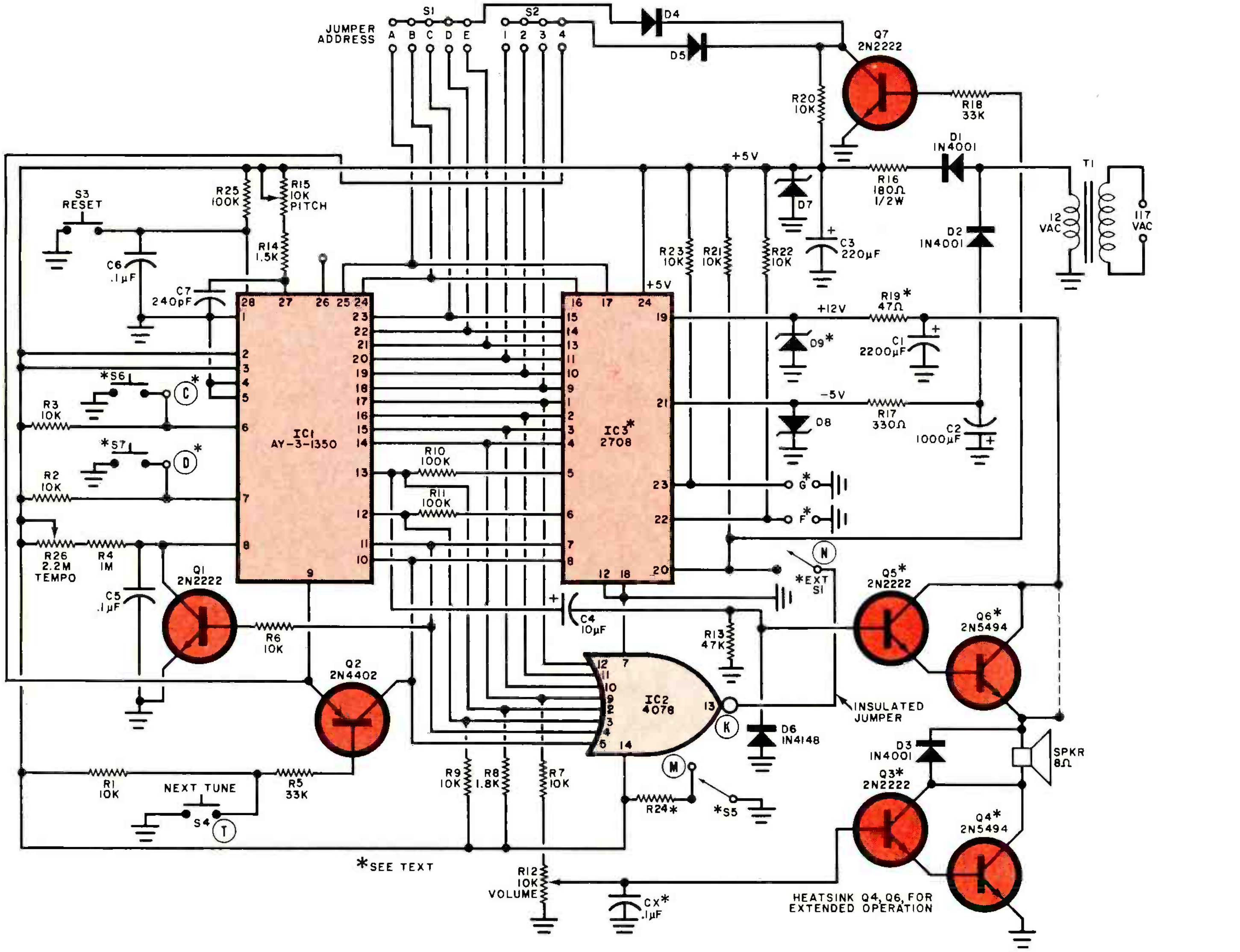


Fig. 1. The circuit uses three ICs: the microprocessor, an eight-input NOR gate, and an optional EPROM.

PARTS LIST

C1—2200-μF, 16-V radial-lead electrolytic
C2—220-μF, 25-V radial-lead electrolytic
C3—1000-μF, 10-V radial-lead electrolytic
C4—10-μF, 15-V radial-lead electrolytic
C5, C6—0.1-μF disc capacitor
C7—240-pF disc capacitor
D1, D2, D3—1N4000 series, 1-A rectifier
D4, D5, D6—1N4148 switching diode
D7, D8—4.7-V, 1-W zener (1N4732 or similar)
D9—12-V, ½-W zener (1N963 or similar)
IC1—AY-3-1350 (General Instrument)
IC2—CD4078BE 8-input NOR-gate
IC3—PROM (see text)
Q1, Q3, Q5, Q7—2N2222 or similar transistor
Q2—2N4403 or similar transistor
Q4, Q6—2N5494 or similar transistor
The following are ¼-W, 10% resistors unless otherwise specified:
R1, R2, R3, R6, R7, R9, R20, through R24—10 kΩ
R4—1 MΩ
R5, R18—33 kΩ
R8—1.8 kΩ
R10, R11, R25—100 kΩ
R12, R15—10-kΩ vertical potentiometer
R13—47 kΩ
R14—1.5 kΩ
R16—180-Ω, ½-W, 10% resistor
R17—330-Ω, ½-W, 10% resistor
R19—47Ω
R26—2.2 MΩ horizontal potentiometer
S1—Eight-section DIP switch
S2—Five-section DIP switch
S3, S4, S6, S7—Spst normally open pushbutton switch
S5—Part of S2
SPKR—Miniature loudspeaker
T1—12-V, 1-A transformer
Misc.—PC board, sockets, etc.

Note 1: The following are available from Bullet Electronics, Box 401244, Garland, TX 75040: complete kit of parts, less *IC3*, SPKR, and switches, for $23.50. Also available separately: drilled, plated, and silk-screened pc board for $5.00; AY-3-1350 IC (IC1) for $12.00; 8-section and 5-section DIP switches for $2.00.

Note 2: Master Music, P.O. Box 448, Mt. Vernon, MO 65712 will supply the following items: sample music 2708 EPROM with more than 800 notes of popular music for $12.50; 2708 EPROM music albums with 1024 bytes containing 25 selections (more than 500 tunes available; write for information) for $15.00; sample music 2716 EPROM with more than 1600 notes of popular music for $27.50; double music albums in 2716 s for $32.00.

and, by using the appropriate address, play any tune in the ROM's "catalog."

Circuit Description. As shown in Fig. 1, the Super Music Maker project consists basically of three ICs: *IC1*, the microprocessor/synthesizer chip; *IC2*, a 4078 CMOS eight-input NOR gate; and *IC3*, an optional EPROM (erasable programmable read-only memory) into which an "album" of tunes is programmed. The remainder of the circuit includes an audio amplifier for driving a small speaker (or the input of a power amplifier) and a power supply.

During program execution, *IC1* sets its address lines at pins 10 through 17 to 00. Closing the EXT ROM-enable switch (part of DIP switch *S1*) initiates the following sequence. When all lines are at logic low, the output of *IC2* goes high and sends *Q7* into conduction. In turn, *Q7* applies a ground to the tune address lines through *D4* and *D5*. The output of *IC2* is also applied to enable pin 20 of *IC3*, where a logic high turns off this IC and presents a high impedance on the IC's I/O lines at pins 9 through 11 and 13 through 17. This allows the address data to be read from the same lines on which the EPROM's information appears. The tune address is then read and stored by *IC1*. On the next cycle, *Q7* cuts off and enables *IC3*. If *IC1*'s internal tunes are selected, *IC3* is disabled by pull-up resistor *R21* on enable pin 20 and *Q7* conducts continuously.

During operation, *IC1* tests for the presence of external PROM *IC3* by going to address location 377 octal and testing for octal 125. If the proper code is sensed, an internal flag in *IC1* is set. The tune address lines are interrogated and then that particular memory location in *IC3* is played. If no PROM is sensed, *IC1* plays the internal tune at the preset tune address. The program then tests for the "next tune" switch closure; if it senses it, *IC1* steps to the next tune and plays it. This operation works in either the internal or external tune mode, permitting all tunes in *IC1* and *IC3* to be played. (Note that the chimes cannot be played when *IC3* is selected.)

TEMPO control *R26* sets the speed at which *IC1* plays the notes, while PITCH control *R15* sets the reference frequency. The waveform at pin 26 of *IC1* is one quarter of the oscillator frequency; it can be varied over a two-and-a-third octave range, from 50 kHz to 250 kHz, with the PITCH control.

Dual in-line package (DIP) switches *S1* and *S2* provide the letter/number address selectors required for addressing a given page of tunes in *IC1* and *IC3*. Also part of *S1* is the EXT ROM-enable switch, and *S5* is part of *S2*. Normally open spst switches are used for RESET and NEXT TUNE switches *S3* and *S4* and

G	F	H	Page Number
1	1	1	1
0	1	1	2
1	0	1	3
0	0	1	4
1	1	0	5
0	1	0	6
1	0	0	7
0	0	0	8

Fig. 2. Page-select settings for S1. Shaded area is used only for the 2716. Zero indicates open switch; one, closed.

optional door-chime switches *S6* and *S7*. Finally, switches F and G at pins 22 and 23 of *IC3* are part of *S1*.

The audio amplifier section, at the lower right in Fig. 1, consists of a pair of Darlington circuits, *Q3/Q4* and *Q5/Q6*. With the arrangement shown, the circuit's output has a certain amount of exponential decay, which gives it an organ-like sound. By eliminating the *Q5/Q6* circuit and jumpering the 12-volt line, as indicated by the dashed line, to the top terminal on the speaker, output volume can be increased, but the tones will have faster attack and decay times, producing a sound more like a piano. If you wish, you can soften this tone by installing optional capacitor *CX*.

Programming External Memory. The system is designed to use either a 2708 (1K × 8) or, with a few simple modifications, the newer 2716 (2K × 8) EPROM. Since *IC1* can address only 256 bytes at a time, however, the high-order address bits must be manually switched to play all the memory by closing the F and G toggles in *S1*. Each 256-byte block comprises a "page" of memory (see Fig. 2 for details on how to select individual pages), which means that a 2708 has four pages and a 2716 has eight pages of memory. Since the frequency and duration of each note are defined by an eight-bit code, a 2708 four-page ROM can accommodate a combination of 1024 notes and rests, while an eight-page 2716 ROM can accommodate 2048 notes and rests. The only limitations here are that no single tune can contain more than 256 notes and rests, and no page can have more than 25 different tunes.

The 2708/2716 series of EPROMs are static memory devices that can be programmed, erased, and then reprogrammed numerous times. Widely used in the computer industry, they are supplied by several major manufacturers at prices that make them relatively inexpensive for nonvolatile memory.

The EPROMs are programmed ("blown") by selecting an address location and applying a 24-volt pulse to the desired program pin. Articles on building and using devices to program EPROMs with tunes of your choice have appeared in POPULAR ELECTRONICS (see August 1980). If you have the capability to program EPROMs, you can use the programming charts in Fig. 3 as a guide. The three least-significant bits (LSBs) in Chart A define the length

Musical notation	Octal	Binary
𝅘𝅥𝅯	0	000
♪	1	001
♪.	2	010
♩	3	011
♩.	4	100
𝅗𝅥	5	101
𝅗𝅥.	6	110
𝅝	7	111

Name	Frequency (HZ)	Octal	Binary
F	175	00	00000
F #	185	01	00001
G	196	02	00010
G #	208	03	00011
A	220	04	00100
A #	233	05	00101
B	247	06	00110
C (middle C)	262	07	00111
C #	277	10	01000
D	294	11	01001
D #	311	12	01010
E	330	13	01011
F	349	14	01100
F #	370	15	01101
G	392	16	01110
G #	415	17	01111
A (international A)	440	20	10000
A #	466	21	10001
B	494	22	10010
C	523	23	10011
C #	554	24	10100
D	587	25	10101
D #	622	26	10110
E	659	27	10111
F	698	30	11000
F #	740	31	11001
G	784	32	11010
G #	831	33	11011
A	880	34	11100
A #	932	35	11101
B	988	36	11110
Reset	Silent	37	11111

Fig. 3. Chart A (above) gives the length of each note. Chart B (right) defines the actual music pitch. Codes 377 and 376 cannot be used as "rest" codes.

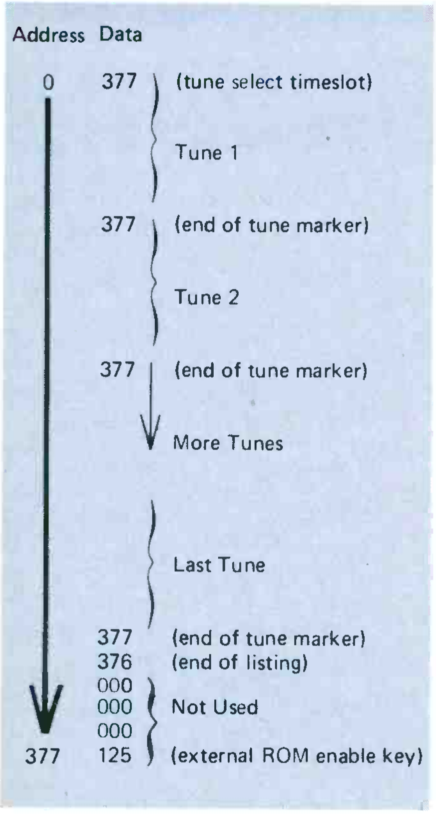


Fig. 4. PROM memory allocations for a simple programming example.

of the note (0 through 7), the shortest, 0, being a sixteenth note and the longest, 7, being a whole note. In Chart B, the upper five bits define the actual musical pitch. Octal 077, for example, would be a middle C of whole-note duration. Depending on the system being used, the code may have to be converted to hexadecimal or binary format.

Required with each tune is an end-of-tune marker of octal 377 or binary 11111111. Also required in the PROM is octal 377 at location 0 and octal 376 at the end of the last tune. The end of each page must be marked with octal 125. In a 2708, octal 125 (55 hex) is required at octal locations 377 (FF hex), 1377 (1FF hex), 2377 (2FF hex), and 3377 (3FF hex). Figure 4 gives a simple programming example.

If you don't have an EPROM programmer or prefer not to blow your own PROMs, you can buy preprogrammed PROMs at reasonable cost (see Note 2 in Parts List).

Construction. Since only low-frequency digital signals are present in the Super Music Maker, the component layout is not critical. The use of a printed circuit board and sockets for the ICs are highly recommended. An actual-size etching-and-drilling guide for the board and a component-placement diagram are shown in Fig. 5.

When assembling the project, be

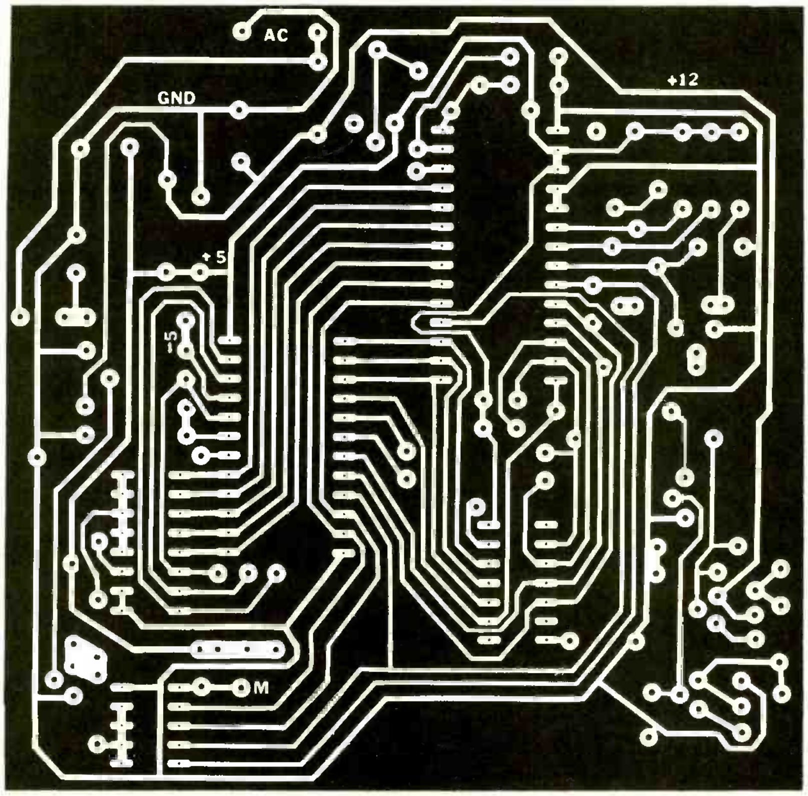
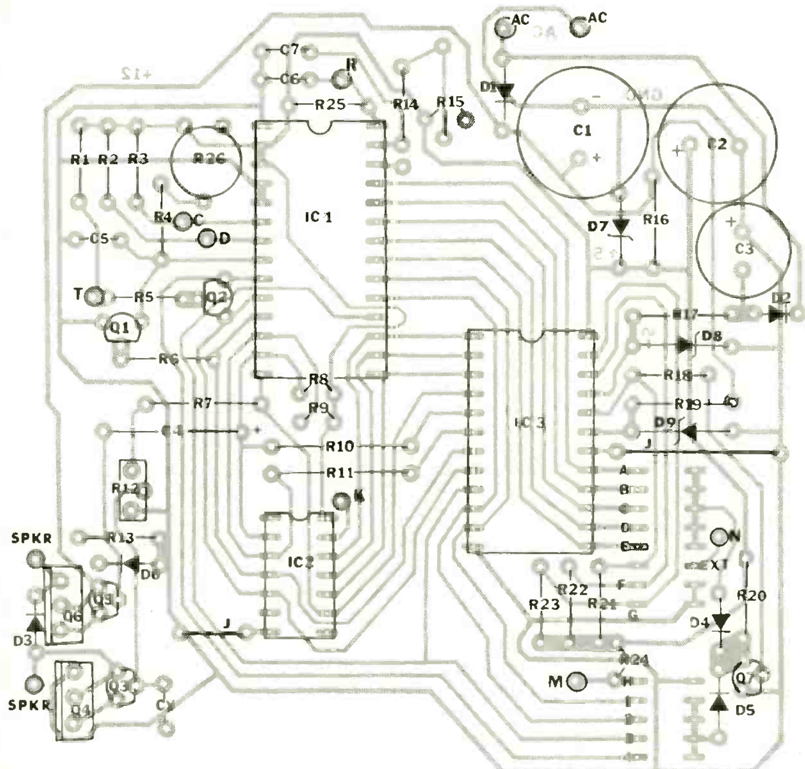


Fig. 5. Actual-size etching and drilling guide for a printed circuit board for the project is shown above. Below is a guide for component layout.



careful to observe the polarities of diodes and electrolytic capacitors and lead locations on the transistors. Do *not* install the ICs in their sockets until told to do so in the following procedure.

If you decide to use a 2716 EPROM for *IC3*, some minor changes must be made in the circuit. Pin 19 of *IC3*, the +12-volt supply-line connection for the 2708, becomes the eleventh address bit (A10) for the 2716. An auxiliary switch with pull-up resistor (*S5* and *R24* in Fig. 1) are used at point M to allow this additional address to be switched. Then, remove *R19* and *D8* and jumper from point M to the *R19* pad whose trace goes to pin 19 of *IC3* and remove *D9* and *R17* and jumper from pin 21 to pin 24 on *IC3*. With these modifications, there will be +5 volts on pins 21 and 24, and pin 19 becomes address bit A10 on *IC3* for the 2716 EPROM.

After assembling the circuit, and before the ICs are installed in their sockets, apply power and check the power supply section to make sure the proper voltages are present. If all voltages are present at the night places, turn off the power and install the ICs in their respective sockets, making certain that they are properly oriented.

Exercise the usual safe-handling procedures to prevent damaging the CMOS ICs with static electricity. That is, ground yourself and tools before handling the ICs to drain off any charge. Once you pick up an IC, holding it by its narrow edges only, don't put it down until it is installed in its socket.

Checkout and Use. Set ROM-select switch EXT in the *S1* assembly to off, and check that all address switches are also off. Pressing RESET switch *S3* should then cause the Westminster chime to play. Adjust TEMPO and PITCH controls *R26* and *R15* for the most pleasing sound.

AO Toreador
BO William Tell
CO Hallelujah Chorus
DO Star Spangled Banner
EO Yankee Doodle

A2 America, America
B2 Deutschland Leid
C2 Wedding March
D2 Beethoven's 5th
E2 Augustine

A4 Hell's Bells
B4 Jingle Bells
C4 La Vie en Rose
D4 Star Wars
E4 Beethoven's 9th

A1 John Brown's Body
B1 Clementine
C1 God Save the Queen
D1 Colonel Bogey
E1 Marseillaise

A3 O Sole Mio
B3 Santa Lucia
C3 The End
D3 Blue Danube
E3 Brahm's Lullaby

Chime X Westminister Chime
Chime Y Simple Chime
Chime Z Descending Octave Chime

Fig. 6. Tunes programmed into the AY-3-1350 (IC1) microprocessor.

Check to see if the system is operating properly as follows. First, set section A in *S1* to on and all other sections in both *S1* and *S2* to off. Pressing the RESET switch should cause the "Toreador" song to play (see Fig. 6 for a list of the tunes programmed into the AY-3-1350 and their addresses). Randomly select a few more addresses and operate the RESET switch to determine if the proper tunes are played.

If you've installed a preprogrammed PROM in *IC3*'s location, you can play it by simply switching from internal to external ROM with the EXT switch in the *S1* assembly. The tune address selected by *S1* and *S2* will then be activated when the RESET switch is operated and that tune will play. While the chime sequences in *IC1* will not play with the EXT switch closed, the NEXT TUNE switch will allow you to step through all the tunes programmed into *IC3*.

Applications. The versatility of the AY-3-1350 gives it a broad range of uses. It can be interfaced with doorbell buttons, toys, and telephones and could make a clock capable of playing a different tune every time it strikes the hour. It could also form the heart of a novel annunciator system. ◇

USING THE SUPER MUSIC MAKER IN A CAR, VAN OR RV

The project can be operated on a vehicle's 12-volt dc electrical system if a negative bias is provided for the 2708 EPROM. A separate 9-volt battery will do fine and will last a long time, since the current drawn is only 20mA. (CAUTION: *Never operate the project without negative bias* or the 2708 will be damaged.) No negative bias is required when a 2716) *not* a Texas Instruments TMS2716) EPROM is used because only a single 5-volt is required. Circuit changes for using the 2716 are detailed in the text.

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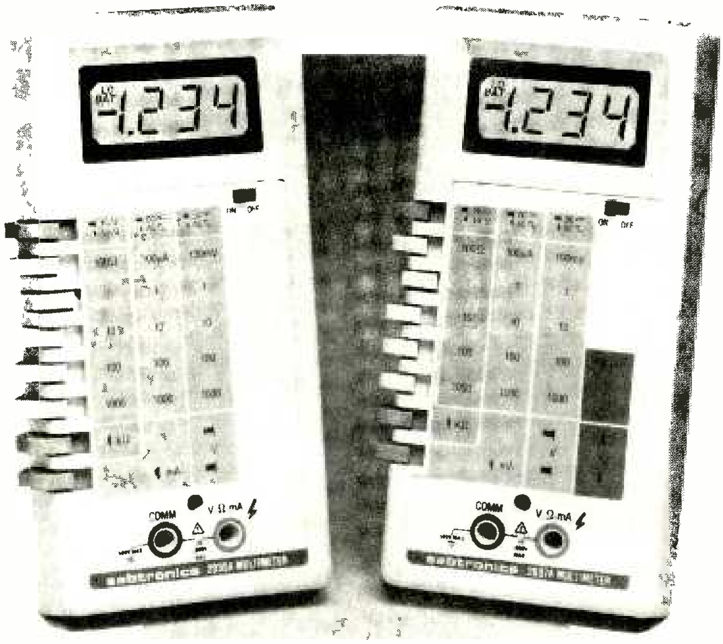

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electronic games

SPACE-AGE LEISURE ACTIVITY

BY JERRY AND ERIC EIMBINDER

Part 2: Comparing what's available today.

THERE are so many hundreds of electronic games on the market today that buying decisions are generally made rather quickly on the spot. In most instances, the buyer has never seen the game before and has no idea if a particular desirable feature might be available in a competing brand. So here's a guide to electronic games to help you prepare yourself before you visit a dealer.

A 10-factor weighted rating system can be employed in evaluating electronic games available in today's marketplace. This system assigns a different number of points from 10 to 25 to each factor, depending on the importance to the user. The highest weight, 25 points, is given to "interest retention" (long-term popularity).

The rating system or "Electronic Game Evaluation Guide" does not include price. Therefore, a game with a high rating is not necessarily a good value. For this reason, ratings we compiled were used mainly to determine the games to be reviewed in this article and actual ratings are mentioned sparingly.

The same system should be helpful to you in evaluating games prior to purchase (if you get an opportunity to try the games). It is described in Table I.

Board Games (Table II) include electronic versions of old, familiar games (chess and backgammon), modified versions of conventional board games (such as "The Generals," a computerized game based on "Stratego") and new games specifically designed to take advantage of electronic technology ("Electronic Detective").

Fidelity emerged as a leader in electronic game technology in 1978 when it captured first place in a San Diego microcomputer chess tournament. Its "Chess Challenger" went undefeated in 12 games (winning 10 and drawing 2) against "Micro-Chess 1.0" (Heath H8), "Micro-Chess 1.5" (Radio Shack TRS-80), "Micro-chess 2.0" (Commodore PET), "BORIS" and "SARGON 1" (Radio Shack TRS-80).

The newest chess product in Fidelity's line is "Voice Sensory Chess Challenger." Its artificial voice lacks the natural qualities of "Speak & Spell," but that's about its only flaw. With a suggested retail price of $360, "Voice Sensory

Fidelity's Voice Sensory Chess Challenger

TABLE I—ELECTRONIC GAME EVALUATION GUIDE

No.	Consideration	Comments	Weight
1	Interest retention	What is the probability that the game will still be popular months after its initial use?	25
2	Player skill required	How much skill and judgment is needed to play? Is it too easy or too difficult?	20
3	Design creativity	How unusual is the game? In the case of sports-based games, does it simulate on-the-field action in an enjoyable manner?	20
4	Competitiveness	Can two or more players feel active competitive involvement?	15
5	Display realism/packaging/controls	How clever are the graphics? How lively is the action on the screen? Are the controls easily manipulated?	15
6	Time needed to learn the game	Is the game tricky to learn? If it is, an experienced player has an advantage not provided by skill but by familiarity with the system.	10
7	Computer as opponent	Is the computer smart enough to perform as a worthy adversary or to challenge the ingenuity of the player?	10
8	Sound effects	Has voice or sound been used effectively to enhance game play?	10
9	Game variation/random generation	Are a number of interesting variations of the basic game offered? Is random generation used, and if so, is it used effectively?	10
10	Overall execution	All factors considered, how well have the previous nine factors been combined to form an appealing game?	15
		Total	150

Challenger" makes good use of its 50-word vocabulary and its 224,000 bits of ROM. For the inexperienced player, it can tell how to set the board and illuminate paths to illustrate how each piece is moved. If the player needs help, the computer will recommend a move. Should the player violate the rules of chess it announces "illegal move."

The new Fidelity game can duplicate 64 of the world's greatest chess games including matches played by Morphy, Capablanca, Spassky and Fischer. The player can assume the role of either of the original participants; the computer will award points for correct moves and reveal how the game was played by the original opponents. It can, of course, also play a mean game of chess when operated at its highest skill level (ten levels are provided).

To move a piece, the player first touches its present position and then touches the new position. This is a great improvement over using the usual separate built-in keypad. A light at each position indicates that the move has been registered with the computer. The computer announces both its own moves and the player's moves. According to the manufacturer's promotional literature, the "Voice Sensory Challenger" calls out every capture; actually, it only announces the computer's captures.

Blending the Old and New. Somewhere in the city, a thief is about to commit a crime. You're a private detective armed with the latest development in sophisticated crime detection equipment, an electronic "Crime Scanner."

You press the "Clue" button on your crime scanner and the display reveals the street on which (or the building in which) the crime is taking place. But that's not all your scanner does; it also monitors the scene of the crime for sound. You hear the thief as he breaks a glass window.

The chase is on. You head for the jewelry store across the street from Ma's Ice Cream Shop. And you're not alone. Other private detectives, who are also after the reward money, are joining in the pursuit.

Now you hear the thief running along the street but you're still too far away to apprehend him. You and the other detectives continue to close in as he heads for a nearby subway station.

You're playing "Stop Thief," an electronic cops-and-robbers game, controlled by a four-bit microcomputer. Eventually, you or one of the other players will track the thief down successfully and move in for the arrest. You'll collect at least $800 in reward money as the police arrive with sirens wailing and guns firing, unless the thief slips away. In that case, all you'll get is a parting, "Na-na-na-an-na-na," from the thief as he escapes.

"Stop Thief" is a modern-day board game; it has buildings and streets, and it's played with dice and paper money. If this description is reminiscent of "Monopoly" it should be pointed out that Parker Brothers, the creators of "Stop Thief," also developed "Monopoly" 45 years earlier.

Are they trying to rework the same formula? Both games have decks of chance cards and both involve moving player pieces along streets (although the streets in "Monopoly" have famous names such as Boardwalk and Park Place; whereas the streets in "Stop Thief" merely have numbers).

No, "Stop Thief" is not "Monopoly," updated. It is uniquely a product of the microcomputer era. It uses a complex software program, imbedded in a Texas Instruments TMS1000 microcomputer IC by a single-level mask technique. Three parts of the microcomputer configuration are programmed simultaneously: read-only (instructions) memory, instruction decoder, and output encoder. These three sections control information storage and processing.

"Stop Thief" can be thought of as a blend of the old and the new. It retains the competitive nature of the basic board game, while introducing computer-controlled challenge (finding the thief), computer-assisted play (for example, if a player forgets some clues, he can recall the last 10 clues from the microcomputer's memory), and computer-generated sound.

A recently published review comparing Ideal's "Electronic Detective" with Parker Brothers' "Stop Thief" came to four conclusions: (1) the two games are similar, (2) "Electronic Detective" is much more complicated, (3) "Electronic Detective" is a greater challenge, and (4) "Stop Thief" is more appropriate for

Ideal's Electronic Detective

TABLE II—ELECTRONIC BOARD GAMES

Game	Description
TRYOM	
Omar V	Computer employs all backgammon strategies against player.
Super System III	Moves shown on LCD display window.
FIDELITY	
Sensory Chess Challenger	Moves automatically entered/indicated on board.
Voice Chess Challenger	Moves shown on LED window and announced.
Voice Sensory Chess Challenger	Indicates and announces moves automatically.
Checker Challenger	Moves shown on LED window.
Backgammon Challenger	Moves shown on LED window; conventional dice.
IDEAL	
The Generals	Electronic equivalent of Stratego.
Electronic Detective*	Killer's identity is deduced through clues.
PARKER BROTHERS	
Stop Thief	Part "Monopoly," part "Clue," but mostly new.
Code Name Sector	"Aging" search-and-destroy submarine hunt.
EPOCH	
Detective Game*	Sound clues, search-and-arrest buttons.
MILTON BRADLEY	
Electronic Battleship	Electronic version of grid-position, sea battle.
LAKESIDE	
Intercept	Attack pilot tries to slip through missile defense system.
CARDINAL	
Brian	Conventional backgammon set with randomly generated electronic dice.
Electronic Chess	Seven-level and 12-level versions (beginner to expert).

**Considered as a board game though a board is not actually used in playing the game* younger players. We disagree on all four counts.

The games are not similar even though they both employ versions of the TMS1000 microcomputer. "Stop Thief," like "Monopoly," is a board game; that is, apprehending the criminal depends upon being in the right place at the right time. Getting there is a combination of luck (resulting from the roll of the dice) and skill (knowing where to move and when). "Electronic Detective" is not a board game; it is a game of deduction, careful scrutinization of alibis and weighing of evidence.

"Electronic Detective" is no more complicated than "Stop Thief" and every bit as easy to learn. "Stop Thief," because the criminal is constantly on the move, presents a different kind of challenge. In one case, the players are trying to overtake a fleeing criminal; in the other, they are trying to determine his or her identity.

As "Electronic Detective" begins, a murder takes place. Now it's up to each player to determine who the killer is through questions keyed into the computer. Alibis of suspects must be carefully checked because even innocent suspects may sometimes lie.

As suspects are interrogated, evidence is uncovered. The player wins if he correctly identifies the killer. But, be careful, a false accusation removes the player from the game. The computer plays the funeral dirge for each detective who is eliminated.

More than 130,000 different crime situations are possible. Players can choose from three levels of skill: gumshoe, sleuth or master detective.

Anyone who likes to solve a mystery, should enjoy playing either "Electronic Detective" or "Stop Thief." The two games differ not only in the type of criminal being tracked down (in "Electronic Detective," he's a murderer; in "Stop Thief," he's just a crook) but in basic concept and method of play. Both games are appropriate for younger players once an experienced player has explained the rules and briefly discussed strategy considerations.

Generals Battle It Out. Ideal's "The Generals" is a computerized version of Milton Bradley's board game "Stratego," which, in turn, was an American version of a game developed in Holland. The marshall in "Stratego" is now a five-star general and the nearly powerless spy has been replaced by an extremely dangerous agent, but the cast of players is generally the same. So is the object, which is to capture the opponent's flag.

In both games, the players are supplied with armies and move their troops across a battlefield. But the addition of an electronic judge in "The Generals" does have its benefits. In an encounter between two battle pieces, the computer identifies the winning piece without revealing its rank. This is a major improvement over "Stratego," where opponents must reveal the ranks of their pieces in each confrontation. Not knowing the ranks of an opponent's remaining pieces forces a player to make more assumptions and use more risky strategic planning.

The role of the electronic arbiter is limited to revealing which of two pieces, engaged in battle, has the higher rank. "The Generals" is strictly a two-player game; one player cannot oppose the computer.

When scored by using the rating system described earlier, "Electronic Detective," "Stop Thief," and "The Generals," each tallied over 80%, as shown in Table III. A score of 65% or better is considered acceptable.

Road Racing (Table IV). You might call Kenner's "Redline" a dashboard game. It is designed as a replica of a dragster steering wheel and has a digital console with gear and gas controls, gear and rpm readouts and a string of engine status lights.

The idea of the game is to control the engine so as to win the race without jumping the start signal or exceeding the safe limit (redline) for engine speed.

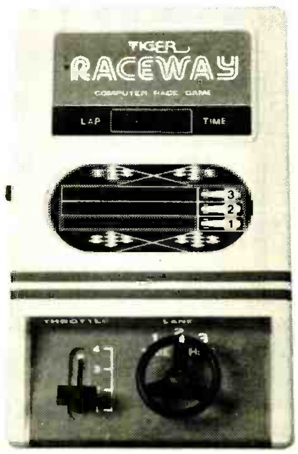
TABLE III—APPLICATION OF RATING SYSTEM

No.	Consideration	Electronic Detective	Stop Thief	The Generals
1	Interest retention	23	24	21
2	Player skill required	17	18	12
3	Design creativity	18	19	14
4	Competitiveness	15	15	15
5	Display realism/packaging/controls	15	13	N/A
6	Time needed to learn the game	6	7	10
7	Computer as opponent	10	10	N/A
8	Sound effects	9	10	7
9	Game variations/random generation	10	10	N/A
10	Overall execution	15	15	15
Total Points		138	141	93
Max. Possible Points		150	150	115
Score (%)		92	94	81

N/A = Not Applicable

TABLE IV—ELECTRONIC ROAD GAMES

Game	Description
BANDAI Champion Racer	5-gear racing game with separate starting line. Two-button steering control.
KENNER Redline	4 gears. No lanes to drive. Player controls engine speed.
MATTEL Auto Race	4-speed gear shift. Sliding control for steering. Zings for victory. Buzzes for defeat.
TIGER Raceway	4-gear racing game. Counts number of collisions. Trumpeting sound for victory; buzzer sound for defeat.



Tiger Raceway

If the player "blows" his engine while shifting gears from neutral through fourth, his foul indicator lights up and he must restart the race. Steering along a raceway is not involved. The sound effects are impressive and include "revving" of the engine, engine blowout, and screeching tires.

Mattel's "Auto Race," Tiger's "Raceway," and Bandai Electronics' "Champion Racer" are all based on driving on a track. The Mattel and Tiger games are very similar. The object of both games is to cover four laps in as short a time period as possible. If the four laps haven't been driven after 99 seconds have elapsed, play ends.

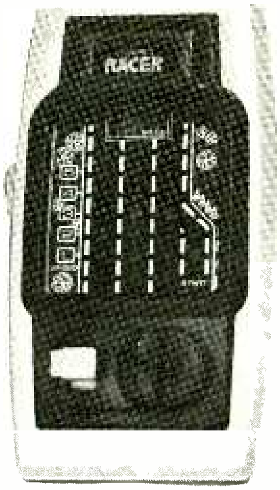
"Raceway" has several nice touches. Its miniature steering wheel and throttle are more realistic than would ordinarily be expected from a car-racing game. Both provide the equivalent feel of full-scale arcade games as the player shifts gears and changes lanes. If the driver successfully completes the required four laps, "Raceway" displays both elapsed time and the number of collisions with oncoming vehicles along the way. Mattel's game only displays elapsed time (or the 99-second time limit).
(another way in which "Champion Racer" differs from "Raceway"). Points are scored by avoiding collisions on the track; the faster the driving speed, the more points that can be accumulated. Each time a collision occurs, the player must start again from the pit.

If a player covers more than 99 miles, the two-digit light-emitting-diode display switches from digital to alpha/numerical readout (A1 = 101 miles, C1 = 121 miles, etc.). The display flashes with 10 seconds left to play alerting the player that the game is ending.

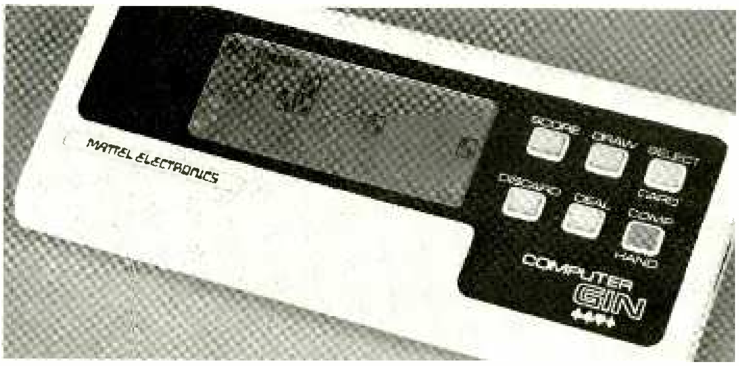
Electronic Games of Chance (Table V). Picture yourself playing Gin. Your opponent says "no thanks," as you discard the ten of clubs. It's his last decision. On your next move, you draw the card you need for Gin. You've just beaten Mattel Electronics' "Computer Gin" at the low-skill setting. Now you're ready to play it at the high-skill level. Besides two skill levels, Computer Gin also can oppose you in Go Draw or 33.

In Gin, you receive 11 cards, face up, on the display. Your hand is unknown to the computer; its hand is unknown to you. You dispose of the least desirable card by pushing the discard button. The discarded card then disappears from the screen; the computer either accepts it with "thanks" or picks a fresh card from the deck. It's your turn again and, automatically, a new card from the deck flashes on the screen. If you want it, you push the select button and again dispose of the least desirable card. If you don't want it, you hit the draw button and receive a different card. And so on, until either you or the computer gets Gin.

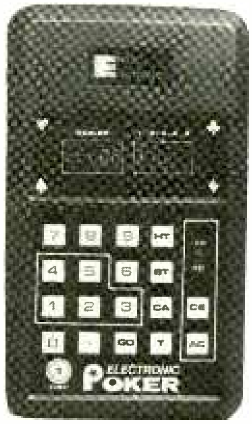
Don't get too excited if you draw a great poker hand against the dealer (the



Bandai Racer



Mattel's Computer Gin



Entex Poker

In both games, the computer sends vehicles into the same driving lane being used by the player; constant reaction by the player, therefore, is needed. Each collision knocks the player's car back one space. If the player doesn't move his car from its lane immediately after a collision, the other car will continue to push him backwards. The cars are displayed as lines, not graphic images. The line representing the player's car is a brighter red than the other lines, which is sufficient for distinguishing between the player's car and other vehicles. However, the pictorial representation of moving cars, such as used by Bandai Electronics in "Champion Racer," is visually superior.

In "Champion Racer," the player has 90 seconds to cover as many miles as possible. He can shift through five speeds (as compared to four with Tiger's "Raceway") and he can move into reverse (not possible with "Raceway").

To start "Champion Racer," the player moves his car from the pit onto the racetrack. He must be careful as he works his way up the field because cars can come at him from either direction

TABLE V—CARD AND CHANCE GAMES

Game	Description
BAMBINO **Blackjack**	Has bet, hit, stay buttons and keyboard. Includes sound effects. Also plays poker and bridge.
ENTEX **Electronic Poker**	Plays 5-card draw poker. Has deal, bet and call buttons plus keyboard. Provides sound effects.
Jackpot Gin Rummy	Plays Gin and Vegas-rules blackjack.
FIDELITY **Voice Bridge Challenger**	Announces bids in accepted bridge terminology. Can be partner or opponents.
Bridge Bidder	Learning aid. Player enters hand. Bid is suggested by computer.
MATTEL **Computer Gin**	Computer can oppose you in three different card games: Gin, Go Draw, and 33.
TRYOM **Goren Bridgemaster**	Uses 40-character keyboard. Has 8-character alphanumeric display. Programmable.
UNION MAJOR **Yacht Four**	Rolls dice numbers electronically. Provides musical cheer for winner.
UNISONIC **"21"**	Has insurance, splitting, doubling down, hit, stand, bet and play buttons; 12-digit display.

computer) when playing Entex's "Electronic Poker." The chances are good that the dealer will fold quickly.

Both hands are dealt face down on an LED display. As in conventional draw poker, the player can discard existing and draw new cards. He can then bet or fold. After the first bet, two dealer cards are revealed. The player can call or bet again, and another dealer card is revealed. The player can bet again, or call and the computer will reveal the winning hand, display the winnings or losses and the accumulated totals.

Union Major's "Yacht Four" is an electronic 5-dice game similar to "Kismet," "Yahtzee," "Poker Dice," and "Casino Games" (trademarks of Spare-Time Products, Inc.; E.S. Lowe Co., a Milton Bradley Company; Aurora Products Corp.; and Invicta Games, respectively). The readout displays the most strategic move to make after each roll.

Land, Sea, Air, and Space Warfare Games (Table VI). Most of the hand-held space-warfare electronic games are similar in concept to the popular arcade game, "Space Invaders." Exceptions are Kenner's "Star Wars," which puts the player in command of the "X-Wing Fighter" in combat with a "Tie-Fighter," and Bambino's "Space Laser Fight," a space version of a shootout in the Old West.

In "Space Invaders," an alien squadron is heading toward the earth. The player defends his planet by destroying the attackers as they attempt to land.

The Entex version is remarkable in its duplication of most of the features of the arcade and video cassette games. The pace of the attack, the rapid fire by the enemy ships, the destruction of the defense shields, the cruising mother ship and the landing on earth are expertly programmed. The visual display provides spaceship replicas not lines as several other games offer.

TABLE VI—WARFARE GAMES

Game	Description
ATARI	
Space Invaders	Hand-held version of popular arcade game.
BAMBINO	
Space Laser Fight	Robots shoot it out on outstanding visual display.
UFO Master Blaster	Simplified version of Space Invaders.
BANDAI	
Missile Invader	The enemy doesn't try to land in this version of Space Invaders.
Super Galaxy Invader	Deluxe version of Missile Invader.
ENTEX	
Space Invader	Well-executed version of the arcade game.
EPOCH	
Invader From Space	Three skill-level version of Space Invader.
KENNER	
Star Wars	Object is to determine grid position of enemy and destroy.
MATTEL	
Space Alert	Mini Space Invaders. Also called Battlestar Galactica and Flash Gordon.
Sub Chase	Drop depth charges while dodging torpedos.
Armor Battle	Duel enemy tank while avoiding line mines.
TIGER	
Sub Wars	Torpedos are fired against fleet.
TOMY	
Cosmic Combat	Avoid enemy missiles when shooting at overhead ships.
VANITY FAIR	
Electron Blaster	Still another version of Space Invaders.

TABLE VII—FOLLOW THE LEADER GAMES

Game	Description
ATARI	
Touch Me	Offers three games requiring repeating of lights, sounds and colors.
CASTLE	
Einstein	Player repeats colors and sounds.
MILTON BRADLEY	
Pocket Simon	Miniature version of Simon.
Super Simon	Player duplicates colors and sounds.
TIGER	
Copy Cat	Sequences of lights and sounds. Speed up as game progresses.

TABLE VIII—CODE-BREAKER GAMES

Game	Description
INVICTA	
Electronic Mastermind	Break the secret code set by the computer.
Supersonic Mastermind	Deluxe Electronic Mastermind with sound.
LAKESIDE	
Computer Perfection	Four games based on turning lights on in sequence.
Le Boom	Search for clues to defuse the bomb.
MILTON BRADLEY	
Comp IV	A correctly guessed number is indicated by flashing lights.

Lakeside Computer Perfection

Follow-the-Leader Games (Table VII) are simply games that test the memory of the player in some way. He might be asked to duplicate a string of numbers or a series of musical notes. Some of the products listed in the multi-function category include follow-the-leader games among other types.

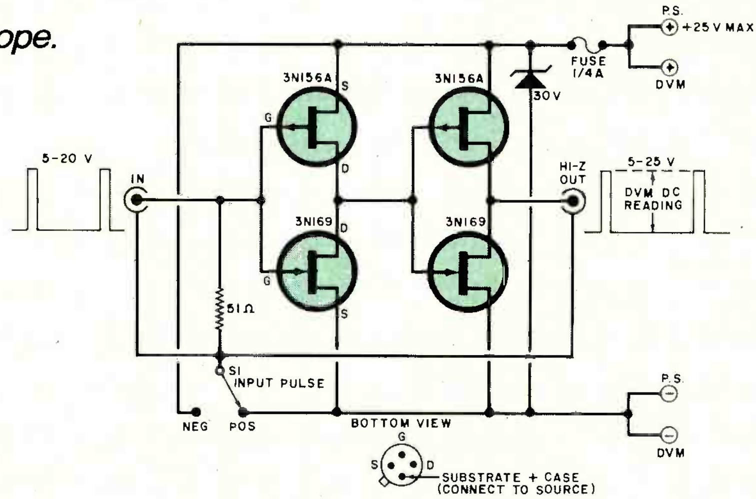
Code-Breaker Games (Table VIII) require the player to identify unknown information generated by the computer. Trial-and-error or deduction techniques are employed. ◇

To be continued next month.

Pulse Amplitude Reference

Easy-to-build circuit amplifies input pulses when calibrating an oscilloscope.

BY IMRE GORGENYI



The circuit can be assembled on a perforated board.

WHEN working with very narrow, low-amplitude, low-energy pulses, it is advantageous to calibrate the scope you are using at actual working conditions with probes and attenuators in place. This is not always easy since pulse amplitude calibrators usually have low-level outputs—often under one volt.

The simple, all-FET circuit shown here provides pulse amplitudes to 25 volts, if desired, from pulse inputs of 5 to 20 volts. Since the two FET pairs are driven to their open-saturated condition, output pulses have the same amplitude as the power supply voltage. Absolute amplitude of the output can be monitored by a DVM at all times.

The circuit can handle narrow pulses and slow repetition rates. It can be assembled on a small piece of perforated board using BNC connectors for the input and output and can be connected directly in the 50-ohm line between the pulse generator and scope. The circuit, including power supply and digital voltmeter connectors, is "floating." Circuit protection is formed by the fuse and zener diode. ◇

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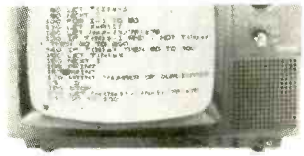

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The MicroAce is not just another personal computer. Quite apart from its exceptionally low price, the MicroAce has two uniquely advanced components: the powerful BASIC interpreter, and the simple teach yourself BASIC manual.

The unique versatile BASIC interpreter offers remarkable programming advantages:

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- Unique syntax check. Only lines with correct syntax are accepted into programs. A cursor identifies errors immediately. This prevents entry of long and complicated programs with faults only discovered when you try to run them.
- Excellent string-handling capability — takes up to 26 string variables of any length. All strings can undergo all relational tests (e.g. comparison). The MicroAce also has string input — to request a line of text when necessary. Strings do not need to be dimensioned.
- Up to 26 single dimension arrays.
- FOR/NEXT loops nested up 26.
- Variable names of any length.
- BASIC language also handles full Boolean arithmetic, conditional expressions, etc.
- Exceptionally powerful edit facilities, allows modification of existing program lines.
- Randomise function, useful for games and secret codes, as well as more serious applications
- Timer under program control.
- PEEK and POKE enable entry of machine code instructions, USR causes jump to a user's machine language sub-routine.
- High-resolution graphics with 22 standard graphic symbols.
- All characters printable in reverse under program control.
- Lines of unlimited length.

'Excellent value' indeed!

For just $149.00 (excluding handling charge) you get everything you need to build a personal computer at home... PCB, with IC sockets for all ICs; case; leads for direct connection to a cassette recorder and television (black and white or color); everything!

Yet the MicroAce really is a complete, powerful, full-facility computer, matching or surpassing other personal computers at several times the price.

The MicroAce is programmed in BASIC, and you can use it to do quite literally anything, from playing chess to managing a business.

The MicroAce is pleasantly straightforward to assemble, using a fine-tipped soldering iron. It immediately proves what a good job you've done: connect it to your TV ... link it to the mains adaptor ... and you're ready to go.

Fewer chips, compact design, volume production-more power per Dollar!

The MicroAce owes its remarkable low price to its remarkable design: the whole system is packed on to fewer, newer, more powerful and advanced LSI chips. A single SUPER ROM, for instance, contains the BASIC interpreter, the character set, operating system, and monitor. And the MicroAce 1K byte RAM (expandable to 2K on board) is roughly equivalent to 4K bytes in a conventional computer — typically storing 100 lines of BASIC. (Key words occupy only a single byte.)

The display shows 32 characters by 24 lines.

And Benchmark tests show that the MicroAce is faster than all other personal computers.

No other personal computer offers this unique combination of high capability and low price.

The MicroAce teach-yourself BASIC manual.

If the features of the BASIC interpreter mean little to you-don't worry. They're all explained in the specially-written book *free* with every kit! The book makes learning easy, exciting and enjoyable, and represents a complete course in BASIC programming-from first principles to complex programs. (Available separately-purchase price refunded if you buy a MicroAce later.)

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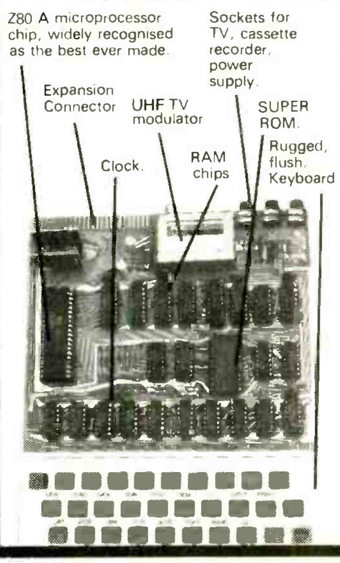
The MicroAce Kit: $149.00 with IK COMPLETE $169.00 with 2K

Demand for the MicroAce is very high: use the coupon to order today for the earliest possible delivery. All orders will be despatched in strict rotation. If you are unsuccessful in constructing your kit, we will repair it for a fee of $20.00, post and packing FREE. Of course, you may return your MicroAce as received within 14 days for a full refund. We want you to be satisfied beyond all doubt — and we have no doubt that you will be.



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CIRCLE NO. 49 ON FREE INFORMATION CARD

Solid-State Developments

By Forrest M. Mims

For Sale: Free Energy from the Sun

SOLAR energy proponents sometimes become so enthusiastic over the free availability of sunlight that they overlook the cost of purchasing and maintaining the equipment necessary to tap and store it. Recently, for example, a specialist in the solar heating of homes appeared as a guest on a popular radio talk show. In response to a listener's question, the guest ventured into an aspect of solar energy conversion about which he knew very little: photovoltaics. He made some elaborate claims about how roof-top panels of solar cells could supply all the electrical needs of a home but failed to mention the enormous expense at today's prices of the panels, storage batteries, voltage regulators and inverters.

If you've ever looked into the subject, you know that the current price of solar cells is a long way from the goal of 50¢ or less per watt set by the U.S. Department of Energy. Unless you can afford to buy in large quantities, the average experimenter will have to pay at least $15 for enough solar cells to generate one watt of electricity!

Many companies that sell parts to experimenters also sell solar cells, and the price per watt for these cells varies widely. To illustrate some typical variations, here's a table comparing the current output (I_{out}) and cost for a 3" circular silicon solar cell having an open-circuit voltage of 0.45 V.

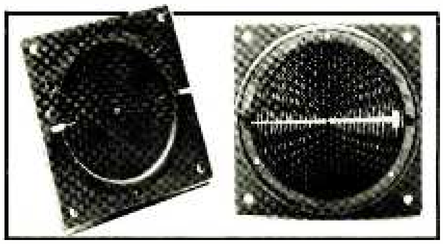

Fig. 1. Ferranti ESC-3 solar-cell module.

The extraordinary price of the Ferranti cell, which is shown in Fig. 1, is due to its unique protective housing and electrical connection pins. All the others are bare cells without connection leads.

The parts dealers who sometimes sell manufacturers' culls may buy their solar cells from more than one source. I learned this the hard way a few years ago upon receiving an order of 3" cells. They appeared to have come from two different sources. Most of them had cosmetic blemishes, and only some were 3" cells. The others were slightly smaller.

You can avoid this problem, if top efficiency is your quest and money is no problem, by purchasing the more costly first-run cells or buying them from a retail electronics parts store so you can inspect them before buying.

Another tip: Since dealers may buy cells from different sources, always compare prices on any size cell you plan to buy. A dealer whose 3" cells are very economical may sell very expensive 2 cm × 2 cm cells.

Company	Stock No.	I_{out} (A)	Cell Cost ($)	$/Watt
Chaney Electronics	C24159	0.75	8.50	25.19
EDI	E-43	1.0	6.88	15.29
Edmund Scientific	42,270	1.2	19.95	36.94
Ferranti	ESC-3	0.8	23.50*	58.75
Newark	69F121	1.2	17.00	31.48
Poly Paks	92CU3862	1.0	7.95	17.67
Radio Shack	276-123	1.0	9.99	22.20

*Per cell in 100-lot quantities.

The cells in this table are made by several manufacturers. The more expensive ones have no defects, while some of the cheaper ones may include culls or seconds. For example, some may have cosmetic blemishes which might reduce slightly the cell's power conversion efficiency (the ratio of solar power striking the cell to electrical power produced by the cell). Others may be inherently less efficient ("below spec") than standard cells due to manufacturing defects.

Practical Solar Cell Applications. By now you probably have the impression that I'm not a solar-energy enthusiast, but quite the contrary is true. Even at today's ridiculously high prices, solar cells can be used in cost-effective power supplies.

For example, you're probably familiar with several different widely adver-

World's First and Only Solar-Powered Watch*

Guaranteed to outperform any watch sold today... or costs you nothing!

The Sunwatch; acclaimed as the most accurate, most versatile, most rugged watch ever made.

These features make all other watches obsolete:

- **Clearly visible by day or night**
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- **100% solar-powered, you never replace batteries**
- **No resetting of calendar, not even in leap years**

Space age accuracy
Now you'll never worry about accuracy again. Because the Sunwatch will keep you on time for the rest of your life. (Accurate to within 1 sec. per month.)

Solar age efficiency
Miniature solar cells automatically convert sunlight, daylight or ordinary bulb light into usable energy for storage. The solar cells last virtually forever. So you'll never replace a watch battery again.

Programmed for over a century
The built-in computer on a chip will always display the correct time date and month. Also, it automatically adjusts the watch calendar for long and short months, leap years and it's programmed until the year 2100!

Easy to read
The natural side-view display lets you tell the time, day and date without twisting your arm into an uncomfortable position.

Numbers always visible
Four varying light intensities are built into the viewing display, allowing the Sunwatch to adjust automatically to any light. This means you can always read it, even in the brightest sunlight.

10 Display functions
The Sunwatch is capable of displaying the following information: hours • minutes • seconds • months • date • day • leap year • speed calibration • AM/PM indicator • seconds count-off.

Extreme accuracy
Unlike other electronic watches using tuned crystals to control timing accuracy, the Sunwatch incorporates a unique, programmable, microcircuit synthesizer to make it the first watch in history that is accurate to less than 1 second per month. That's 5 times more accurate than the latest quartz Accutron.

The Power Source
Tiny silicon power cells, which are constantly being energized by natural sunlight, daylight or an ordinary light bulb keep the Sunwatch energy storage system charged. Should the watch not be exposed to light, it will continue to operate for months on stored power.

The most indestructible watch in the world
The workings of the watch: solar panels, energy cells, quartz crystal, computer on a chip, etc., are all permanently sealed in a Lexan module. This module is so unique it's protected by U.S. and foreign patents.

Completely waterproof
Leave the Sunwatch in salt water for months. Dive with it in depths up to 750 feet. There are no openings — magnetic slide bars activate all functions. With Sunwatch's exclusive, permanently sealed Lexan module, there are no "O" rings or seals to leak.

Shock resistant to 25,000 G's
You can crash it into a rug-surfaced brick wall at 90 mph with no noticeable effect. Wear it while doing heavy work, exercise or any strenuous activity.

Temperature resistant
Put the Sunwatch in boiling water for 30 minutes, freeze it in a block of ice for a year. Extreme temperatures will not damage your Sunwatch.

Pressure resistant
There are no air spaces inside the Sunwatch. Therefore, it is not susceptible to high pressures such as might be encountered diving to great depths.

The perfect watch for a lifetime
Imagine split-second accuracy for the rest of your life. Sunwatch is a virtually indestructible, beautifully styled, space-age timepiece, and it's available in three exciting finishes: Brushed stainless steel, Gold tone stainless steel, or a Durable black finish on stainless steel. All Sunwatches come with a matching stainless steel band with removable links and adjustable clasp.

Made in the United States
The Sunwatch, designed by Roger Riehl, was being worn by its inventor nearly a year before the first electronic digital watch was even available to the general public. Since that time constant engineering evaluations and design improvements have been made on the Sunwatch to incorporate the latest in digital microcircuit and solar power technology. Thus the Sunwatch today represents state-of-the-art electronics technology. It is built to the same rigid standards practiced by the manufacturer in creating sophisticated computer microcircuits for the U.S. Government and other major users of these components.

*** A word about other "Solar Watches"**
Roger Riehl, designer of the Sunwatch, states that there is no other completely solar powered watch on the market today. Claims of solar power by other watch manufacturers are based on the use of a small solar cell. Due to their limited size, these cells can be proven, in technical terms, to be of virtually no significant value in extending the life of a watch battery. For this reason, all other so-called "solar watches" must have replaceable batteries. The Sunwatch's power storage system, however, need never be changed and is, in fact, permanently sealed to withstand abuse and the elements.

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Available in a special gift box (see order form) the Sunwatch makes an ideal gift for special holidays, birthdays, graduation, Father's Day, etc. Perfect for business people, commuters, teachers, athletes and sportsmen, who require split second accuracy.

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The Sunwatch is covered by a 2 year limited warranty issued by Riehl Time Corporation (manufacturers of the prestigious Synchronar 2100) and included with your watch. A copy of the warranty may also be obtained free of charge by writing to Riehl Time Corp., 53 S. Jefferson Rd., Whippany, NJ 07981. This warranty gives you specific legal rights, and you may have other rights which vary from state to state.

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Please add $3.95 per watch shipping and insurance.
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Quick delivery direct from the manufacturer CIRCLE NO. 66 ON FREE INFORMATION CARD tised solar-powered watches and calculators. These devices aren't gimmicks. The solar cells provide a trickle charge to one or more nickel-cadmium storage cells, even in subdued light. The solar cells used in these products are so small that their cost is perfectly reasonable for the purpose they serve.

A typical reader cannot begin to afford to purchase enough solar cells to power his home. (Nor can the typical columnist.) Nevertheless, there are some very practical household and recreational applications for solar-cell power supplies, the most obvious being battery charging.

Some boat owners use small solar-cell panels to maintain a charge on their rig's storage battery. The battery can then be used to start an engine, operate a bilge pump or power the running lights.

Hikers and campers can also benefit from small solar-cell battery chargers. Several companies sell small solar-cell panels specifically designed to charge small batteries that can then be used to power flashlights and radios.

If you're a do-it-yourself enthusiast, you may be able to save some money by building your own solar panels. The November 1976 installment of "Experimenter's Corner" (POPULAR ELECTRONICS, p. 110) described a couple of homemade solar cell battery chargers I once assembled for use on a bicycle tour in the mountains of New Mexico. Those two panels are now four years old and are still working well. They've certainly paid for themselves several times over, and, hopefully, will see many more years of service.

Their latest assignment was to recharge the lighting system on my bicycle during a recent bike tour to the Texas Gulf Coast. One panel charged the NiCd cells in a homemade miniature xenon strobe light that clips onto my cycling shorts while night riding. The other panel charged a 6-volt light mounted on a headstrap.

Figure 2 is a photograph showing both these solar chargers hard at work atop a chunk of volcanic rock in New Mexico's Jemez Mountains. The small panel at left recharges two NiCd AA cells installed in a holder mounted on the panel's back. A small blocking diode prevents the batteries from discharging through the solar cells during periods of darkness.

The larger panel at right is charging a series-connected module of four AA batteries attached to the headband of a 6-volt headlight. When fully charged the batteries will power the light for about 55 min. continuous operation.

The small meter in the photo monitors the charging current of the larger panel. Thanks to the very clear New Mexico sky, the panel was generating more than 90 milliamperes when the photo was snapped. Here at my home in south central Texas, almost exactly four years later, this same panel is charging a NiCd pack with a current of slightly more than 85 milliamperes as this is being written.

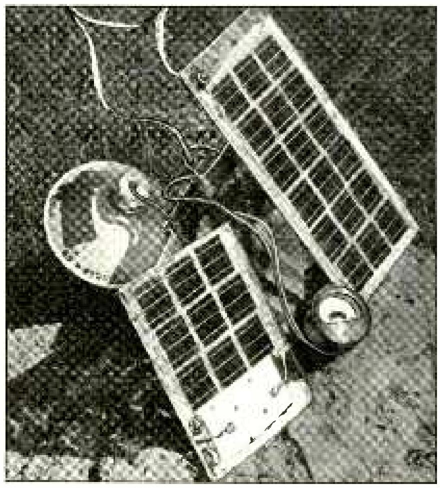


Fig. 2. Solar-cell arrays shown here are being used to recharge batteries on long bicycle trips.

How to Build One. If you want to try building your own solar panel, your best plan of action is to collect as much manufacturer's literature as possible before selecting and buying the cells *and* storage cells. The latest edition of McGraw-Hill's *Electronics Buyers' Guide* lists 39 companies that sell or make photovoltaic cells. Here are some companies that have recently supplied this column with good data sheets and applications information:

- Edmund Scientific Co. (150 Edscorp Building, Barrington, NJ 08007)
- Motorola Semiconductor Products (Box 20912, Phoenix, AZ 85036)
- Sensor Technology, Inc. (21012 Lassen St., Chatsworth, CA 91311)
- Solarex Corporation (1335 Piccard Drive, Rockville, MD 20850)

The applications literature from Solarex is particularly good, although I've yet to see an applications note that covers thoroughly all the considerations involved in the design of even a simple solar-cell battery charger. You can combine applications guidelines from Solarex and other firms with the specifications for various solar panels sold by these same companies to design your own custom panel. Here are a few important points to remember:

1. A typical solar cell has an open-circuit voltage of 0.45 volt. Connect cells in series to boost the voltage.

2. Connect cells in parallel to boost the current output.

3. Make sure the finished panel does not deliver too much current to the batteries it is intended to charge. Big 1-ampere cells may be fine for charging large storage batteries, but they are totally unsuited for charging AA, C and other small NiCd batteries.

4. Solar cells are very brittle. Use care when handling them. Protect them from damage with a clear protective housing.

5. Use care when soldering connection leads to solar cells. See the August 1980 issue of POPULAR ELECTRONICS (p. 90) for tips about soldering leads to solar cells.

6. For best results, use four series-connected cells for each NiCd cell you plan to charge. One additional solar cell per array will be needed if you use a blocking diode (and you should). Therefore you will need nine cells to charge two series-connected NiCd batteries (see Fig. 2).

7. Make sure *all* the cells in an array are equally illuminated. Blocking the light to most or all of but one cell in a series-connected array will reduce the output to almost nothing.

New Solar-Cells Developments. In recent years several breakthroughs in photovoltaic technology have occurred. One is the growth of continuous ribbon or film solar cells from silicon. Another is the development of potentially inexpensive solar cells made by coating thin films of polycrystaline silicon on a graphite substrate.

Many other kinds of silicon photovoltaic devices are also undergoing development, but many solar cells of the future may be made from gallium arsenide or cadmium sulfide, not silicon. Gallium-arsenide solar cells are more expensive to make than silicon cells, but they have demonstrated a much higher efficiency (26% vs. 22%).

Cadmium-sulfide photovoltaic generators have a maximum possible power conversion efficiency of only 16%. So far more than 9% has been achieved in the laboratory. While this isn't nearly as high as silicon or gallium arsenide, cadmium-sulfide cells are potentially *very* inexpensive. Some researchers predict a cost for such cells of only 10¢ to 30¢ per watt by 1990! One scientist has predicted a cost of 35¢ per watt as early as 1982. Should that happen, people can begin thinking seriously about deriving some of their household electrical power from sunlight.

Miniature Solar Cells. As noted earlier, solar cells are being used to power electronic watches and calculators. Surprisingly small cells can be employed, thanks to the ultra-low power consumption of the CMOS circuits used in these products. Actually, small cells *must* be used since the tiny NiCd batteries that power these products must be charged at very low current levels.

I learned about the latter point firsthand a few months ago after building a miniature (1" × 3") radiation detector. The detector is powered by a single 1.2-volt NiCd button cell, and I wanted to design a midget solar charger for it. Unfortunately, none of the solar cells in my limited benchstock were small enough to deliver less than the maximum allowable current to the cell!

Several companies make miniature solar cells and panels. Three new entries from Japan's Sharp Corporation are series-connected arrays designed to power watches with a liquid-crystal display. These tiny arrays contain 5, 6 or 8 cells and produce 1.5, 1.8 and 2.4 volts, respectively. The cells, which measure 2 × 5 mm, are slightly smaller than a 3-digit number on the reader's service card in this magazine. The cells are mounted on a thin Kapton film.

Probably the most interesting miniature solar-cell developed thus far was announced earlier this year by NASA. Conventional silicon solar cells must be soldered together in series to produce voltages higher than the 0.45 volt available from a single cell. NASA's new development, which is not yet available commercially, allows an array of series-connected cells to be formed on the surface of a monolithic silicon substrate.

In one version, the silicon substrate includes a sine-wave generator integrated adjacent to the solar-cell array to provide an ac output. Future uses for integrated circuits with on-chip solar-cell arrays include chips which are powered solely by light.

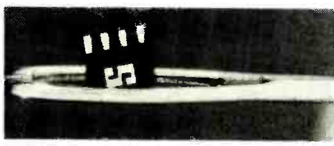
Super Capacitors. Two Japanese companies, NEC Electron and Panasonic, have announced a new kind of electrolytic capacitor with up to several-thousand times the capacity per unit volume of conventional electrolytics. Panasonic will soon be selling a complete line of 1-to-100-farad (that's farad, *not* microfarad!) capacitors small enough to fit on a pc board. Panasonic will be selling a line of "Supercaps" ranging from 0.1 to 1 farad.

There are some exciting applications for small capacitors with such huge capacities. Super long timing and power backup for CMOS memory chips are two possibilities.

Size? One of NEC's 0.47-F Supercaps comes in a squat cylinder about the diameter of a C cell and a fourth as long. I've not yet seen prices for these new capacitors, but they should be about the same as conventional electrolytics.

Midget ICs. Figure 3 shows a new IC package Signetics offers as an option for 13 of its standard analog chips. The new microminiature package is one-fourth the size of a standard 8-pin mini-DIP.

Fig. 3. Microminiature IC package now available from Signetics for thirteen of its analog chips.



The new package has exciting possibilities for circuit miniaturization. A bonus feature of its size is much better ac specifications than standard DIPs.

Are the new chips too small for experimenters to use? Based upon my experience with flat-pack ICs, I suspect a careful experimenter could solder these new chips to a pc board by using *reflow soldering*. This is a soldering method wherein solder is applied to both halves of a prospective connection. The two solder-coated terminals are then placed together (perhaps secured by a small clamp or with tape) and the connection is reheated. The solder on the two halves of the connection melts together to effect a sturdy bond. A magnifying lens and a soldering iron with a very small tip will be essential. ◊

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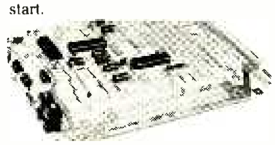

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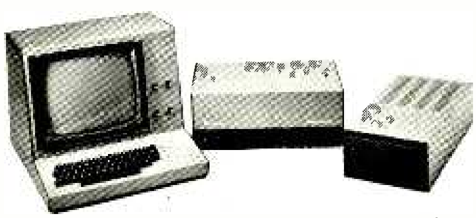

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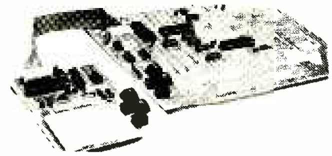

Level "A" With Hex Keypad/Display

LEVEL "A" SPECIFICATIONS

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

PC Board: Glass epoxy, plated through holes with solder mask. • **I/O:** Provisions for 25-pin (DB25) connector for terminal serial I/O, which can also support a paper tape reader . . . cassette tape recorder input and output . . . cassette tape control output . . . LED output indicator on SOD (serial output) line . . . printer interface (less drivers) . . . total of four 8-bit plus one 6-bit I/O ports. • **Crystal Frequency:** 6.144 MHz. • **Control Switches:** Reset and user (RST 7.5) interrupt . . . additional provisions for RST 5.5, 6.5 and TRAP interrupts onboard. • **Counter/Timer:** Programmable, 14-bit binary. • **System RAM:** 256 bytes located at F800, ideal for smaller systems and for use as an isolated stack area in expanded systems . . . RAM expandable to 64K via S-100 bus or 4k on motherboard.

System Monitor (Terminal Version): 2k bytes of deluxe system monitor ROM located at F000, leaving 0000 free for user RAM/ROM. Features include tape load with labeling . . . examine/change contents of memory . . . insert data . . . warm start . . . examine and change all registers . . . single step with register display at each break point, a debugging/training feature . . . go to execution address . . . move blocks of memory from one location to another . . . fill blocks of memory with a constant . . . display blocks of memory . . . automatic baud rate selection to 9600 baud . . . variable display line length control (1-255 characters/line) . . . channelized I/O monitor routine with 8-bit parallel output for high-speed printer . . . serial console in and console out channel so that monitor can communicate with I/O ports.

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

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

LEVEL "B" SPECIFICATIONS

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

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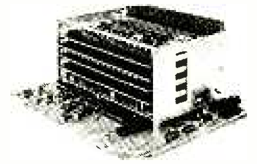
Level "C" expands Explorer/85's motherboard with a card cage, allowing you to plug up to six S-100 cards directly into the motherboard. Both cage and card are neatly contained inside Explorer's deluxe steel cabinet. Level "C" includes a sheet metal superstructure, a 5-card, gold plated S-100 extension PC board that plugs into the motherboard. Just add required number of S-100 connectors.



Explorer/85 With Level "C" Card Cage.

LEVEL "D" SPECIFICATIONS

Level "D" provides 4k of RAM, power supply regulation, filtering decoupling components and sockets to expand your Explorer/85 memory to 4k (plus the original 256 bytes located in the 8155A). The static RAM can be located anywhere from 0000 to EFFF in 4k blocks.

LEVEL "E" SPECIFICATIONS

Level "E" adds sockets for 8k of EPROM to use the popular Intel 2716 or the TI 2516. It includes all sockets, power supply regulator, heat sink, filtering and decoupling components. Sockets may also be used for 2k x 8 RAM IC's (allowing for up to 12k of onboard RAM).

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Hobby Scene Q&A

By John McVeigh, Technical Editor

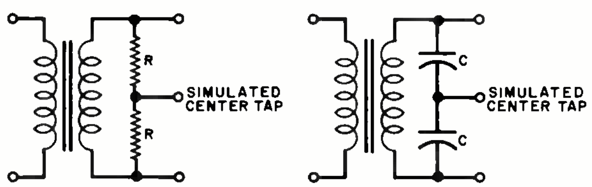
Video Bandwidth Limitations

Q. *I recently modified a solid-state, black-and-white television receiver for use as a terminal in a TRS-80 computer system. My problem is that the dots which comprise the displayed characters are smeared horizontally to such an extent that neighboring dots overlap. This slight overlap makes the horizontal portions of displayed characters too bright. Therefore, legibility is poor—even when the receiver's brightness and contrast controls have been adjusted for "optimal" performance. I applied the video signal from the computer interface to the base of the video amplifier. Removing the 4.5-MHz sound trap did not improve the situation. Any suggestions? —Dennis Kehoe, Flint, MI.*

A. It is obvious from a glance at one of the schematics you included with your letter that you consulted the *TV TYPEWRITER COOKBOOK* by Don Lancaster. I really can't offer you much advice that does not appear in Don's book. The major techniques for improving video resolution (which is to a large degree a function of video bandwidth) that Don suggests are careful adjustment of brightness and contrast controls (lowest possible brightness and contrast are best), removal of the sound trap, mini-

Adding a Center Tap Revisited

Q. *In reference to the item that appeared in the July 1980 Hobby Scene column, a center tap may be successfully obtained by simulation (no "surgery" required). The procedure involves placing two resistive or reactive components in series across the winding in question. Examples are shown in the accompanying figure. The choice of component types and their values are subject to several variables. Unfortunately, there has been little written on this specific technique, but available material on voltage dividers and*



dual-polarity power supplies can serve as a starting point in arriving at a suitable design for a specific application.

Resistors are probably the most frequently used components for this purpose and should be satisfactory in certain power and audio applications. Nonpolar, low series-inductance capacitors are acceptable for r-f work, as are high-Q inductors. If the impedances of the components employed are equal, the voltage drop across each of them will be half the total voltage induced across the secondary winding. This gives the simulated "center tap" the desired symmetry.

Some inefficiency is the price to be paid if this solution is adopted. Any center-tap current has to flow through (at any one time) one of the two devices forming the voltage divider. Also, the divider itself places a load on the transformer. In some applications, these effects are acceptable, and the cost of a center-tapped transformer can be avoided if necessary. —Norman M. Monro, Gadsden, AL.

A. Thanks for your suggestions. (Thanks also to readers Harford R. Post, H. Johnson, Hal Knippenberg, and H.L. McFann for similar responses.) I was aware of this technique, and have employed it in op-amp and r-f applications. I did not mention it because I inferred that the intended use was in a relatively high-current, bipolar or full-wave dc supply. In that case, the inefficiency introduced by the resistors would most probably be unacceptable. However, I stand by my original answer. I know of no way of *adding* a center tap to the secondary of an existing transformer without rewinding it. The technique described by Mr. Monro and the other readers who were kind enough to write in *effectively* center-taps a transformer or *simulates* the addition of a center tap—but it doesn't add a *true* center tap, and cannot be used in every application.

mizing stray capacitance, adding more peaking, and "running hot" by increasing the operating current of the video output stage.

Having already eliminated the sound trap and adjusted the brightness and contrast controls for best performance, you must look into the other approaches. Stray capacitances can be suppressed by keeping all video-signal-carrying leads as short as possible. If the video output stage is the bandwidth-limiting factor, it will sometimes respond to increasing its operating current. Before doing this, make sure that the stage can dissipate the additional amount of heat and handle the extra current, that the power supply can cope with the increased demand to be placed on it, and that the video-output stage is not already operating at its gain-bandwidth peak.

In all probability, adding additional peaking will make matters worse. As Don says . . . *Generally, too little peaking will give you low-contrast dots; too much will give you sharp dots but will run dots together and shift the more continuous portions of the characters objectionably. Peaking is changed by increasing or decreasing the series inductor* (peaking coil) *from its design value.* If the peaking is excessive, the circuit might "ring." This can cause smearing of the trailing edges of the dots.

Solving the TV "Whistle" Problem

In our February, 1980 column, reader Jon Dattorro asked if we knew the possible source of a high-frequency "whistle" coming from his TV receiver. We replied that the noise was probably due to magnetostriction in the horizontal output transformer and that there was not a very satisfactory solution. However, we have received some letters since then with hints that may be helpful. Here are two suggestions.

Frank J. Burris, Fallbrook, CA, says that any open mounting supports on the flyback transformer should be examined, and frame holding screws tightly secured. A piece of electrical tape can be inserted between the doped lamination bundles (does not apply to molded powered-iron cores) and the frame elements. Small wooden wedges (toothpicks?) can be slipped between the winding core and the laminations. This tightens up the laminations that usually produce the 15-kHz audio noise.

Jim Gieseke, Garden City Park, NY, suggests the use of liberal coats of "corona dope" to the laminations of the transformer to hold them together.

Thanks to those readers who took the time to send me their tips.

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.

Experimenter's Corner

By Forrest M. Mims

More On Shift Registers

IN LAST month's column, we introduced the shift register as one of the most versatile of all digital-logic circuits. Shift-register operation and several shift-register applications were then covered. This month, we'll complete our discussion of shift registers by examining some specific chips and experimenting with some application circuits we think you'll enjoy.

Integrated Shift Registers. As we mentioned last month, you can custom-design a shift register by using any number of cascaded flip-flops. Fortunately, this procedure is rarely necessary. Semiconductor companies have designed and manufactured in integrated form most of the popular shift-register configurations.

Many different TTL and MOS shift registers are available, often for very reasonable prices. Even if you don't have immediate plans for incorporating one or more shift registers in a project of your own design, you'll be far better prepared to tackle a future project if you're aware of some of the chips that are now available.

TABLE I—TTL SHIFT REGISTERS

Type	Function	Bits	Freq. (MHz)	Shift Right	Shift Left	Load	Hold
7491	SISO	8	10	Yes	No	No	No
7494	SISO	4	10	Yes	No	Yes	No
7495	PIPO	4	36	Yes	No	Yes	No
7496	PIPO	5	10	Yes	No	Yes	No
74L99	PIPO	4	3	Yes	No	Yes	No
74164	SIPO	8	25	Yes	No	No	No
74165	PISO	8	25	Yes	No	Yes	Yes
74166	PISO	8	20	Yes	No	Yes	Yes
74178	PIPO	4	25	Yes	No	Yes	Yes
74179	PIPO	4	25	Yes	No	Yes	Yes
74194	B/PIPO	4	25	Yes	Yes	Yes	Yes
74195	PIPO	4	30	Yes	No	Yes	No
74198	B/PIPO	8	25	Yes	Yes	Yes	Yes
74199	PIPO	8	25	Yes	No	Yes	Yes
74LS295	PIPO	4	25	Yes	No	Yes	No
74LS299	B/PIPO	8	35	Yes	Yes	Yes	Yes
74LS323	B/PIPO	8	35	Yes	Yes	Yes	Yes
74LS395	PIPO	4	25	Yes	No	Yes	No

TABLE II—CMOS SHIFT REGISTERS

Type	Function	Bits	Freq. (MHz)	Shift Right	Shift Left	Load	Hold
4006	SISO	18	10	Yes	No	No	No
4014	PISO	8	5	Yes	No	Yes	No
4015	SIPO	8	9	Yes	No	No	No
4021	PISO	8	5	Yes	No	Yes	No
4031	SISO	64	8	Yes	No	No	No
4034	B/PIPO	8	10	Yes	Yes	Yes	Yes
4035	PIPO	4	5	Yes	No	Yes	No
4094	SIPO	8	5	Yes	No	No	Yes
40100	B/SISO	32	3	Yes	Yes	No	Yes
40104	B/PIPO	4	9	Yes	Yes	Yes	No
40194	B/PIPO	4	9	Yes	Yes	Yes	Yes

Tables I and II list most of the TTL and CMOS shift registers available to experimenters. These tables, which were compiled from Motorola, National, RCA and Texas Instruments data books, list only some of the more important shift register parameters. Also, some specifications (such as maximum clock frequency) can vary somewhat within the same chip type if different manufacturers are involved. Therefore, you should check the specifications provided by the manufacturer of the chip you are thinking of using in a project for more specific information.

Here is a brief explanation of the table headings:

Function. The function of each shift register is identified by a four- or five-letter code. S means serial, P parallel, I in, O out, and B bidirectional. Therefore, a shift register listed as B/PIPO can provide bidirectional, parallel-in/parallel-out operation. Incidentally, many of the shift registers listed in the tables will provide more than one operating function. Most PIPO registers, for instance, also provide SISO operation.

Bits. This parameter specifies the number of register elements in the listed device.

Frequency. The maximum shift (clock) frequency is given. Frequency specifications for CMOS shift registers vary with both the V_{DD} supply voltage and the manufacturer. Consult the manufacturer's literature for the specific operating frequencies for a given chip.

Modes. Four operating modes are given. Those whose functions are obvious are *shift left* and *shift right*. *Load* is normally found on parallel-input shift registers. Depending upon the status of the load input, upon receipt of the next clock pulse, the register will either ignore or accept the data present at its input(s). *Hold* means that the clock input can be inhibited or disabled so that the shift register will store its contents like a memory register.

Several other operating modes not listed in the tables may also be available. *Preset* or *clear* enables all the register elements to be cleared to logic 0. *Recirculate* causes the data at the output of a shift register to be cycled back to the input.

Exotic Shift Registers. Several kinds of elaborate integrated shift registers are available for such serial-memory applications as refreshing cathode-ray tube traces and storing characters to be printed by high-speed printers. A typical example is Synertek's SY1404A 1024-bit MOS dynamic shift register. This family also includes a dual 512-bit register (SY1403A) and quad 256-bit register (SY1402A). The maximum clock rate for these chips is a relatively slow 2.5 MHz, but by means of a multiplexing technique, data can be accepted at a 5-MHz rate. Even more capability is provided by 2048-bit shift registers such as the SY2401 and SY2827.

Bubble memories and charge-coupled devices (CCDs) are among the most exotic shift registers available. Bubble-memory capacity can exceed a *million bits per chip*, making this exotic register a strong contender in the search for a solid-state replacement for the disk memory.

Application Circuits. Now let's try experimenting with some readily available shift registers to see how they work and what they can do. The circuits that follow use both CMOS and TTL shift registers. Once you see how easy it is to use

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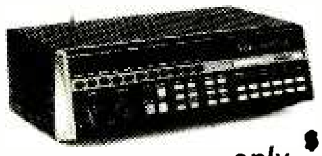

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these various chips, you'll want to consider experimenting with other shift registers as well.

Pseudorandom Sequencer. Figure 1 is the schematic of a pseudorandom generator whose operation is patterned after the S2688/MM5837 shift-register noise generator that was described in the March 1980 installment of this column. The circuit consists of two 8-bit 4021 CMOS shift registers (*IC2* and *IC4*) cascaded to form a single 16-bit register.

The 4021 is a PISO register with the bonus feature that the outputs of the 6th, 7th and 8th stages are available. This means it can be used as a 6-, 7- or 8-bit shift register and makes possible the pseudorandom sequencer circuit. Such a circuit requires that the outputs of two stages in a shift register be coupled back to the input via an exclusive-OR gate.

By connecting the exclusive-OR gate's inputs to the final two outputs of the shift register, the sequencer will generate a pseudorandom sequence that recycles after 255 clock pulses. The bit pattern within a single 255-bit cycle is essentially random, but the periodic recycling of the pattern compromises its randomness over the long term.

V_{DD} or V_{SS} to set up any desired sequence of logic 0's and 1's. Then toggle *S1* from RUN to INITIATE and then back to RUN to load the PARALLEL DATA inputs. Repeat this procedure as desired to create many different bit sequences.

Incidentally, if you intend to use this circuit for commercial purposes, you should first write the U.S. Patent and Trademark Office (2021 Jefferson Davis Highway, Arlington, VA 22202) and request a copy of U.S. Patent 4,191.175. The fee for a single copy of a patent is 50¢. I've not yet seen this patent myself. However, after the March 1980 "Experimenter's Corner" appeared, William L. Nagle, president of Paratronic Systems, Inc. (Honeybrook, PA 91344) wrote to this magazine that, ". . . your readers should be cautioned that use of this for any other than private purposes would be an infringement of the patent our company holds for such devices and their applications." The complete letter was reproduced in the *Letters* column of the July 1980 issue.

I am interested in seeing this patent because its number indicates an issuance date late in 1979. Publications describing pseudorandom sequence generators date back to at least 1973 when Fairchild Semiconductor's *The TTL Applications Handbook* (a truly outstanding book) described two such sequencers on pages 8 through 21.

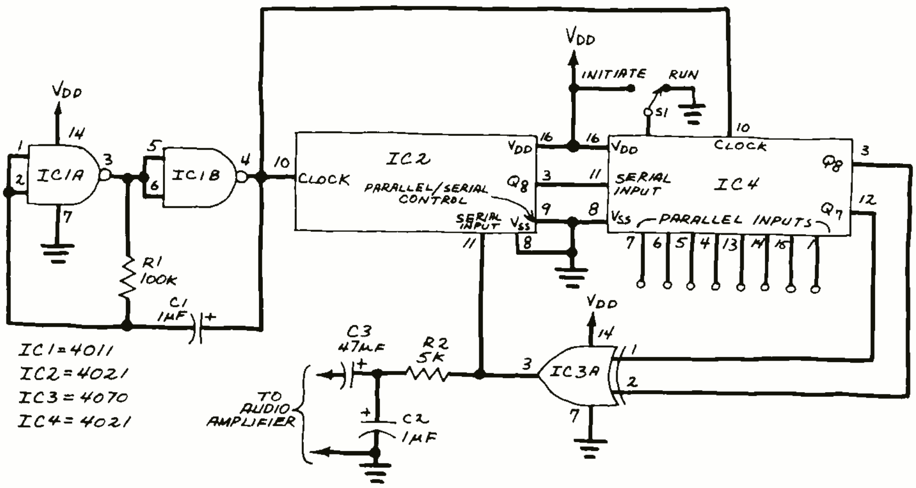

Fig. 1. Schematic diagram of a pseudo-random sequencer made from CMOS shift registers.

Two of the gates in *IC1* form a simple clock for this circuit. This is a CMOS chip, so be sure to connect the unused inputs (pins 8, 9, 12 and 13) to V_{DD} or V_{SS} to keep the chip from drawing excess current and overheating. You should also connect the unused inputs of *IC3* (pins 5, 6, 8, 9, 12 and 13) to either V_{DD} or V_{SS}.

This circuit has several useful applications. Connect its output to an audio amplifier through the low-pass filter composed of *R2* and *C2* to convert the pseudorandom bit pattern into audible noise. For best results, speed up the clock by reducing the value of *C1* to 0.01 µF or so. At very fast clock speeds, the output will sound like a pure tone. At slower frequencies, the repetitious pattern present in the output signal can be heard.

An interesting LED flasher can be made by connecting the output of the circuit to the cathode of a LED whose anode is connected to V_{DD} through a 1000-ohm series resistor. Slow the clock rate to a few hertz by increasing the value of *C1* to 10 µF or so. The LED will then flash on and off in an irregular, seemingly random pattern. This LED-flasher application illustrates how the circuit can be used to strobe (actuate) another circuit at a pseudorandom rate.

As you alter the clock rate or change the connections to the shift registers, the pseudorandom sequence generator might shut down. Make sure the clock is working by monitoring its output with an audio amplifier and loudspeaker (a tone should be heard) or with an oscilloscope (a square wave should be displayed). If the clock is running, try resetting each shift register by switching its pin 9 (the PARALLEL/SERIAL CONTROL input) from V_{SS} to V_{DD} and then back to V_{SS}. The circuit should then resume normal operation.

You can control the pattern of bits moving through the shift registers. Connect the PARALLEL DATA inputs of *IC4* to

Incidentally, one of the Fairchild circuits employed one 4-bit and seven 8-bit shift registers to generate a truly *long*, nonrepetitive output bit sequence. According to the descriptive text, ". . . even at a frequency of 20-million states per second the counter would not repeat until more than 18 centuries had elapsed." (!) For more information about pseudorandom sequencers, see Don Lancaster's indispensable *CMOS Cookbook* (Howard Sams & Co., 1977). Don discusses the topic and presents two circuits on pages 318 through 323.

Pseudorandom Voltage Generator. Connect a suitable resistive ladder network to the outputs of a SIPO or PIPO shift register set up as a pseudorandom sequencer and you get a pseudorandom voltage generator. The resistor network serves as a digital-to-analog converter.

Figure 2 shows such a circuit designed around a 74164 or 74LS164 SIPO 8-bit shift register. The four NAND gates (*IC2A* through *IC2D*) form an exclusive-OR gate. You can substitute one-fourth of a 7486 quad exclusive-OR gate in the circuit if you prefer.

Use a 555 timer IC connected as an astable oscillator like the one shown in Fig. 3 to provide clock pulses for the circuit. The amplitude of the pseudorandom, stepped output voltage can be changed by connecting pin 2 of *IC2A* to any of the six other output pins of *IC1*.

An interesting application for this circuit is a pseudorandom tone sequencer that can be made by connecting its output to the control input of a voltage-controlled oscillator or voltage-to-frequency converter. One suitable vco is the 4046, a chip that was highlighted in "Experimenter's Corner" for July and August 1980. Suitable V/F converters include the

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9400 and LM331—see "Experimenter's Corner," for October 1979 for details.

8-Bit Serial-to-Parallel Data Converter. Here's a circuit that you can use to load serial data onto an 8-bit data bus. Referring to Fig. 4, clock pulses are applied simultaneously to counter *IC1* and shift register *IC3*. The data to be loaded on the bus should be applied at the clock rate to the serial input of the shift register.

The 7490 (*IC1*) is configured as a divide-by-eight counter. It generates a load pulse that causes *IC2*, a 74LS374 octal D flip-flop, to accept the data appearing at the parallel outputs of shift register *IC3*.

Summarizing, after 8 bits have been loaded into the shift register, a pulse from the counter causes the data to be transferred to the octal flip-flop. The flip-flop is updated with new data from the register after eight additional clock pulses.

You can use the 555 oscillator shown schematically in Fig. 3 as a clock circuit for the data converter. If you want to experiment with the circuit as I did when working with the prototype, connect the cathode of a LED to each output pin of *IC2*. Connect the anodes of the LEDs to 1000-ohm resistors which are in turn connected to +5 volts. You can use smaller resistance values (as small as 270 ohms) for the current-limiting resistors if you want the LEDs to glow brighter. I prefer 1000 ohms to keep current consumption down to 2 or 3 milliamperes per LED.

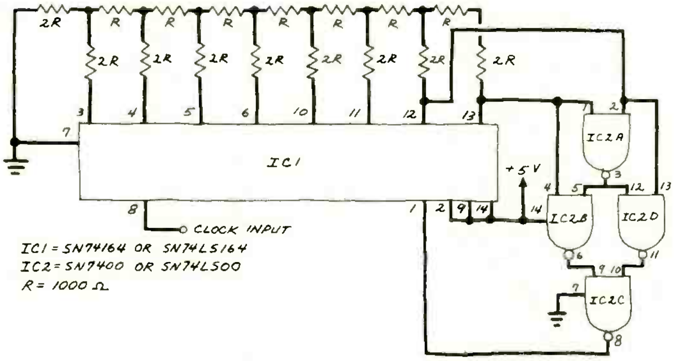


Fig. 2. Schematic of a pseudo-random voltage generator.

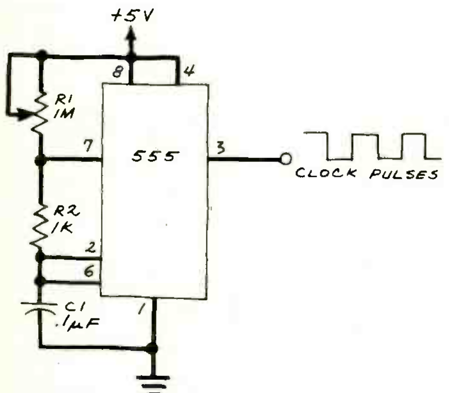


Fig. 3. A 555 clock pulse generator.

An additional LED and series resistor connected between pin 8 of *IC1* and ground will allow you to monitor the status of the shift register. You can then manually test the circuit by slowing down the clock to about one pulse per second and applying input data bits to pin 1 of *IC3*.

This circuit can be used as the receiving portion of a digital data-transmission system. A good design exercise would be to devise a suitable transmitter for converting 8-bit bytes into a serial bit stream. Hint—use a PISO shift register and a divide-by-8 counter.

Programmable Sequence Generator. Figure 5 schematically shows an 8-bit programmable sequence generator made from two series-connected 74194 shift registers (*IC1* and *IC2*). In operation, any desired bit pattern is first selected by means of switches *S1* through *S8*. A normally closed push-button switch, *S9*, is momentarily opened to load the selected bit pattern into the two shift registers. When clock signals are applied simultaneously to pin 11 of both shift registers, the bit pattern will be shifted one position for each clock pulse. Because the serial output of the second shift register (pin 12 of *IC2*) is connected to the serial input of the first shift register (pin 2 of *IC1*), so long as the clock pulses are received the bit pattern will recirculate through the registers. It will remain unchanged until it is modified by means of the data-select and load switches.

Use the oscillator shown in Fig. 3 to generate clock pulses for this circuit. The output LEDs shown in Fig. 5 are optional, but including them allows the circuit to double as an attention-getting programmable light flasher. The LEDs can be arranged in various patterns to enhance the effect.

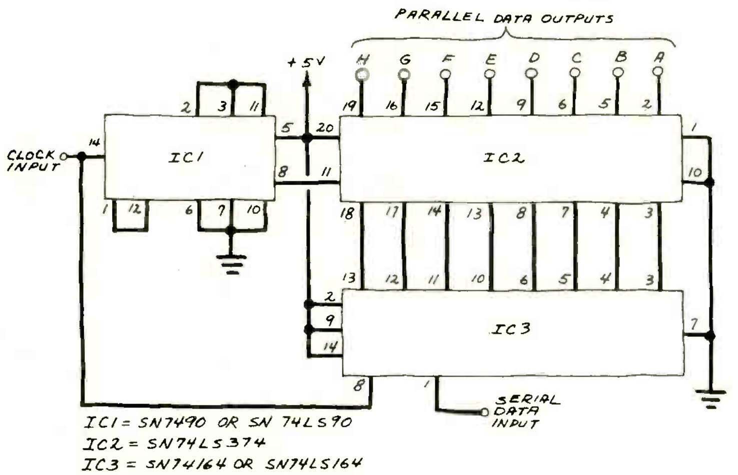


Fig. 4. Schematic of an 8-bit serial-to-parallel data converter.

A more practical application can be accomplished by connecting a resistor ladder network (see Fig. 2) to the outputs of the shift registers. The circuit then will function as a programmable waveform generator. Without the ladder network, the circuit can be used to strobe various circuits in any programmed sequence. More shift registers can be added for even longer sequences.

If you build this circuit, be sure to include the 0.1-μF power-supply decoupling capacitors. Without these capacitors, the shift registers will be affected by power-supply transients that can arise during the switching sequence. A typical effect of such a transient is an unwanted change in the sequence.

stage goes low, the bit resulting from the gating of the first and last bits is a logic 0.

Because this bit is fed back to the input of the first register (pin 2 of *IC1*), it might at first glance appear that all of the register outputs would remain at logic 0 after the first cycle of clock pulses. Note, however, that the output of gate *IC3C* is connected to pin 10 of both registers. When the output of this gate is logic 0, the shift registers ignore the data presented to their parallel inputs. When its output switches to logic 1, the shift registers load the data present at their inputs. This, of course, is what occurs when the ENABLE INPUT is brought to logic 0 to start the circuit.

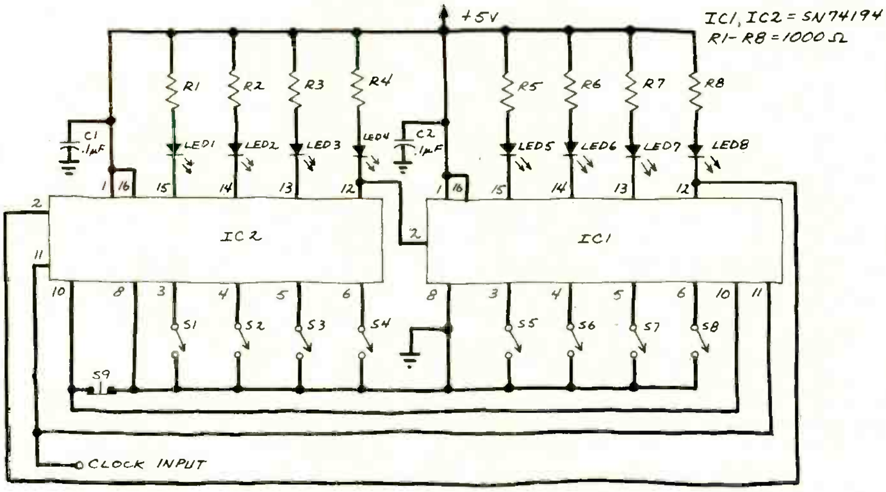


Fig. 5. A shift-register 8-bit programmable sequence generator.

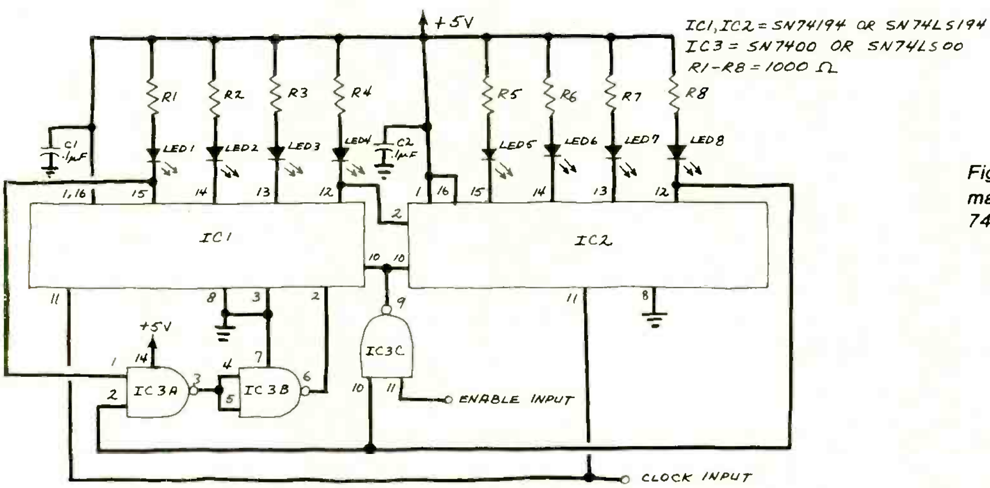


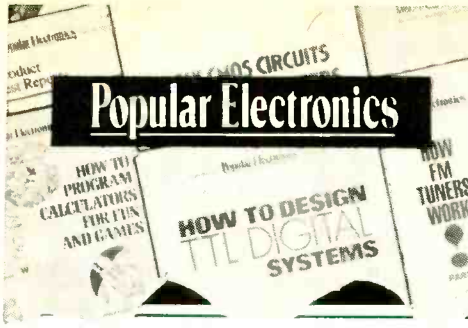
Fig. 6. A bargraph generator made from a pair of 74194 shift registers

Bargraph Generator. Figure 6 is the schematic diagram of an unusual bargraph generator made from a pair of 74194 shift registers. In operation, the circuit's ENABLE INPUT is brought momentarily to logic 0 to start the circuit. This causes seven of the eight bit positions to be loaded with logic 1's, because their inputs are left unconnected and therefore assume a high state. The output of the first stage of *IC1* goes to logic 0 because its input (pin 3) is grounded.

The bits in the first and last stages, logic 0 and logic 1, respectively, are combined in AND fashion by *IC3A* and *IC3B*. The result is presented to the serial input of the first shift register. On the first clock pulse, therefore, the outputs of the first two positions go to logic 0 while all of the other outputs stay at logic 1. This pattern continues as subsequent clock pulses are received until each of the shift-register outputs switches in turn from logic 1 to logic 0. When the final

This circuit has such practical applications as strobing various external circuits in a sequential fashion. It also makes a very interesting visual display.

Going Further. Shift registers are ideally suited for experimentation. The bargraph generator shown in Fig. 6 is a good example of this. I began with the remnants of the circuit in Fig. 5 (the input switches were removed) and tinkered with the basic circuit by adding a single 7400 quad NAND gate IC. Within a few minutes, the bargraph effect was achieved. You can do the same kind of experimentation on your own by selecting different register outputs to be connected to NAND gate *IC3A* in Fig. 6. You can also try adding additional stages for more complex effects. The cost of integrated shift registers is very reasonable, and you'll learn a good deal about these very versatile logic circuits by experimenting with them. ◇



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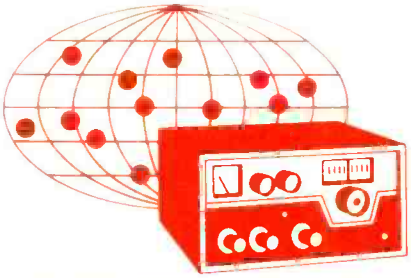


DX Listening

By Glenn Hauser

Business Programs

DX LISTENERS can keep up with worldwide economic developments through financial, economic and business programs on certain stations. Here is a selected listing of such programs. All times and days are GMT.

AFRTS-Washington conveniently groups six different U.S. network business reports into a 25-minute block, Tuesday-Saturday at 0035, repeated at 0435 (times one hour earlier until Oct. 27). Among the frequencies are 21570 and 6030 kHz.

Radio Australia has a "Business Report" Monday-Friday at 0820 on 15115, 11740, 9570, repeated at 1220 on 9580, and also every two hours through 2220 when *R. Australia* is more difficult to pick up here. There's also "Week in Business," Saturdays at 0212 on 21740 and 17795 and 0810 on the same frequencies as above.

BBC World Service excels in this programming area, as in so many others. "Stock Market Report" is Monday-Friday (except bank holidays, which also affect some of the programs below), at 1939-1943; try 15070 and 12095. "Financial News" is Monday-Friday 2230-2239 on 15260, 15070, and 9410; repeated at 0445 on 9510, 9410, and 6175.

BBC also has two weekly business programs: "Financial Review," Sundays at 0445 to 0454 on 9510, 9410, and 6175, repeated at 1709 on 17830 and 15260. And the half hour show, 'Business Matters', Thursdays 1130 on 11775, 11750, 9740, 9510, and 6195; 2130 on 15420, 15260, and 15070; and Fridays 0330 on 9410, 6175, and 5975.

Canada's "As It Happens" newsmagazine once included a Tuesday segment called "Easy Money," and may still do so, sometime between 2330 and 0100 on 5960 (one hour earlier until Oct. 27).

South Africa: *Radio RSA* has business programs at these approximate times: "Business Front," Mondays 1130 on 25790, 21535, and 15220; 2135 on 21535; Tuesdays 0235 on 11900 and 9585. "Economic News" is Monday-Friday at 1245 on 25790, 21535, and 15220. "Economic Review," Saturdays 0410 on 11900; 9585, and 5980; 2110 on 21535 and Sundays 0210 on 11900 and 9585.

South Africa also has a Monday-Friday "Market and Meat Prices" on its domestic services at 1607, last reported on 4880, though not likely to be heard in North America. But keep it in mind if you're further east.

Austria. Thursday broadcasts of ORF's "Report from Austria" include a segment on the Austrian economy—0130 and 0330 on 9770 and 5945; 0430 on 12015; 1230 on 21655.

All the programs mentioned so far are in English, but for business programs from two other countries we of necessity go to their native languages. **France** has a "Bourse" spot Monday-Friday 1158-1200 and 1705 on 21645, 21595 and 17775 and at 1820 on 21620, 21580, 21515, 17720, as well as many other frequencies.

West Germany's *Deutsche Welle* has a Monday-Friday stock market quotation report ("Börsenkurse") at about 2255 on 15410, 9735, repeated at 0255 on 9735, 6145 and others.

Country by Country

Anguilla. This tiny Caribbean island may gain a shortwave voice if an American gospel broadcasting organization follows through on plans to establish "The Caribbean Beacon" here.

Austria. *ORF* is working to upgrade its signal into North America by 1982, with a new 250-300-kW transmitter and two new antennas (a fixed but slewable curtain, and a "turntable" antenna).

Costa Rica. Radio Noticias del Continente survived a challenge about irregularities in its licensing. The government of Argentina and other Latin American military-led administrations have brought pressure against Costa Rica for allowing this private left-wing voice to be heard (almost 24 hours a day on 9615). One solution proposed was to let it continue broadcasting, but cut its power from 50 kW to one kW so it could no longer be heard well in Argentina.

Cuba. Though a country which is (barely) in the tropics, post-revolutionary Cuba has never used the tropical bands deliberately (though its prolific mediumwave harmonics fall in this area). One pre-revolutionary station, *COCW*, had a frequency of 5045 kHz. More than twenty years later *Radio Moscow World Service* and *The Voice of Cuba* were heard testing on that frequency between 1000 and 1100 GMT—seemingly with a transmitter much more powerful than the one kilowatt listed for COCW.

Meanwhile, the growing Cuban population in Florida has led to an increase in clandestine broadcasting, headed by *La Voz de la Junta Patriotica Cubana*, heard most evenings on 7400.

A Hialeah man accused of broadcasting illegally as "Comandante David" was busted by the FCC in July.

Ecuador. *HCJB* may be middle-of-the-road in its gospel outlook, but it's extremist in broadcast power. A nominally 100-watt experiment on 26020 kHz may be dropped to only 10 watts; on the other hand, its homemade 500,000-watt transmitter, under construction for several years in Elkhart, Indiana, has been installed in Ecuador and should be testing on the air now. Meanwhile, another faith is on the air from Ecuador—Radio Baha'i, on 2340 kHz during the daytime. We'll have to wait for its projected morning and evening broadcasts on 60 meters in order to hear them.

France. *Radio France Internationale* continues to ignore its great potential audience in North America, as it announces plans to begin using new relay facilities in Gabon, French Guiana and Morocco to improve reception in Africa and Latin America.

Guatemala. The *V. of Guatemala*, 6180 kHz, has begun a brief English feature, "Guate-Scope," heard at varying times late at night.

Iran. Besides the Soviet-based *National Voice of Iran*, which has been on the air for many years from Baku, three other anti-Khomeini clandestine radio stations went on the air this year. A report in the *Financial Times* placed *The Free Voice of Iran* in Baghdad on behalf of Gen. Gholam Ali Oveissi; *Radio Iran* in Basra, Iraq on behalf of former prime minister Shapur Bakhtiar; and *Radio Homeland* in Cairo, connected with supporters of the late shah. The last station is also tied in with *Radio of the Mujaheddin* (Islamic guerrillas) *of Afghanistan*. Frequencies for these often change. *Radio Homeland* may still be on 15555 kHz at 1705 to 1800.

Ireland. *R. Condor* is testing for North America during October at 0600 to 0800 on 6243 kHz; in November, the time will change to 0700 to 0900 and 11463 kHz will be added.

Korea, North. *Radio Pyongyang* has a well-deserved reputation for far-out broadcasting, both in program content and frequency choice far outside the designated bands (such as 9977 kHz). But now, a great many frequencies inside the SWBC bands have been registered by North Korea with the ITU. Few of them so far have actually been heard, so this may just be for the sake of appearances.

Mexico. Super-power border station *XERF*, 1570 kHz, is now carrying "The Mexican Hour" in English, GMT Mondays, at 0400. A new station, *XEVJ*, in Linares, N. L., 5980 kHz, has been advertising in a Monterrey newspaper.

Nicaragua. Clandestine radio played a major role in the victory of the Sandinistas. Last May, the tables were turned with the appearance on 6015 kHz of "FESGA"—the *Voice of the Special Forces of Anti-Communist Guerrillas*, possibly a mythical organization. Embarrassed Honduran authorities quickly located the station in San Pedro Sula and supposedly closed it down. Press reports said it was transmitted from *Radio Swan*, which in the past had operated as an anti-communist outlet.

Papua New Guinea. Night owls should check 9520 kHz after 0600 GMT for sporadic broadcasts from *NBC*, and on special occasions, 9575 kHz.

Portugal has an external service of its own, and serves as a relay site for several other countries and religious broadcasters. Now, the Lisbon Catholic station, *Radio Renascença*, is adding shortwave, perhaps by the end of the year, to reach expatriates.

Solomon Islands. Like Papua New Guinea, this country operates irregularly on the 31-meter band after 0600 GMT. Try 9545 kHz, and if you don't hear them there, 5020.

Surinam. *Radio Apintie*, a tiny commercial station, put a 50-watt shortwave transmitter on 4795 kHz in order to reach remote regions of that country. Surprisingly enough, the station was heard elsewhere, including Holland, where many Surinamese live. Now *Radio Apintie* plans to go about international broadcasting in a big way, with a ten-fold power increase to a hefty 500 watts. The frequency may have changed to 4950.

Sweden. *Radio Sweden* acquired some 500-kilowatt transmitters a few years ago, but was chagrined to learn that its antennas would handle no more than 350 kW. Six new curtain antennas are under construction at Hörby now, so the station should soon be able to put a stronger signal into North America.

U.S.A. With unrest in the Philippines, the *Voice of America* has been investigating other countries for shortwave relay stations. Among the possibilities are Darwin and North West Cape, Australia; and U.S. territory in Guam, Hawaii, and the Aleutian Islands.

U.S.S.R. *Radio Moscow* uses a great many sites throughout the country, but either through incompetence or for security reasons, the sites it acknowledges seldom correspond to sites determined by other evidence. In his USSR *High-Frequency Broadcast Newsletter*, Roger Legge reports on a study by Douglas Johnson and Olle Alm of "Operational Navigation Charts" issued by the U.S. National Ocean Survey, which show where broadcasting towers are located in the U.S.S.R. An 18-transmitter complex, previously believed to be near Zhigulevsk, was determined to be near Kuybyshev instead. Ten transmitters at "Armavir" are actually near Krasnodar. Four transmitters designated as at "Orsha" are actually at Moghilev. Frunze, listed as a site, does not have any suitable towers. Five 500-kW transmitters are at Nikolayev in the Ukraine, not at other sites in that S.S.R. However, sites in Alma Ata, Dushanbé and Tashkent were confirmed.

Vanuatu. The independence controversy here produced some interesting listening. *Radio Vanuatu*, on 7260 could be heard with English news at 0830 GMT, and live coverage of independence ceremonies at the end of July. The breakaway group on Espiritu Santo, led by Jimmy Stevens, revived its broadcasting station, but on a new name and new frequency: *Radio Vemarana*, on 3522 and 3576 kHz, broadcasting in the 0730-1130 GMT period for several weeks before and after independence..

Information Sheet. We'll be glad to send you a listing of many other sources of information about shortwave and DX listening if you send a self-addressed stamped envelope to: Glenn Hauser, University Radio WUOT, Knoxville, TN 37916. ◊

Tips & Techniques

Low-Cost Crystal Oven

When a stable frequency source is needed, an oscillator designed around a quartz crystal is the logical choice. There are some applications, however, in which a standard quartz crystal oscillator is simply not stable enough. The principal problem in such a situation—say, the timebase of an accurate frequency counter—is that changes in ambient temperature cause small variations in the dimensions of the crystal and hence frequency drift.

One way to reduce thermally caused drift is to keep the temperature in the vicinity of the crystal as constant as possible. This can be done by means of a *crystal oven*, a small, temperature-controlled environment in which a piezoelectric crystal can be kept for maximum stability. In this article, we shall describe a simple crystal oven that can be built from a handful of low-cost components. It's very possible that you have all of the components in your junk box, which will reduce the effective cost of the oven to zero. Because the oven's circuit is simple and uses readily available parts, it provides an especially attractive way to enhance the stability of a planned or existing crystal oscillator.

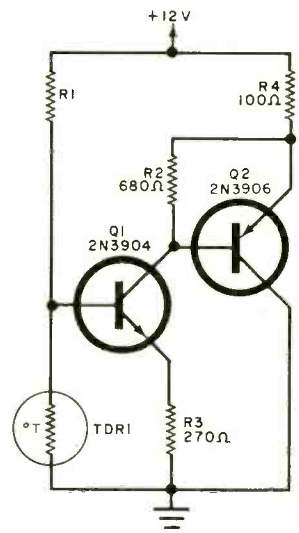
A schematic diagram of the crystal oven circuit appears in the figure. The heart of the circuit is *TDR1*, a negative-coefficient thermistor (temperature-dependent resistor) chosen so that its resistance is approximately 1000 ohms at room temperature. This thermistor, together with resistor *R1*, form a voltage divider which supplies base drive to *Q1*.

When power is first applied to the circuit, the resistance of *TDR1* is approximately 1000 ohms. Transistor *Q1* is approximately 1000 ohms. Transistor *Q1* begins to conduct and sinks base current for *Q2*. As these transistors conduct, they dissipate heat which is coupled to the crystal and to *TDR1*. This warms up the thermistor, causing its resistance to decrease. The decrease in thermistor resistance results in the application of less base current to *Q1* and hence to *Q2*. With less collector current flowing through the transistors, less heat is generated, causing increases in its resistance and base current through *Q1*.

The process continues in this manner, with *TDR1* acting as a thermostat and the transistors as heating elements. Once equilibrium is espablished, temperatures of the crystal and the thermistor remain at fairly constant values. Heat is generated by the transistors and coupled to the crystal and thermistor as needed to make up for radiated energy.

The circuit of the Low-Cost Crystal Oven is very simple, so it can be easily assembled using point-to-oint wiring techniques. The author's prototype was assembled by cutting a small strip of copper flashing so that its short dimension equalled the height of the crystal case. The transistors have TO-92 plastic packages with one flat side. The author affixed the flat side of each transistor case to the copper strip using epoxy cement. He also epoxied *TDR1* to the strip.

Next, silicone thermal compound was applied to the crystal case and tightly wrapped the copper strip around it. He temporarily held the strip in place with a large alligator clip and soldered the point where one end of the strip overlapped the other. using a small soldering pencil, he made the necessary connections between the transistors, resistors, thermistor and power supply. Finally, he took a small block of styrofoam and cut out a slot in it so that the crystal/oven-circuit assembly could be slid into the slot. The styrofoam is a good insulator and helps stabilize the crystal temperature once power has been applied to the oven circuit.



Any one of several thermistors can be used for *TDR1*, as the choice of a specific component is not critical. In general, the device should be a small glass-bead or glass-probe type with a negative temperature coefficient and a resistance at room temperature approximately equal to 1000 ohms. The value of the other member of the voltage divider, *R1*, is not shown in the schematic. It is intentionally omitted because the exact value depends on both the thermistor employed and the temperature at which the crystal is to be kept. A good ballpark figure is 10,000 ohms. Substituting the series combination of a 1000-ohm fixed resistor and a 10,000-ohm or 25,000-ohm potentiometer for *R1* allows adjustment of the oven circuit for best performance.

An AT-cut crystal has, in its normal range of ambient temperature, a negative temperature coefficient. That is, as temperature increases, the frequency of oscillation decreases. At higher ambient temperatures (usually between 70 and 75° C), the oscillating frequency stops decreasing and is about to start increasing. This is the *turning point* of the crystal. Commercial ovens are often adjusted to keep the crystal at its turning point. This is done by allowng the oscillator to run for a while and then sampling its output in such a way as to disturb the operation of the circuit as little as possible. The sample is then measured using a very accurate frequency counter and the oven's temperature control adjusted so that the oscillator is at its lowest operating frequency.

You can follow this approach to the adjustment of the potentiometer if that component is included in the oven circuit. However, if you don't want to bring the crystal up to its turning point, you'll find that the oven still enhances the stability of the oscillator over what it would be if the ambient temperature of the crystal was not controlled.

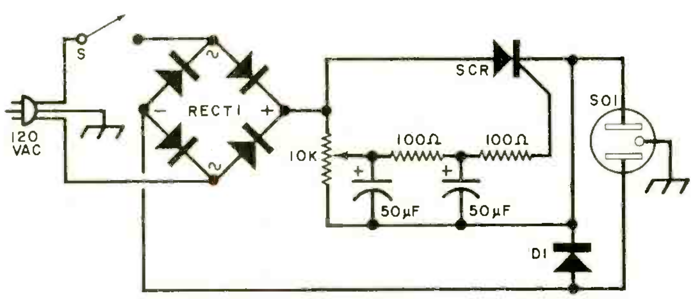
The most common application for the crystal oven is the stabilization of an oscillator in an existing piece of equipment. Thanks to its compact size, the finished oven will fit easily inside just about any existing equipment enclosure, such as one housing a frequency counter, receiver or transceiver. If the equipment employs more than one crystal whose oscillating frequency is critical, several ovens can be built. Each one could be fitted over a given crystal and then the crystal returned to its socket.

The operating voltage for the oven circuit should be regulated and can usually be furnished by the host components power supply. An operating voltage other than the 12 volts specified can be used, but some changes in component values might be necessary.

The low cost, simplicity, and compactness of this crystal oven make it ideal for installation in existing or planned equipment employing a quartz crystal oscillator, or for experimental work with very stable oscillators. If you intend to experiment, keep the following points in mind. All quartz crystals suffer to some extent from aging. In general, high-quality crystals are more expensive but are made from select material and are cut in such a way as to minimize aging. Finally, keep in mind that power input to the crystal should be kept as low as possible if a low aging rate is to be maintained. This means that oscillators teaming up quartz crystals to TTL gates are to be avoided in preference to those employing CMOS gates or very-low-power discrete devices.—*Jack Rutherford, Burlington, N.C.*

Drill Speed Control

If you don't have a variable-speed electric drill, you probably wish you did. There are a number of situations in which low-speed drilling yields the best results—drilling such brittle materials as Bakelite and Plexiglass, drilling in tight spaces, and where a slip of the drill would be disasterous, such as drilling holes in a finished front panel or project enclosure. Medium-speed drilling is often employed when working on nonferrous metals such as aluminum and brass. The circuit presented in the figure will allow you to vary the speed of a standard fixed-speed drill without performing any modifications to the tool.



Modular bridge rectifier *RECT1* converts the ac power waveform into full-wave rectified pulsating dc. A portion of the rectified current passes through the 10,000-ohm potentiometer to the *RC* network that delivers gate drive to the SCR. The drill is plugged into socket *SO1* and its speed controlled by the setting of the potentiometer. Diode *D1* protects the circuit from reverse voltage spikes.

The SCR and the modular bridge rectifier should have current ratings of 25 amperes and *PIV* ratings of 600 volts. Diode *D1* should have a current rating of 2 amperes or more and a PIV rating of 600 volts. A small aluminum utility box can function as the circuit's enclosure. A power tool or other appliance (soldering iron, lamp, etc.) drawing up to 10 amperes or so can be controlled by the circuit. If the tool or appliance plugged into *SO1* draws four to eight amperes on a continuous basis for more than 10 minutes, the SCR must be heat sinked. *Harry J. Miller, Sarasota, FL.*

Electronics Library

Archer Semiconductor Replacement Guide (1980 Edition)

This is a useful publication for those who need to cross-reference an OEM semiconductor type number to a component that is available at the retail level. According to the publisher, the book contains cross-reference/substitution listings for more than 100,000 semiconductor devices. These listings are said to have been generated by computer and to be the result of an analysis of the key parameters of each device. In addition, information is included on the care and handling of semiconductors, on case styles and dimensions, and on testing transistors and diodes. There is also a glossary of terms, symbols and abbreviations. Pertinent electronic and physical characteristics of each member of Radio Shack's line of semiconductors are presented in data-sheet form.
Published by the Radio Shack Div. of Tandy Corp., 1300 One Tandy Center, Fort Worth, TX 76102. 224 pages. $1.99 soft cover.

Programming the Z80

by Rodnay Zaks

Contained in this book is a wealth of information that can help you get started programming a Z80 computer at the machine/assembly-language level. Each chapter proceeds from the simple to the complex, and overall treatment covers elementary through intermediate programming techniques to get you started programming on your own. Flow charting and other data presentation methods and Z80 hardware organization are introduced in the early chapters. Then almost 50% of the book is devoted to fully detailed description of the Z80's powerful instruction set. The final chapters cover addressing techniques, I/O techniques, I/O devices, application examples, data structures, and program development.
Published by Sybex, Inc., 2020 Milvia St., Berkeley, CA 94704. Soft cover. 624 pages. $14.95.

Radio Enters the Home

by Harry F. Bart

This book was originally published in 1922 by the Sales Department of the Radio Corporation of America. It was intended, "For those who desire to be entertained with concerts, lectures, dance music—as well as for the radio amateur," and cost 35 cents. The book will be of interest to old-time radio buffs as well as those who would like to learn about the early days of wireless communications. Included are descriptions of radio phenomena, receivers (crystal sets, primitive vacuum-tube designs), early vacuum-tube transmitters, and a catalog of components and assembled units. Radio amateurs could consult the book for schematics, a summary of Radio Laws and Regulations of the U.S., National Electrical Code Radio Rules, a Morse code table, vacuum-tube precautions, a glossary of technical terms used in radio, and various useful data. The book is profusely illustrated with photographs and line drawings of broadcasting studios, receivers being used in the home, and commercial radio products.
Reprinted and published by the Vestal Press, Box 97, Vestal, NY 13850. Soft cover, 128 pages. $12.50. Postage and handling charge $0.50 for U.S. orders.

The Radio Amateur's License Manual

edited by Wyland Dale Clift, WA3NLO

This latest edition of *The Radio Amateur's License Manual* (77th Edition) is a radical departure from those of the past 50 years. Gone are the question-and-answer format and coverage of theory for the Novice Class license exam. Theory for the Technician, General, Advanced and Extra Class license exams is now presented in easy-to-read essay form. There is a short chapter dealing with the Novice Class license and exam, but a note directs readers interested in becoming Novices to employ the ARRL's code-and-theory package for the Novice test entitled *Tune In The World With Ham Radio*. There are separate chapters for amateur licensing procedures, the station license, Technician/General Class theory, Advanced Class theory, Extra Class theory, International Regulations, and where and how to take an amateur examination. At the end of each theory section are sample questions, answers to which are presented in the back of the book. The text in the theory sections is illustrated with many schematics and line drawings.
Published by the American Radio Relay League, 225 Main Street, Newington, CT 06111. Soft cover, 168 pages. $4 in the U.S.

How to Make Printed Circuit Boards

by Joel Goldberg

How to Build Electronic Projects

by Douglas R. Malcolm, Jr.

These two books make an excellent training course in project building for newcomers to the electronics hobby. *Printed Circuit Boards* details every aspect of single- and double-sided pc-board fabrication, from initial design through final assembly. Photos and drawings help describe how to make pc boards from scratch using direct, photographic, and silk-screen techniques. *Electronic Projects* details with numerous photos and drawings procedures for converting schematic diagrams and components into finished projects. Leading off with component descriptions, it proceeds to soldering techniques and

project layout and circuit board construction and closes with a selection of circuits to build, using the information contained in previous chapters.
Published by Gregg/McGraw-Hill, 1221 Ave. of Americas, New York, NY 10020. PC Boards: Soft cover. 128 pages. $6.50. Projects: Soft cover. 144 pages. $7.95.

Antenna Data Reference Manual

by Joseph Carr, K4IPV

Contained in this book is design information for those who want to construct antennas for amateur, shortwave listening, CB and FM broadcast applications. Each chapter deals with a different type of antenna (Horizontal Dipoles, Inverted Vees, Verticals, Quads, Yagis, etc.) and has computer program printouts giving the physical dimensions for a sequence of frequencies within each amateur and broadcast band. Also provided are line drawings showing the physical configurations of the antennas described, summaries of their electrical and radiating characteristics, and suggestions for their physical construction. Other topics discussed are transmission lines, tuning procedures, impedance-matching systems, and antenna measurements and instrumentation.
Published by Tab Books, Blue Ridge Summit, PA 17214. 266 pages. $12.95 hard cover, $7.95 soft cover.

Introduction to T-BUG

by Don & Kurt Inman

Written to acquaint the reader with the use of Radio Shack's T-BUG Monitoring and Debugging Aid, this book describes in detail the machine-language operations of the TRS-80 microcomputer. (It is *not* intended to serve as a complete machine-language textbook.) Each T-BUG command is thoroughly explained and examples are given to demonstrate how each can be used. Every step is discussed for each of the many sample programs contained in the book, and each program is accompanied by a sketch of the video display.
Published by Dilithium Press, 30 NW 23 Pl., Portland, OR 97210. Soft cover. 120 pages. $6.95.

DC Power Supplies

by Robert J. Traister

Detailed information on dc power-supply theory and applications is contained in this book. Where it departs from most similar books is in its stress on experimentation with existing circuitry so the reader can develop new designs for particular needs. Divided into two parts, the first deals with theory, covering power-supply circuitry, components and ratings, dynamic and electronic regulation, protective circuits, voltage multiplication, metering, and safety circuits. Part II focuses on actual circuits: ac and dc supplies and low-, medium-, and high-voltage circuits.
Published by Reston Publishing Co., Inc., Reston, VA 22090. Hard cover. 234 pages. $16.95.

New Literature

Personal Software Catalog

A 20-page Spring 1980 Catalog from Personal Software Inc. describes 15 of its current line of programs for professional, business, entertainment, and educational application. Programs for Apple II and II plus, Radio Shack TRS-80, and Commodore PET/CBM include CCA Data Management, Desktop Plan and VisiCalc. Games include Gammon Gambler, Checker King, Microchess, Bridge Partner, and Time Trek. New health education programs cover Growing Up, Birth Control, Your Blood Pressure, etc. Available from Personal Software Inc., 1330 Bordeaux Dr., Sunnyvale, CA 94086 and dealers.

Hy-Gain Amateur Equipment

Hy-Gain's new 24-page catalog (No. AM 2504) covers 100 base and mobile antennas, towers, rotators, microphones, boom mic headsets and accessories for the amateur radio operator. Detailed specifications, including SWR curves on all base antennas, are given. Address: Kit Kitterer, Hy-Gain., Div. of Telex Comm., Inc., 8601 NE Highway Six, Lincoln, NB 68505.

Updated Buzzword Guide

The 1980 edition of "Sherry's Guide to Data Communication Buzzwords" contains 24 pages of 192 definitions of words commonly used in communications and data processing. Address: Corporate Relations Dept., Racal-Milgo, Inc., 8600 N.W. 41st St., Miami, FL 33166.

VIZ Instrument Catalog

Over seventy VIZ electronic instruments are illustrated and described in its new 44-page catalog for 1980. Features including ranges and limits, power required, weight, etc. are given on DMMs, VOMs, power supplies, isolation transformers, signal generators, and frequency counters. Address: VIZ Mfg. Co., 335 E. Price St., Philadelphia, PA 19144.

Radio Frequency Directory

The Federal Frequency Directory features over 100,000 discrete listings of frequencies, agencies, and locations of U.S. Government radio communications installations in the 2-420-MHz spectrum as released under the Freedom of Information Act. Entries include Justice, Treasury, NASA, FCC, FAA, Interior, Army, Navy, Air Force, and Coast Guard listings arranged in order of frequency, agency, and geographical location. Available for $14.95 postpaid from Grove Enterprises, Box 156B, Brasstown, NC 28902 and qualified dealers.

TRS-80 Educator's Sourcebook

A 27-page booklet entitled "TRS-80 Microcomputer Sourcebook for Educators" has been issued by Radio Shack as a guide to the use of microcomputers as both a medium and an object of instruction in the classroom and as a tool for the school administrator. It provides guidelines for selecting a system based on potential applications, costs, service, reliability and courseware. Address: Radio Shack, Dept. NR-17, 1300 One Tandy Center, Fort Worth, TX 76102.

Instrument Rental Catalog

The 1980 Electronic Instrument Rental Catalog from Continental Resources, Inc. describes over 1,000 pieces of test equipment for monthly rental. Specifications and rental rates are given for such items as oscilloscopes, recorders, logic analyzers, microprocessor test systems, power meters, function generators, frequency synthesizers, and computer peripherals. Address: Continental Resources, Inc., 175 Middlesex Turnpike, Bedford, MA 01730.

Control Devices Catalog

"Switches, Pilot Lights and Control Devices" lists, in 174 pages, the stock of manufacturers such as Sigma, Potter & Brumfield, and Struthers Dunn available from the distributor, Relay Specialties, Inc. Included in Catalog C-109 are sockets, photoelectric controls, terminal strips and blocks, circuit breakers, counters, buzzers, sensor, solenoids, etc. Address: Relay Specialties, Inc., 13-00 Plaza Rd., Fair Lawn, NJ 07410.

RCA Microprocessors

A 60-page Product Guide (MPG-180C) from RCA describes all the elements needed to build a microprocessor system. Included are ICs, support systems, and accessories in the 1800 COSMAC family. It covers the CDP1802 microprocessor with data on a variety of RAMs, ROMs, and I/O devices, with characteristics and functional and terminal diagrams. A cross-reference gives RCA types for other manufacturers' equivalents. Address: RCA Solid State Div., Box 3200, Somerville, NJ 08876.

Catalog of R-F Diodes and Transistors

Uprated and extended ranges are characteristics of the 125 r-f devices in Ferranti's new 24-page catalog. Details on function, application, and essential parameters are given on variable capacitance tuner diodes, hyperabrupt variable capacitance tuner diodes, Schottky barrier diodes, and r-f transistors. Address: Ferranti Electric, Inc., Semiconductor Products, 87 Modular Ave., Commack, NY 11725.

Operation Assist

If you need information on outdated or rare equipment—a schematic, parts list, etc.—another reader might be able to assist. Simply send a postcard to Operation Assist, POPULAR ELECTRONICS, 1 Park Ave., New York, NY 10016. For those who can help readers, please respond directly to them. They'll appreciate it. (Only those items regarding equipment not available from normal sources are published.)

Precision model 960-S transistor and crystal diode tester. Need schematic and operation instructions. Guy Edwards, 104 Hancock, San Francisco, CA 94114.

Marantz model 2252B receiver (without Dolby. Need schematic. Pedro Kay Delgado, Casilla 947, Concepcion, Chile.

Precision picture tube tester and rejuvenator model CR60. Need schematic, operation instructions and tube chart. D. Acquavella, Box 857, Wildwood, FL 32785.

Hallicrafters model S-20R "Sky Champion" 4 band communications receiver. Need schematic. Glen Steinman, 7915 E. Michigan Ave., Jackson, MI 49201.

Atwater Kent model 427 AM receiver. Need original speaker with output transformer. Ron McCay, Box T-42, APO, NY 09164.

Philco model 39-36 radio. Need schematic, wiring diagram push buttons and glass plate dial. Max Cooper, Route 1, Box 58 Peabody, KN 66866.

National model NC-183 receiver. Need operation manual and schematic. A.O. Henderson, 1040 Warwick Ave., Fallon, NV 89406.

Garrett ITM2 calculator. Need schematic. Larry Thorne, 1600 Royal Crest # 160, Austin, TX 78741.

Philco model P1052 video board and **Synphonic**model TPS5050. Need parts list. N. Carter, 1276 West 3 Street, Room 319, Cleveland, OH 44113.

Heathkit model DX-20 transmitter. Need owners manual and operation manual. Bill Landreth, 15918 Lime Grove, Poway, CA 92064.

Knight-Kit model R-100 amateur communications receiver. Need schematic and operating manual. W.T. Kramer, 3533 Scranton Rd., Cleveland, OH 44109.

Webcor model 2500 stereo tape deck. Need schematic and parts list. J. Walsh, Box 616, Merrifield, VA 22116.

Solar model CE capacitor analyzer. Need schematic and service manual. John Oberritter, 1229 Linden Ave., Park Ridge, IL 60068.

Sonnett model 181P AM/FM PB radio. Need schematic and wiring diagram. Richard W. Tucker, 907½ N. Sycamore Street, Creston, IA 50801.

Delco Radio Division G.M.C. U.S. Army BC-683-BM radio receiver, serial # 9030. Need any available information. Darrell Grubbs, #2 227, Wartrace, TN 37183.

Johnson viking ranger. Need operation and service manual. Alfred Adams, Box 3394, Morehead City, NC 28557.

Hammarlund HQ180A. Need noise blanker circuit or any available information.

Heath model HO-10 and HO-13 ham scopes. Need spare parts or non working unit. R.F. Cann, 1606 Lockwood Dr., Richmond, VA 23233.

Rogers Majestic Radio type 24. Need tube layout and schematic. N. Durrant, 628 Carlton St., St. Catherines, Ontario, Can. L2M 6Z1.

National US190 radio general coverage receiver. Need discarded unit for parts. Ms. Ralph J. Monson, Rd 1, Box 736, Lancaster, VA 22503.

Tektronix model 535 oscilloscope. Need repair manual and schematic. J.E. Willson, 6757 IFFN Drive, Anderson, CA 96007.

JVC model CHR-250UB 8-track recorder. Need parts layout and schematic. Dana Smith, 70A Taralli Terrace, Framingham, MA 01701.

West Bend model DHH 6000 radar gun. Need service manuals or specifications. Navcom Electronics, Box 1568 Blaine, WA 98230.

Precision Apparatus Co., Inc. model ES500A oscilloscope. Need schematic and owners manual. James N. Felts, #50 Paradise M.H.P., Radcliff, KY 40160.

RCA model WO-91B oscilloscope. Need schematic. John B. Riley, 914 N. Cordova St., Burbank, CA 91505.

Hy-Gain model H-61 programmable scanner. Need schematic. Billy S. Holley, 110 Roberson Rd., Ripley, MS 38663.

Concord model 884 tape recorder. Need operations manual, service manual and parts list. Also need rubber idler wheel. Ted Budnik, 81 Chestnut, Chicopee, MA 01013.

RCA model AR-8507 radio marine receiver. Need schematic and parts list. Bruce Myers, 9915 Oleander Ave., Vienna, VA 22180.

Decca model DR349 AM/FM stereo radio. Need schematic and parts list. Harry Frable, Jr., 106 N. Warren St., Easton, PA 18042.

Pintsch Electro RC test oscillator. Need schematic. Werner Stier, 5249 Hoevels, Germany.

Hallicrafter model SW500 radio receiver. Need service manual and technical manuals. Andy Anderson, RFD-2 Box 83G, Winnshore, TX 75494.

Dressen-Barnes model 1K500b power supply. Need schematic and operating manual. J. Allen Call, 1876 E. 2990 S. Salt Lake City, UT 84106.

Tennelec MS2 memory scanner. Need service manual. Richard S. Wiederhold, 7425 N. Fifth, Fresno, CA 93710.

Hallicrafters model S-53A receiver. Need schematic and operation manual. Andy Reid, RR7, Peterborough, Ontario K9J 6X8, Can.

Panasonic 8 track player and recorder, model #RS-803US, serial #RK005350 and **SonyTV** model 500U. Need schematics, parts lists and service manuals. Herman Rummelt, 9365 Wabasis Ave., Greenville, MI 48838.

Radio Shack hi-fi tuner, model Realist FM and Realistic FM-2. Need schematics and tube location guides. Jacques Blais, 1698 9th Ave., Charny, Quebeck G6W 4H2.

Elco model 460 oscilloscope. Need operations manual, schematics, and construction manual. Brian Test, Box 336, Mereclosia, IL 62665.

Hallicrafters model SX-62 shortwave receiver. Need operation manual or any available information. Kurt Vosburg, 815 Tibbals, Holdrege, NB 68949.

Sanyo model #FT406 cassette. Need schematic and owners manual. Jeff Sens, 1014 5th. Street, Sandusky, OH 44870.

Tektronix model 511-A oscilloscope. Need power transformer. Erik J. Vallow, WB3IXY, Beech Road, Ambler, PA 19002.

Fairchild model 7001 clock IC. Need clock circuit that accompanied IC. Sigmund S. Kahn, M.D., 670 East 18th St., Brooklyn, NY 11230.

Hughes model 104 memoscope. Need schematics, manuals and plug-ins. Greg Campbell, 12131 Camp Campana, San Diego, CA 92128.

Dumont Fairchild model 425 oscilloscope. Need model 4212 4-trace plug-in and manual. **Crown** model CTV-12 television radio. Need schematic and/or video board. D. Laydсen, 412 Forest St., Oconomowoc, WI 53066.

Ross Electronics model 5011 AM/FM TV. Need schematic and parts list. Wayne R. Larson, 210 S. 37th, Artesia, NM 88210.

Lexitron digital cassette drive. Need maintenance and repair manuals and schematics. W. H. Tripp, 801 Ward, SP.21, Ridgecrest, CA 93555.

Espey model R-366TRR-5 receiver. Need operations manual. Dave Day, 2711 Beech, Bakersfield, CA 93301.

DuMont cathode ray oscillograph model 208-B. Need schematic and service manual. Greg Moran, 11 Jerome Ct., Walnut Creek, CA 94598.

National Radio Institute scope. Need HV oscillator transformer part # 4C020. James McMullan, 205 So. Plaza Dr., Little Rock, AR 72205.

Dietzgen model ESR-1 slide rule calculator and **Olivetti-Underwood** programma 101. Need service manuals and schematics. Jim Morgan, 916 So. 27th Ave., Yakima, WA 98902.

PROJECT OF THE MONTH

BY FORREST M. MIMS

THIS month's project is a programmable digital timing circuit that has countless applications around the shop and home. You can learn how the circuit works by referring to the schematic diagram in Fig. 1. Astable multivibrator *IC1* provides clock pulses for *IC3*, a 74192/74LS192 decimal counter. The clock frequency can be altered by changing the value of either *R1* or *C1*.

The circuit can be programmed to generate any one of ten timing intervals. Any desired starting point from 0000 (0) to 1001 (9) is selected by means of switches *S1* through *S4*. When pushbutton *S5* is closed momentarily, the BCD number present at the parallel data inputs of the counter's input. The clock pulses cannot reach the counter when the BORROW output is at logic 1.

As *IC3* begins its downward count, the current BCD number present at its outputs is decoded by *IC4* and is displayed on a common-anode, seven-segment LED readout. Once the count has reached 0000, the BORROW output goes to logic 0 upon receipt of the next clock pulse. Clock pulses are thereupon blocked and the counter outputs idle at 0000. The counting cycle can be initiated again by momentarily depressing *S5*. Of course, a new starting point can first be loaded into the counter by means of switches *S1* through *S5*.

The circuit shown in Fig. 1 includes

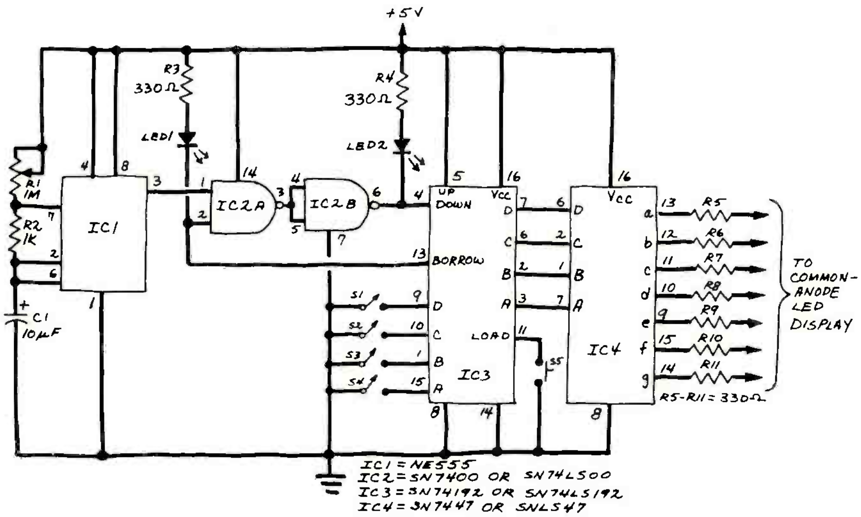


Fig. 1. Schematic diagram for a programmable countdown timer.

ter is loaded into it, and the chip's BORROW output (pin 13) goes to logic level 1.

Both the BORROW output of the counter and the output of the clock are combined in AND fashion by NAND gates *IC2A* and *IC2B*. The resulting logic signal is applied to the count-down input of the 74192. When the BORROW output is at logic 1, clock pulses pass through the gates to the two optional indicator LEDs. The diode designated *LED2* flashes each time a clock pulse is applied to the input of the counter. The other diode, *LED1*, is dark during the counting sequence, but begins to glow one clock pulse after the count has reached 0000. You can omit these LEDs if you choose, or you can connect other circuits in their place which will then be actuated by the counter.

Programmable Countdown Timer

Model-Rocket Countdown Launcher. Having long been a model-rocket enthusiast, my favorite application for countdown timers is in automatic rocket-launching systems. Such systems are ideal for rocketeers who like to photograph their birds lifting off their launch pads. An audible beeper circuit triggered by the clock pulses applied to the counter input would be a helpful addition. It would allow the photographer to keep track of the countdown sequence while he aims his camera at the rocket as it sits on its launcher.

Figure 2 schematically shows how to add a rocket-motor ignition circuit to the basic countdown timer. A relay is used as the power-switching component because the resistance of its closed contacts is much less than the "on" resistance of an SCR or other solid-state switching device. This ensures that the highest possible current will flow through the nichrome-wire rocket-motor igniter. The diode connected across the relay coil absorbs the high-voltage spikes which can be generated by the collapsing magnetic field when the relay coil is deprived of current.

If you use this circuit to launch model rockets, be sure to follow all of the standard safety precautions. Avoid the temptation to place the ignition-control system adjacent to the model-rocket launcher. Instead, connect the countdown circuit to the launcher with a 20' length of lamp cord. Be sure to include a disarming switch so that you can safely and quickly deactivate the launch sequence should an unforeseen problem occur. You can use the ignition circuit's 6-volt battery to power the count-down circuit as well, if you so desire. This will simplify the overall launch system by eliminating the need for two separate power supplies. To do this, connect the +5-volt bus of Fig. 1 to the cathode of a 1N4001 diode. Connect the anode of the diode to the positive terminal of the battery, and the ground bus of Fig. 1 to the negative battery terminal, using a suitable length of lamp cord.

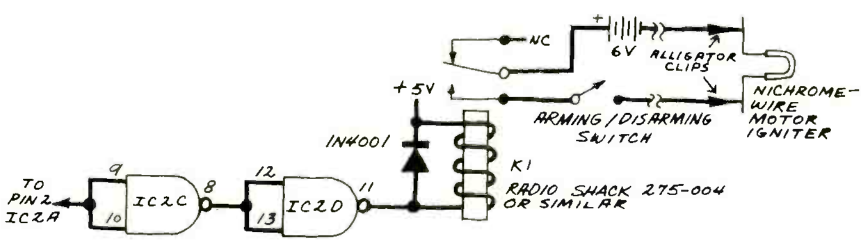


Fig. 2. How to add a relay to the timer for igniting model rockets.

Other Applications. Of course, lauching model rockets is only one application for this versatile circuit. Many others are possible. For example, you can alter the timer's clock circuit to produce pulses at the rate of, say, 5 Hz. It can then be used as a darkroom timer. Slowing down the clock rate to one pulse per minute makes it possible to time a boiled egg, a phone call, or any other event lasting 10 minutes or less.

You can even extend the timing capacity of this circuit by cascading one or more additional counting stages. And you can reverse its operating mode by applying the gated clock pulse to the count-up input (pin 5) and connecting pin 2 of *IC2A* to the CARRY output of the counter (pin 12) instead of to pin 13, the BORROW output. Because the programmable countdown timer circuit is reasonably foolproof, it's an excellent first project for the novice experimenter. ◇

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P809	33		.29	2.45
P810	47		.32	2.72
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P813	10	25	.25	2.13
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P815	33		.33	2.76
P816	3.3		.24	2.03
P817	4.7	35	.25	2.07
P818	10		.26	2.23
P819	22		.32	2.23
P820	1		.24	2.72
P821	.22		.24	2.03
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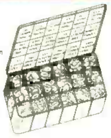

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K4A13	KOA13	1K	.32	$2.40	$21.00
K4A23	KOA23	2K	.32	$2.40	$21.00
K4A53	KOA53	5K	.32	$2.40	$21.00
K4A14	KOA14	10K	.32	$2.40	$21.00
K4A24	KOA24	20K	.32	$2.40	$21.00
K4A54	KOA54	50K	.32	$2.40	$21.00
K4A15	KOA15	100K	.32	$2.40	$21.00
K4A25	KOA25	200K	.32	$2.40	$21.00
K4A55	KOA55	500K	.32	$2.40	$21.00
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Q1A13	QOA13	1K	.40	$3.20	$26.00
Q1A23	QOA23	2K	.40	$3.20	$26.00
Q1A53	QOA53	5K	.40	$3.20	$26.00
Q1A14	QOA14	10K	.40	$3.20	$26.00
Q1A24	QOA24	20K	.40	$3.20	$26.00
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Q1A15	QOA15	100K	.40	$3.20	$26.00
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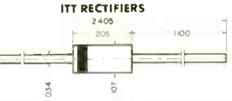

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1N4002	1 Amp 100 PIV Silicon Rectifier	DO-41	.80	7.00	60.00	540.00
1N4003	1 Amp 200 PIV Silicon Rectifier	DO-41	.80	7.50	64.00	576.00
1N4004	1 Amp 400 PIV Silicon Rectifier	DO-41	.80	8.00	68.00	612.00
1N4005	1 Amp 600 PIV Silicon Rectifier	DO-41	1.00	9.20	74.00	666.00
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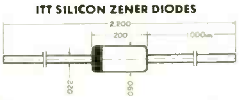

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1N5228B	3.9 V 5% 500mW Zener (1N748A equiv.)	.24	1.80
1N5229B	4.3 V 5% 500mW Zener (1N749A equiv.)	.24	1.80
1N5230B	4.7 V 5% 500mW Zener (1N750A equiv.)	.24	1.80
1N5231B	5.1 V 5% 500mW Zener (1N751A equiv.)	.24	1.80
1N5232B	5.6 V 5% 500mW Zener (1N752A equiv.)	.24	1.80
1N5233B	6.0 V 5% 500mW Zener	.24	1.80
1N5234B	6.2 V 5% 500mW Zener (1N753A equiv.)	.24	1.80
1N5235B	6.8 V 5% 500mW Zener (1N957B equiv.)	.24	1.80
1N5236B	7.5 V 5% 500mW Zener (1N958B equiv.)	.24	1.80
1N5237B	8.2 V 5% 500mW Zener (1N959B equiv.)	.24	1.80
1N5238B	8.7 V 5% 500mW Zener	.24	1.80
1N5239B	9.1 V 5% 500mW Zener (1N960B equiv.)	.24	1.80
1N5240B	10 V 5% 500mW Zener (1N961B equiv.)	.24	1.80
1N5241B	11 V 5% 500mW Zener (1N962B equiv.)	.24	1.80
1N5242B	12 V 5% 500mW Zener (1N963B equiv.)	.24	1.80
1N5243B	13 V 5% 500mW Zener (1N964B equiv.)	.24	1.80
1N5244B	14 V 5% 500mW Zener	.24	1.80
1N5245B	15 V 5% 500mW Zener (1N965B equiv.)	.24	1.80
1N5246B	16 V 5% 500mW Zener (1N966B equiv.)	.24	1.80
1N5247B	17 V 5% 500mW Zener	.24	1.80
1N5248B	18 V 5% 500mW Zener (1N967B equiv.)	.24	1.80
1N5249B	19 V 5% 500mW Zener	.24	1.80
1N5250B	20 V 5% 500mW Zener (1N968B equiv.)	.24	1.80
1N5251B	22 V 5% 500mW Zener (1N969B equiv.)	.24	1.80
1N5252B	24 V 5% 500mW Zener (1N970B equiv.)	.24	1.80
1N5253B	25 V 5% 500mW Zener	.24	1.80
1N5254B	27 V 5% 500mW Zener (1N971B equiv.)	.24	1.80
1N5255B	28 V 5% 500mW Zener	.24	1.80
1N5256B	30 V 5% 500mW Zener (1N972B equiv.)	.24	1.80
1N5257B	33 V 5% 500mW Zener (1N973B equiv.)	.24	1.80

DIGITAL CLOCK BEZEL

THE J.M.J. DIGITAL DISPLAY BEZEL

WITH RED FILTER
Part No. 400

UNIVERSAL SIZE
HANDLES MOST REQUIREMENTS

Be Sure to Order the Proper Adapter for Your Digital Clock

Part	Description	Price
400	Digital Display BEZEL with Red Filter	$4.95
420	Mounting Adapters for MA1001, MA1002, etc.	.69
421	Mounting Adapters for MA1010, MA1020, MA1026	.69
422	Universal PC Board Mounting Adapters	.69
423	Mounting Adapter for MA1023	.69

NEW" MA1032 Clock

Digital LCD Clock Module

- Operates from a single 1.5V Battery
- 0.5" LCD Display

Instructions Included In All Orders

- User selectable 12 or 24-hour mode
- 24-hour alarm with ON-OFF control
- Pretetable 59-minute sleep timer with reset to zero
- 7-minute snooze timer
- Fast/Slow setting controls
- Seconds display
- 90 mA hour battery will typically last one year
- Minimum external parts required for travel clock/clock radio
- Backlighted Display

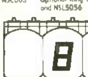
Catalog No.	Description	Cost
MA1032M	LCD Clock Module only	$24.95
MA1032C	Switch for MA1032M	2.85
MA1032R	MA1032M, MA1032C, & AA battery holder	$28.20

Multi-Digit LED Numeric Series

DEVICE TYPE	DIGIT SIZE	FORMAT	DRIVE	PRICE
NSN334			CA DIRECT	$3.00
NSN373			CC DIRECT	$3.00
NSN374	0.3" Red		CA DIRECT	$3.00
NSN381			CC MULTI	$3.00
NSN382			CA MULTI	$3.00
NSN534			CA DIRECT	$3.50
NSN581			CC MULTI	$3.50
NSN582	0.5 Red		CA MULTI	$3.50
NSN583			CC DIRECT	$3.50
NSN584			CA DIRECT	$3.50
NSN734			CA DIRECT	$4.00
NSN781			CC MULTI	$4.00
NSN782	0.7" Red		CA MULTI	$4.00
NSN783			CC DIRECT	$4.00
NSN784			CA DIRECT	$4.00
NSB3382			CA MULTI	$5.50
NSB3881	0.3 Red		CC MULTI	$5.50
NSB3882			CA MULTI	$5.50
NSB5382			CA MULTI	$6.50
NSB5881	0.5 Red		CC MULTI	$6.50
NSB5882			CA MULTI	$6.50
NSB7382			CA MULTI	$7.50
NSB7881	0.7 Red		CC MULTI	$7.50
NSB7882			CA MULTI	$7.50

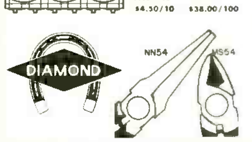
Red LED Lamps

NSL5053	Diffused red T1 3/4 lamp	5	2.20/10 $19.50/100
NSL5056	Diffused narrow angle red T-1 3/4 lamp	5	2.20/10 $19.50/100
NSC003	Optional Ring and clip for mounting NSL5053 and NSL5056	5	.30/10 2.00/100



Hewlett Packard Two Digit High Brightness L.E.D. 1.7VDC 10mA 500mW

5082-7432 $.50 $4.50/10 $38.00/100



All Capoloy pliers are furnished with coil spring and plastic covered handles

Diagonal Cutting Plier. General purpose cutter with 7/16" cutting blade. Cat. No. MS54 $8.39

Thin Diagonal Cutter. diagonal flush cutter for reaching into confined places. Cat. No. MS54-3 $10.09

Angled Flush Cutter. Cutting blade is flush ground and angled at 29° Carbide cutting plier not guaranteed. Cat. No. GA54 $15.25

Subminiature Long Nose Pliers. Very fine point for delicate work in very confined areas. Cat. No. L4 $8.59

Long Nose Pliers. LN54 has finely scored jaws. Cat. No. LN54 $8.59

Long Nose Side Cutter. Similar to long nose pliers but with 7/32" cutter in joint. Cat. No. SN54 $9.45

Transverse End Cutters. Ideal for cutting close on printed circuit work. Cat. No. EC54 $9.45

Needle Nose Pliers. NN54 has scoring on jaws. Cat. No. NN54 $10.29

Duck Bill Pliers. Flat nose duck bill pliers with smooth jaws. Cat. No. DN54 $7.99

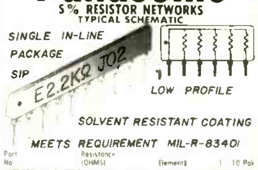
Angle Blade Flush Cutting. Ideal for cutting wire or plastic in difficult areas. Cat. No. AN54 $17.85

Pro-Hobby Pliers: Contains one each SN54, EC54, DN54, GA54, NN54, MS54. Cat. No. 6 $60.82

Electronics Handy Pack Assortment. Six popular pliers in a sturdy leather pocket. Tools included are EC54, NS54, SN54, NN54, LN54, DN54. Order assortment number C-1. Cat. No. C-1 $66.15

Panasonic

5% RESISTOR NETWORKS



Part No.	Resistance (OHMS)	Element	1	10 Pak
Q5101	100	5	.38	3.49
Q5102	1K	5	.38	3.49
Q5103	10K	5	.38	3.49
Q5104	100K	5	.38	3.49
Q5105	1.0M	5	.38	3.49
Q5131	150	5	.38	3.49
Q5132	1.5K	5	.38	3.49
Q5133	15K	5	.38	3.49
Q5134	150K	5	.38	3.49
Q5221	220	5	.38	3.49
Q5222	2.2K	5	.38	3.49
Q5223	22K	5	.38	3.49
Q5224	220K	5	.38	3.49
Q5331	330	5	.38	3.49
Q5332	3.3K	5	.38	3.49
Q5333	33K	5	.38	3.49
Q5334	330K	5	.38	3.49
Q5471	470	5	.38	3.49
Q5472	4.7K	5	.38	3.49
Q5473	47K	5	.38	3.49
Q5474	470K	5	.38	3.49
Q5681	680	5	.38	3.49
Q5682	6.8K	5	.38	3.49
Q5683	68K	5	.38	3.49
Q5684	680K	5	.38	3.49
Q7101	100	7	.51	4.70
Q7102	1K	7	.51	4.70
Q7103	10K	7	.51	4.70
Q7104	100K	7	.51	4.70
Q7105	1.0M	7	.51	4.70
Q7131	150	7	.51	4.70
Q7132	1.5K	7	.51	4.70
Q7133	15K	7	.51	4.70
Q7134	150K	7	.51	4.70
Q7221	220	7	.51	4.70
Q7222	2.2K	7	.51	4.70
Q7223	22K	7	.51	4.70
Q7224	220K	7	.51	4.70
Q7331	330	7	.51	4.70
Q7332	3.3K	7	.51	4.70
Q7333	33K	7	.51	4.70
Q7334	330K	7	.51	4.70
Q7471	470	7	.51	4.70
Q7472	4.7K	7	.51	4.70
Q7473	47K	7	.51	4.70
Q7474	470K	7	.51	4.70
Q7681	680	7	.51	4.70
Q7682	6.8K	7	.51	4.70
Q7683	68K	7	.51	4.70
Q7684	680K	7	.51	4.70
Q9101	100	9	.59	5.45
Q9102	1K	9	.59	5.45
Q9103	10K	9	.59	5.45
Q9104	100K	9	.59	5.45
Q9105	1.0M	9	.59	5.45
Q9131	150	9	.59	5.45
Q9132	1.5K	9	.59	5.45
Q9133	15K	9	.59	5.45
Q9134	150K	9	.59	5.45
Q9221	220	9	.59	5.45
Q9222	2.2K	9	.59	5.45
Q9223	22K	9	.59	5.45
Q9224	220K	9	.59	5.45
Q9331	330	9	.59	5.45
Q9332	3.3K	9	.59	5.45
Q9333	33K	9	.59	5.45
Q9334	330K	9	.59	5.45
Q9471	470	9	.59	5.45
Q9472	4.7K	9	.59	5.45
Q9473	47K	9	.59	5.45
Q9474	470K	9	.59	5.45
Q9681	680	9	.59	5.45
Q9682	6.8K	9	.59	5.45
Q9683	68K	9	.59	5.45
Q9684	680K	9	.59	5.45

Panasonic Batteries

CARBON ZINC BATTERIES

Part No.	Panasonic Model	Size	(V)	Each	Carton
P101	UM1-N	D	1.5	.94/1	17.14/24
P102	UM2-N	C	1.5	.60/1	12.05/24
P103	UM3-N	AA	1.5	.41/1	20.36/60
P104	006PN		9	1.81/1	12.91/12

ALKALINE BATTERIES

Part No.	Panasonic Model	Size	(V)	(mA)	Each	Carton
P105	AM-1	D	1.5	320	1.87/1	29.61/20
P106	AM-2	C	1.5	300	1.33/1	23.33/20
P107	AM-3	AA	1.5	130	.88/1	36.57/50

NICKEL CADMIUM BATTERIES

Part No.	Panasonic Model	(V)	Capacity 5 HR (mAh)	Each	Carton
P110	N4-N	1.2	150	2.59/1	199.50/100
P111	NR-N F1	1.2	150	2.70/1	266.00/100
P112	NR-AAA	1.2	180	2.47/1	249.00/126
P113	NR-AAA-F1	1.2	180	2.79/1	292.50/126
P108	NR-1/3AA	1.2	110	2.20/1	221.00/120
P109	NR-1/3AA-F1	1.2	110	2.53/1	254.00/120
P114	NR-2/3AA	1.2	250	2.39/1	399.00/200
P115	NR-2/3AA-F1	1.2	250	2.70/1	432.00/200
P116	NR-AA	1.2	500	2.42/1	161.00/80
P117	NR-AA-F1	1.2	500	2.70/1	183.35/80
P118	NR-1/2SC	1.2	600	3.37/1	443.70/150
P119	NR-1/2SC-F1	1.2	600	3.88/1	482.00/150
P120	NR-SC	1.2	1200	4.50/1	372.00/100
P121	NR-SC-F1	1.2	1200	4.81/1	398.00/100
P122	NR-C	1.2	1800	6.12/1	102.00/20
P123	NR-C-F1	1.2	1800	6.42/1	107.00/20
P124	NR-D	1.2	4000	11.04/1	92.00/10
P125	NR-D-F1	1.2	4000	11.34/1	94.50/10
P126	NR-F	1.2	7000	25.91/1	214.00/10
P127	NR-F-F1	1.2	7000	26.21/1	216.50/10

GELLED ELECTROLYTE LEAD ACID BATTERIES

Part No.	Panasonic Model	(V)	Capacity (Ah)	Each	Carton
P129	LCR-306P	6	3.0 (10h. rate)	15.86/1	290.00/24
P130	LCR-456P	6	4.5 (10h. rate)	22.70/1	422.32/24
P131	LCR-606P	6	6.0 (10h. rate)	27.10/1	306.30/24
P132	LCR-756P	6	7.5 (10h. rate)	39.70/1	373.00/12
P128	6M1.2	6	1.2 (20h. rate)	12.30/1	364.00/40

LITHIUM BATTERIES

Part No.	Panasonic Model	Type	(V)	Capacity (mAh)	Each	Carton
P140	BR425	Pin	3	20	2.16/1	180.00/100
P139	BR-435	Pin	3	25	2.16/1	180.00/100
P141	BR400S				.75/1	63.00/100
P134	BR-2325	Coin	3	150	2.67/1	405.00/200
P136	BR-1/2A	Cyl.	3	750	14.31/1	239.00/20
P133	BR-2/3A	Cyl.	3	1200	14.45/1	178.41/20
P135	BR-2320	Coin	3	110	2.67/1	445.00/200
P137	BR-2016	Coin	3	50	2.67/1	445.00/200
P138	CR-2016	Coin	3	50	2.67/1	445.00/200
P142	BR-2325MML1	Coin	3	160	3.15/1	629.00/100
P143	BR-2325MML2	Coin	6	160	9.53/1	797.30/100

ZNR

PANASONIC TRANSIENT SURGE ABSORBER

Part No.	Range at 1mA DC	Max Volt VAC RMS	Max Volt VDC	Max Clamp Volt	Price 1	Price 10
CO-7201	185-225	130	170	340	.88	7.40
CO-7221	198-242	140	180	360	.88	7.40
CO-7241	216-264	150	200	395	.88	7.40
C1-0201	185-225	130	170	340	1.04	8.70
C1-0221	198-242	140	180	360	1.04	8.70
C1-0241	216-264	150	200	395	1.04	8.70
C1-4201	185-225	130	170	340	1.21	10.10
C1-4221	198-242	140	180	360	1.21	10.10
C1-4241	216-264	150	200	395	1.21	10.10
C2-0201	185-225	130	170	340	1.38	11.50
C2-0221	198-242	140	180	360	1.38	11.50
C2-0241	216-264	150	200	395	1.38	11.50

HOBBY-BLOX

THE NEW MODULAR CIRCUIT BUILDING SYSTEM

Whether you're a beginner or an advanced hobbyist, Hobby-Blox is the right system for you. The Hobby Blox System takes you as far as your imagination will go. Begin at the beginning with a Hobby-Blox starter pack. You can expand the Hobby Blox System with a complete line of modules.

BASIC INTEGRATED CIRCUIT STARTER PACK
The IC Starter Pack includes two terminal strips, two distribution strips and a spacer support strip, already in a Hobby Blox tray, ready for use. A free project booklet containing ten IC projects with step-by-step instructions completes the pack. Purchase of the IC Starter Pack saves you one dollar over price of modules purchased separately.
Part No. 921490 R $5.97

BASIC DISCRETE COMPONENT STARTER PACK
This starter pack contains a tray, discrete component strip, battery holder and connector (battery not included) and project booklet with ten projects. Purchase of the Discrete Component Starter Pack saves you one dollar over price of modules purchased separately.
Part No. 921480 R $6.57

Available from DIGI-KEY in one package, all the electronic components needed for the HOBBY-BLOX Starter Packs.

INTEGRATED CIRCUIT STARTER PACK COMPONENTS
Order Part No. 921491 R $8.95

DISCRETE COMPONENT STARTER PACK COMPONENTS
Order Part No. 921481 R $3.95

FREQUENCY COUNTER, DIGITAL VOLTMETER & PULSE GENERATOR
This build up shows the versatility of the HOBBY BLOX system. The tray layout consisting of 2 horizontal trays and 2 vertical trays locked together provides several advantages. First of all, the six displays were able to be mounted in line in a good and readable location. Also, the tray division made it possible to build the various functions in separate physical sections. The 6 binding posts provide a convenient interface means for power supply connections as well as input/output connections to the various functions in this triple instrument.

SLOT MACHINE
Here's a version of the old one-armed bandit built on the HOBBY BLOX system. Note the extra versatility of the dark grey 3x16 terminal strips. The LEDs mounted on them simulate the three reels. The counters and decoder drivers are also mounted on them and you can see how this arrangement helped clean up the wiring.

CONTINUITY TESTER & LOGIC PROBE
The continuity tester circuit (on the rear-most terminal strips) was a snap to build on the HOBBY-BLOX system. The easy speaker mounting completes the tester. In the logic probe section, a discrete component strip was used for the transistor circuitry while again the 3x16 terminal strip was just right for mounting the 7-segment display.

TRAY Part No. 921500-R $1.98
All modules fit easily into the Hobby-Blox tray which is the basis for the entire Hobby Blox system.

DISTRIBUTION STRIPS Part No. 921510-R $1.99
Includes two distribution strips, each of which has two continuous 26 tie-point terminals. With the Hobby-Blox distribution strips, it's easy to connect your circuitry to power and ground.

3x36 TERMINAL STRIPS Part No. 921505-R $2.99
Two terminal strips and a spacer/support strip make up this pack. Each terminal strip contains 26 3 tie-point terminals.

BLANK PANEL PACK Part No. 921550-R $1.69
A custom piece for any hobbyist. The blank panel allows you to drill holes in any manner of configuration to suit any mounting you desire.

BUS STRIP Part No. 921520-R $2.99
This Hobby Blox module contains two continuous rows of 60 tie-point terminals for easy power and ground busing the entire length of the tray and also between trays with its unique tray interlocking features.

3x16 TERMINAL STRIP Part No. 921525 R $2.99
Consists of three patterns of terminals with each pattern containing two rows of eight contracts. This strip will accept three each 7 segment displays, 14 or 16 pin DIPS.

L.E.D. STRIP Part No. 921530 R $1.99
Accepts six LEDs and includes a common BUS for current limiting resistor.

DISCRETE COMPONENT STRIP Part No. 921515-R $2.99
This module is the answer to breadboarding circuits with larger components. It contains 14 terminals, each with five tie-points. The tie points are spaced 2" apart both vertically and horizontally.

BINDING POST STRIP Part No. 921560-R $3.39
Includes three five-way binding posts. Each binding post is electronically connected to a solderless plug-in tie-point.

TRAY EXTENDER CLIPS Part No. 921570-R $1.29
Expandability is not only side-by-side with the Hobby Blox system. The tray extender clips allow you to attach trays end to-end also. Includes four clips.

CONTROL PANEL PACK Part No. 921545-R $1.69
Includes two control panels and two spacer/support strips. Accepts a wide variety of switches and indicators.

SPEAKER PANEL PACK Part No. 921540 R $1.69
Includes two speaker panels and two spacer/support strips. Readily accepts a 2" or smaller diameter speaker.

BATTERY HOLDER PACK Part No. 921555-R $2.59
Includes battery holder and connector for a 9 volt battery. (Battery not included)

VERTICAL TRAY PACK Part No. 921535-R $1.69
Includes a smaller tray and an adaptor strip that allows you to mount the tray perpendicular to the horizontal tray.

SUPER-STRIPS

UNIVERSAL BREADBOARDING ELEMENTS WITH SOLDERLESS PLUG-IN TIE POINTS

The A P Super-Strips combine a power/signal distribution system with a matrix of 128 terminals, each with 5 tie points. The distribution system consists of eight buses, each individual bus consisting of a line of 25 tie points. All tie points are the solderless plug-in type of the same design used on A P terminal Strips and A P Distribution Strips.

923252	(Alloy 770 Terminals)	17.00
923748	(Gold plated Terminals)	29.95

POWERACE

For faster and easier prototyping. They have built in power supplies.

Powerace 101
With plus 5 to plus 15 VDC adj power supply, No. 923101 $79.95

Powerace 103
Triple-output power supply for digital & linear, No. 923013 $124.95
Other equipment too numerous to mention, available

Powerace 102
A digital lab including a logic probe & clock, No. 923102 $124.95

For complete AP Products specifications get your FREE DIGI-KEY catalog today

DIGI-KEY Precut/Prestripped Wire

Precut/Prestripped 100 Wire Package

Bulk Wire Wrap Wire

Wire Assortment No. WK-1-A
900 Precut/Prestripped No. 30 Wire Wrap Wire. Assortment consists of following lengths and quantities:
250—3" 100—4½"
250—3½" 100—5"
100—4" 10—6"
Catalog No. WK-1-A $17.95

Wire Assortment No. WK-2-A
2800 Precut prestripped No. 30 Wire Wrap Wire. Assortment consists of following lengths and quantities:
250—2½" 250—5"
500—3" 100—5½"
500—3½" 250—6"
500—4" 100—6½"
250—4½" 100—7"

Wire Stripped 1" both ends. Catalog No. WK-2-A $42.95

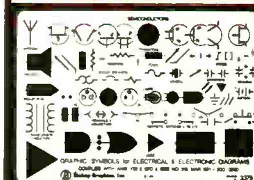
PRECUT/PRESTRIPPED WIRE 100 Wires/Package

Part No.	Color / Length	Cost
B3	30-AWG Blue Wire, 3" Overall Length	$2.25
Y3	30-AWG Yellow Wire, 3" Overall Length	2.25
W3	30-AWG White Wire, 3" Overall Length	2.25
R3	30-AWG Red Wire, 3" Overall Length	2.25
B4	30-AWG Blue Wire, 4" Overall Length	2.40
Y4	30-AWG Yellow Wire, 4" Overall Length	2.40
W4	30-AWG White Wire, 4" Overall Length	2.40
R4	30-AWG Red Wire, 4" Overall Length	2.40
B5	30-AWG Blue Wire, 5" Overall Length	2.65
Y5	30-AWG Yellow Wire, 5" Overall Length	2.65
W5	30-AWG White Wire, 5" Overall Length	2.65
R5	30-AWG Red Wire, 5" Overall Length	2.65
B6	30-AWG Blue Wire, 6" Overall Length	2.90
Y6	30-AWG Yellow Wire, 6" Overall Length	2.90
W6	30-AWG White Wire, 6" Overall Length	2.90
R6	30-AWG Red Wire, 6" Overall Length	2.90
B7	30-AWG Blue Wire, 7" Overall Length	3.50
Y7	30-AWG Yellow Wire, 7" Overall Length	3.50
W7	30-AWG White Wire, 7" Overall Length	3.50
R7	30-AWG Red Wire, 7" Overall Length	3.50
B8	30-AWG Blue Wire, 8" Overall Length	3.75
Y8	30-AWG Yellow Wire, 8" Overall Length	3.75
W8	30-AWG White Wire, 8" Overall Length	3.75
R8	30-AWG Red Wire, 8" Overall Length	3.75

30 AWG Kynar Insulated in Bulk Continuous Length

Part No.	Color	Length	Cost
100 RD	Red	100 feet	$3.10
100 BK	Black	100 feet	3.10
100 BU	Blue	100 feet	3.10
500 RD	Red	500 feet	13.50
500 BK	Black	500 feet	13.50
500 BU	Blue	500 feet	13.50
1000 RD	Red	1000 feet	23.75
1000 BK	Black	1000 feet	23.75
1000 BU	Blue	1000 feet	23.75

Bishop Graphics



Graphic Symbols For Electrical & Electronic Diagrams. Combination of frequently used symbols for quick delineation of electronic circuitry. Designed for use with .200" grid 0.030" thick.
Catalog No. 3378-ND $7.50

DONUT PADS

Quantity: 500 Symbols/Pkg.

	OD IN	OD MM	ID IN	ID MM	CAT. NO	Price PKG (Block)
Standard Inch	.050	1.27	.015	0.38	D135-ND	$4.40
	.075	1.91	.025	0.64	D311-ND	$4.40
	.100	2.54	.031	0.79	D101-ND	$4.40
Not Etchant Immersible	.125	3.18	.040	1.02	D102-ND	$2.90
	.150	3.81	.031	0.79	D144-ND	$2.90
	.150	3.81	.040	1.02	D203-ND	$2.90
	.156	3.96	.031	0.79	D103-ND	$2.90
	.187	4.75	.040	1.02	D104-ND	$2.90
	.200	5.08	.040	1.02	D204-ND	$2.90
	.250	6.35	.062	1.57	D109-ND	$2.90
	.375	9.53	.062	1.57	D114-ND	$3.70
	.500	12.70	.062	1.57	D119-ND	$5.70

DUAL IN-LINE PACKAGE

(DIP) Pattern
Not Etchant Immersible

No. of Leads	Qty.	Scale	Cat. No	Price Per Pkg (Block)
8	250	1X	6487-ND	$9.95
	250	2X	6488-ND	$9.95
10	250	1X	6511-ND	$11.00
	250	2X	6512-ND	$11.00
14	250	1X	6014-ND	$11.00
	250	2X	6038-ND	$11.00
16	250	1X	6004-ND	$11.00
	250	2X	6109-ND	$11.00
18	250	1X	6900-ND	$11.00
	250	2X	6901-ND	$11.00
24	100	1X	6535-ND	$11.00
	100	2X	6536-ND	$11.00
28	100	1X	6903-ND	$11.00
	100	2X	6904-ND	$11.00
	100	1X	6559-ND	$11.00
36	100	2X	6560-ND	$14.10
	100	1X	6906-ND	$14.10
40	100	2X	6907-ND	$14.10

Precision Slit PC Artwork Tape

Not Etchant Immersible

Tape Size	MM Equiv	Order No. Black (T201) 20 Yds	Price Per Roll
.020	0.51	201-020-11-ND	$1.15
.031	0.79	201-031-11-ND	$1.15
.040	1.02	201-040-11-ND	$1.15
.050	1.27	201-050-11-ND	$1.15
.062	1.57	201-062-11-ND	$1.15
.080	2.03	201-080-11-ND	$1.15
.100	2.54	201-100-11-ND	$1.20
.125	3.18	201-125-11-ND	$1.20
.156	3.96	201-156-11-ND	$1.20
.200	5.08	201-200-11-ND	$1.20
.250	6.35	201-250-11-ND	$1.44
.300	7.62	201-300-11-ND	$1.44
.375	9.53	201-375-11-ND	$1.70
.400	10.16	201-400-11-ND	$1.70
.750	19.05	201-750-11-ND	$2.50

Multimeter

by YFE

Ranges:
DC voltage: 525 125 500 2.5k Volts (20,000 Ohms per volt)
AC voltage: 10 50 250 1000 Volts (10,000 Ohms per Volt)
DC Current: 0__50uA 0__250mA
Resistance: 0__60k, 0__6M
Decibels: -20 to plus 22DB
Output jacks for audio measurements.
Instructions for use and schematic diagram are included with each meter.
Model YF-20K-ND $19.95

The Digi-Key volume discount and handling charges are simple to apply. Most items sold by Digi-Key may be combined for a volume discount. Items that are not discountable are identified by the suffix-ND following the part number. After writing your order, total all of the discountable items and apply the appropriate discount. To this subtotal, add the non-discountable items. Then add the handling charge. We pay all shipping and insurance to addresses in the U.S.A., Canada and Mexico when payment accompanies order.
WHEN ORDERING BY PHONE, CALL: 1-800-346-5144 (Mn., Ak., Hi., call 218-681-6674) By mail send your order to: DIGI-KEY, Highway 32 South, Thief River Falls, MN 56701
You may pay by check, money order, Master Charge, VISA or C.O.D. *DIGI-KEY GUARANTEE:* Any parts or products purchased from Digi-Key that prove to be defective will be replaced or refunded if returned within 90 days from receipt with a copy of your invoice.

HANDLING CHARGES		VOLUME DISCOUNT	
$ 0.00-$ 9.99	Add $2.00	$ 0.00-$ 99.99	NET
$ 10.00-$25.00	Add $0.75	$ 100.00-$249.99	Less 10%
$ 25.00-$49.99	Add $0.50	$ 250.00-$499.99	Less 15%
$ 50.00-$99.99	Add $0.25	$ 500.00-$999.99	Less 20%
$100.00 & Up	No Charge	$1000.00 & Up	Less 25%

CIRCLE NO. 19 ON FREE INFORMATION CARD

SN7400N	.25	**7400**		SN74156N	.79
SN7401N	.25			SN74157N	.69
SN7402N	.25			SN74160N	.89
SN7403N	.25	SN7472N	.29	SN74161N	.89
SN7404N	.25	SN7473N	.35	SN74162N	.89
SN7405N	.29	SN7474N	.35	SN74163N	.89
SN7406N	.35	SN7475N	.49	SN74164N	.89
SN7407N	.35	SN7476N	.35	SN74165N	.89
SN7408N	.29	SN7480N	.50	SN74166N	1.25
SN7409N	.29	SN7482N	.99	SN74167N	2.79
SN7410N	.25	SN7483N	.69	SN74170N	1.95
SN7411N	.29	SN7485N	.89	SN74172N	4.95
SN7412N	.35	SN7486N	.35	SN74173N	1.39
SN7413N	.40	SN7489N	1.75	SN74174N	.99
SN7414N	.69	SN7490N	.49	SN74175N	.89
SN7416N	.29	SN7491N	.59	SN74176N	.79
SN7417N	.29	SN7492N	.45	SN74177N	.79
SN7420N	.25	SN7493N	.45	SN74179N	1.49
SN7421N	.29	SN7494N	.69	SN74180N	.79
SN7422N	.45	SN7495N	.69	SN74181N	2.25
SN7423N	.29	SN7496N	.69	SN74182N	.79
SN7425N	.29	SN7497N	3.00	SN74184N	2.49
SN7426N	.29	SN74100N	1.49	SN74185N	2.49
SN7427N	.25	SN74107N	.35	SN74190N	1.25
SN7429N	.39	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

74LS00	.29	**74LS**		74LS192	1.15
74LS01	.29			74LS193	1.15
74LS02	.29	74LS92	.75	74LS194	1.15
74LS03	.29	74LS93	.75	74LS195	1.15
74LS04	.35	74LS95	.99	74LS197	1.19
74LS05	.35	74LS96	1.15	74LS221	1.19
74LS08	.29	74LS107	.45	74LS240	1.95
74LS09	.35	74LS109	.45	74LS241	1.95
74LS10	.29	74LS112	.45	74LS242	1.95
74LS11	.75	74LS113	.49	74LS243	1.95
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74LS15	.35	74LS125	.89	74LS248	1.19
74LS20	.29	74LS126	.55	74LS249	1.19
74LS21	.35	74LS132	.99	74LS251	1.49
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74LS26	.35	74LS136	.49	74LS257	.89
74LS27	.35	74LS138	.89	74LS258	.99
74LS28	.35	74LS139	.89	74LS260	.69
74LS30	.29	74LS151	.89	74LS266	.69
74LS32	.35	74LS153	.89	74LS273	1.95
74LS33	.59	74LS154	1.75	74LS279	.75
74LS37	.45	74LS155	1.19	74LS283	1.09
74LS38	.49	74LS156	1.19	74LS290	.99
74LS40	.35	74LS157	.89	74LS293	.99
74LS42	.89	74LS158	.99	74LS298	1.25
74LS47	.89	74LS160	1.15	74LS352	1.29
74LS48	1.15	74LS161	1.15	74LS353	1.29
74LS49	1.15	74LS162	1.15	74LS365	.75
74LS51	.29	74LS163	1.15	74LS366	.75
74LS54	.29	74LS164	1.25	74LS367	.75
74LS55	.29	74LS165	1.25	74LS368	.75
74LS73	.45	74LS166	1.25	74LS373	1.95
74LS74	.45	74LS168	1.19	74LS374	1.95
74LS75	.59	74LS169	1.19	74LS375	.89
74LS76	.45	74LS170	2.49	74LS386	.69
74LS78	.49	74LS173	1.19	74LS393	2.49
74LS83	.89	74LS174	.99	74LS399	2.49
74LS85	1.25	74LS175	.99	74LS670	2.49
74LS86	.45	74LS181	2.95	81LS95	1.95
74LS90	.59	74LS190	1.25	81LS97	1.95
		74LS191	1.25		

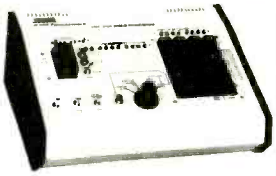
74S00	.50	**74S**		74S244	3.25
74S02	.50			74S251	1.45
74S03	.50	74S133	.55	74S253	1.45
74S04	.55	74S134	.69	74S257	1.35
74S05	.55	74S135	1.19	74S258	1.35
74S08	.50	74S136	1.75	74S260	.79
74S09	.50	74S138	1.35	74S280	2.95
74S10	.50	74S139	1.35	74S287*	4.95
74S11	.50	74S140	1.15	74S288*	4.95
74S15	.50	74S151	1.35	74S373	3.49
74S20	.50	74S153	1.35	74S374	3.49
74S22	.50	74S157	1.35	74S387*	5.95
74S30	.50	74S158	1.35	74S472*	19.95
74S32	.55	74S174	1.59	74S473*	19.95
74S40	.55	74S175	1.59	74S474*	21.95
74S51	.50	74S188	4.95	74S475*	21.95
74S64	.50	74S194	1.95	74S570*	7.95
74S65	.50	74S195	1.95	74S571*	7.95
74S74	.79	74S196	3.95	74S572*	19.95
74S86	.79	74S240	2.95	74S573*	19.95
74S112	.79	74S241	2.95	74S574*	14.95
74S113	.79	74S242	3.25	74S940	3.15
74S114	.79	74S243	3.25	74S941	3.15

* LIMITED AVAILABILITY ON THESE PROMS

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

CD4000	.39	**CD—CMOS**		CD4082	.39
CD4001	.39			CD4093	.99
CD4002	.39			CD4098	2.49
CD4006	1.19			CD4506	.75
CD4007	.25	CD4041	1.49	CD4507	.99
CD4009	.49	CD4042	.99	CD4508	3.95
CD4010	.49	CD4043	.89	CD4510	1.39
CD4011	.39	CD4044	.89	CD4511	1.29
CD4012	.25	CD4046	1.79	CD4514	3.95
CD4013	.49	CD4047	2.50	CD4515	2.95
CD4014	1.39	CD4048	1.35	CD4516	1.49
CD4015	1.19	CD4049	.49	CD4518	1.79
CD4016	.59	CD4050	.69	CD4519	.89
CD4017	1.19	CD4051	1.19	CD4520	1.29
CD4018	.99	CD4052	1.19	CD4526	1.79
CD4019	.49	CD4053	1.19	CD4528	1.79
CD4020	1.19	CD4056	2.95	CD4529	1.95
CD4021	1.39	CD4059	9.95	CD4543	2.79
CD4022	1.19	CD4060	1.49	CD4562	11.95
CD4023	.29	CD4066	.79	CD4566	2.79
CD4024	.79	CD4068	.39	CD4583	2.49
CD4025	.23	CD4069	.45	CD4723	1.95
CD4026	2.95	CD4070	.55	CD4724	1.95
CD4027	.69	CD4071	.49	MC14409	14.95
CD4028	.89	CD4072	.49	MC14410	14.95
CD4029	1.49	CD4073	.39	MC14411	14.95
CD4030	.49	CD4075	.39	MC14412	11.95
CD4035	.99	CD4076	1.39	MC14419	4.95
CD4040	1.49	CD4081	.39	MC14433	13.95

JE608 PROGRAMMER
2708 EPROM PROGRAMMER



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

The JE608 EPROM Programmer is a completely self-contained unit which is independent of computer control and requires no additional systems for its operations. The EPROM can be programmed from the Hexadecimal Keyboard or from a pre-programmed EPROM. The JE608 Programmer can emulate a programmed EPROM by the use of its internal RAM circuits. This will allow the user to test or pretest a program, for a system, prior to programming a chip. Any changes in the program can be entered directly into the memory circuits with the Hexadecimal Keyboard so that rewriting the entire program will not be necessary. The JE608 Programmer contains a Programmer/Board with 25 IC's and including 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

DISCRETE LEDS

XC556R	.200" red	5/$1	MV50	.085" red	6/$1	XC111R	.190" red	5/$1
XC556G	.200" green	4/$1	XC209R	.125" red	5/$1	XC111G	.190" green	4/$1
XC556Y	.200" yellow	4/$1	XC209G	.125" green	4/$1	XC111Y	.190" yellow	4/$1
XC556C	.200" clear	4/$1	XC209Y	.125" yellow	4/$1	XC111C	.190" clear	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			

INFRA-RED LED
¼" x ¼" x 1/16" flat
IRL — 5/$1

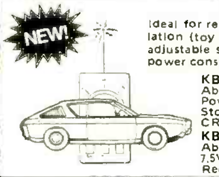
DISPLAY LEDS

C.A. — Common Anode C.C. — Common Cathode

Type	Polarity	Ht	Price	Type	Polarity	Ht	Price
MAN 1	C.A.—red	.270	2.95	DL741	C.A.—red	.600	1.25
MAN 2	5x7 D.M.—red	.300	4.95	DL746	C.A.—red ± 1	.630	1.49
MAN 3	C.C.—red	.125	.25	DL747	C.A.—red	.600	1.49
MAN 52	C.A.—green	.300	1.25	DL750	C.C.—red	.600	1.49
MAN 54	C.C.—green	.300	1.25	DL33B	C.C.—red	.110	.35
MAN 71	C.A.—red	.300	.75	FND70	C.C.	.250	.69
MAN 72	C.A.—red	.300	.75	FND358	C.C. ± 1	.357	.99
MAN 74	C.C.—red	.300	1.25	FND359	C.C.	.357	.75
MAN 82	C.A.—yellow	.300	.49	FND503	C.C. (FND500)	.500	.99
MAN 84	C.C.—yellow	.300	.99	FND507	C.A. (FND510)	.500	.99
MAN 3620	C.A.—orange	.300	.49	HDSP-3401	C.A.—red	.800	1.50
MAN 3630	C.A.—orange ± 1	.300	.99	HDSP-3403	C.C.—red	.800	1.50
MAN 3640	C.C.—orange	.300	.99	5082-7613	C.C., R.H.D.—red	.300	1.25
MAN 4610	C.A.—orange	.400	.99	5082-7620	C.A., L.H.D.—yel.	.300	1.25
MAN 6610	C.A.—orange—DD	.560	.99	5082-7623	C.C., R.H.D.—yel.	.300	1.25
MAN 6630	C.A.—orange ± 1	.560	.99	5082-7730	C.A., L.H.D.—red	.300	.99
MAN 6640	C.C.—orange—DD	.560	.99	5082-7731	C.A., R.H.D.—red	.300	1.25
MAN 6650	C.C.—orange ± 1	.560	.99	5082-7750	C.A., L.H.D.—red	.430	1.75
MAN 6660	C.A.—orange	.560	.99	5082-7751	C.A., R.H.D.—red	.430	1.25
MAN 6710	C.A.—red—DD	.560	.99	5082-7760	C.C., R.H.D.—red	.430	1.75
MAN 6750	C.C.—red ± 1	.560	.99	5082-7300	4x7 sgl. dig. RHD	.600	22.00
MAN 6780	C.C.—red	.560	.99	5082-7302	4x7 sgl. dig. LHD	.600	22.00
DL704	C.C.—red	.300	1.25	5082-7304	Overnge. char. (±1)	.600	19.95
DL707	C.A.—red	.300	1.25	LIT-1	Photo Xsistor Opto-Isol.		.69
DL728	C.C.—red	.500	1.49	MOC3010	Optically Isol. Triac Driver		1.25

RADIO CONTROL CIRCUITS

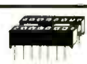
NEW!



Ideal for remote control systems which use pulse amplitude modulation (toy cars, boats, tanks, etc.) Features: five function control, adjustable steering angle, suitable for 27 and 47MHz bands and low power consumption.

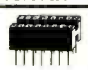
KB-4428 TRANSMITTER $4.25
Abs. max. rating (TA@25° C). Supply volt.: Vccl 12VDC. Power Dissip.: PD: 300mW; Temp. range: Oper. 0-+50°C — Storage -30— +125° C. Rec. oper. volt.: 7-11V. Crystal or CR Oscillation circuits acceptable.

KB-4429 RECEIVER $5.95
Abs. max. rating (TA@25° C). Supply volt.: Vccl: 11V. Vcc2: 7.5V. Power Dissip.: 600mW. Temp. range: Oper. 0 ± 50°C. Rec. oper. volt.: VOP1 7-11V — VOP2 3-6V.



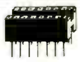
LOW PROFILE (TIN) SOCKETS

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



SOLDERTAIL STANDARD (TIN)

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



SOLDERTAIL (GOLD) STANDARD

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

WIRE WRAP SOCKETS (GOLD) LEVEL #3

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

1/4 WATT RESISTOR ASSORTMENTS – 5%

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

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INTERSIL

Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	22.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	28.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
7201IDR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	9.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	11.10
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	4-Digit LED Up/Down Counter	12.95
7218CIJI	8-Digit Univ. LED Drive	10.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IPA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.50
8212CPA	Volt Ref/Indicator	2.50

* INTERSIL'S EVALUATION KITS

74C00	.39	**74C**		74C195	1.59
74C02	.39			74C221	1.95
74C04	.39			74C240	2.25
74C08	.39	74C106	.75	74C244	2.25
74C10	.39	74C107	1.89	74C373	2.49
74C14	.75	74C151	2.95	74C374	2.59
74C20	.39	74C154	3.95	74C901	.89
74C30	.39	74C157	2.25	74C903	1.15
74C42	1.39	74C160	1.69	74C911	10.95
74C48	1.95	74C161	1.60	74C912	10.95
74C73	.79	74C162	1.49	74C915	1.69
74C74	.79	74C163	1.69	74C917	10.95
74C85	1.95	74C164	1.59	74C922	5.49
74C86	.99	74C173	1.39	74C923	5.75
74C89	6.95	74C174	1.39	74C925	7.50
74C90	1.29	74C175	1.39	74C926	7.50
74C93	1.29	74C192	1.69	80C95	.79
74C95	1.59	74C193	1.69	80C97	.79

LH0002CN	6.85	**LINEAR**		NE570N	4.95
LM10CLH	4.50			LM702H	.79
LM11CLH	4.75			LM703CN	.89
LH0070-OH	6.05	LM340T-5	1.25	LM709N	.29
TL071CP	.79	LM340T-12	1.25	LM710N	.79
TL072CP	1.39	LM340T-15	1.25	LM711N	.79
TL074CN	2.49	LM341P-5	.75	LM723N	.69
LH0082CD	35.80	LM341P-12	.75	LM733N	1.00
TL082CP	1.19	LM341P-15	.75	LM739N	1.19
TL084CN	2.19	LM342P-5	.69	LM741CN	.35
LH0094CD	36.80	LM342P-12	.69	MC1741SCG	3.00
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LM304H	1.95	LF351N	.60	LM1310N	1.95
LM305H	.99	LF353N	1.00	LM1458CN	.59
LM307CN	.45	LF355N	1.10	LM1488N	1.25
LM308CN	1.00	LF356N	1.10	LM1489N	1.25
LM309H	1.95	LM358N	1.00	LM1496N	1.95
LM309K	1.25	LM359N	1.79	LM1556V	1.75
LM310CN	1.75	LM370N	4.49	LM1800N	2.95
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LM312H	2.49	LM377N	2.95	LM1889N	3.20
LM317MP	1.15	LM380N	1.25	LM1896N	1.75
LM317T	1.75	LM381N	1.95	LM2002T	1.49
LM317K	3.95	LM382N	1.79	LM2877P	2.05
LM318CN	1.95	LM384N	1.95	LM2878P	2.25
LM319N	1.95	LM386N-3	1.29	LM2896P-1	2.25
LM320K-5	1.35	LM387N	1.45	LM3189N	2.95
LM320K-12	1.35	LM389N	1.35	LM3900N	.69
LM320K-15	1.35	LM392N	.69	LM3905CN	1.25
LM320T-5	1.25	LF398N	4.00	LM3909N	1.15
LM320T-12	1.25	LM399H	5.00	LM3914N	3.95
LM320T-15	1.25	TL494CN	4.49	LM3915N	3.95
LM323K-5	5.95	TL496CP	1.75	LM3916N	3.95
LM324N	.99	NE510A	6.00	RC4136N	1.25
LM329DZ	.65	NE529A	4.95	RC4151NB	3.95
LM331N	3.95	NE531H	3.95	RC4194TK	5.95
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LM335Z	1.40	NE540H	6.00	KB4428	4.25
LM336Z	1.75	NE544N	4.95	KB4429	5.95
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LM340K-12	1.35	LM566CN	1.95	75450N	.89
LM340K-15	1.35	LM567V	1.25	75451CN	.39

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

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

100 VOLT MYLAR FILM CAPACITORS

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

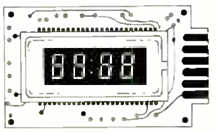
+20% DIPPED TANTALUMS (Solid) CAPACITORS

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

MINI. ALUMINUM ELECTROLYTIC CAPACITORS

Axial Lead				Radial Lead			
.47/50V	.16	.14	.10	.47/25V	.15	.13	.12
1.0/50V	.19	.16	.12	.47/50V	.16	.14	.13
3.3/50V	.17	.15	.11	1.0/16V	.15	.13	.12
4.7/25V	.18	.15	.11	1.0/25V	.16	.14	.13
10/25V	.18	.15	.11	1.0/50V	.17	.15	.14
10/50V	.19	.16	.12	4.7/16V	.15	.13	.12
22/25V	.19	.16	.12	4.7/25V	.16	.14	.13
22/50V	.24	.20	.18	4.7/50V	.17	.15	.14
47/25V	.25	.21	.19	10/16V	.15	.13	.12
47/50V	.29	.25	.23	10/25V	.16	.14	.13
100/25V	.28	.24	.22	10/50V	.17	.15	.14
100/50V	.41	.37	.34	47/50V	.25	.21	.19
220/25V	.39	.34	.33	100/16V	.21	.17	.14
220/50V	.49	.45	.41	100/25V	.25	.23	.21
470/25V	.54	.49	.45	100/50V	.37	.34	.31
1000/16V	.79	.69	.61	220/16V	.25	.21	.19
2200/16V	.89	.79	.69	470/25V	.35	.31	.27

National Semiconductor Clock Modules



12VDC AUTOMOTIVE/ INSTRUMENT CLOCK

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

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 $16.95

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MA1002 .5" LED Display Dig. Clock & Xformer	9.95

National Semiconductor

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MM5290J-2 (MK4116/UPD416) . . . **$6.95 each**
16K DYNAMIC RAM (150NS)
(8 EACH $49.95) (100 EACH $550.00/lot)

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(8 EACH $23.95) (100 EACH $250.00/lot)

MM2114-3 .... $5.95 each
4K STATIC RAM (300NS)
(8 EACH $43.95) (100 EACH $450.00/lot)

MM2114L-3 .... $6.25 each
4K STATIC RAM (LOW POWER 300NS)
(8 EACH $44.95) (100 EACH $475.00/lot)

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.

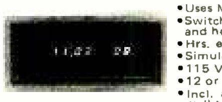
UVS-11E $79.50

Jumbo 6-Digit Clock Kit

- Four .630"ht. and two .300"ht. common anode displays
- Uses MM5314 clock chip
- Switches for hours, minutes and hold functions
- Hours easily viewable to 30 feet
- Simulated walnut case
- 115VAC operation
- 12 or 24 hour operation
- Includes all components, case and wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE747 .... $29.95

6-Digit Clock Kit



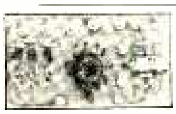
- Bright .300 ht. comm. cathode display
- Uses MM5314 clock chip
- Switches for hours, minutes and hold modes
- Hrs. easily viewable to 20 ft.
- Simulated walnut case
- 115 VAC operation
- 12 or 24 hr. operation
- Incl. all components, case & wall transformer
- Size: 6¾" x 3-1/8" x 1¾"

JE701 .... $19.95

Regulated Power Supply

Uses LM309K. Heat sink provided. PC board construction. Provides a solid 1 amp @ 5 volts. Can supply up to ±5V, ±9V and ±12V with JE205 Adapter. Includes components, hardware and instructions. Size: 3½" x 5" x 2"H

JE200 .... $14.95



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

DC/DC converter with +5V input. Toriodal hi-speed switching XMFR. Short circuit protection. PC board construction. Piggy-back to JE 200 board. Size: 3½" x 2" x 9/16"H

JE205 .... $12.95

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INS8080A	CPU	6.50
DP8212	8 Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
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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)	7.95
DP8253	Prog. Interval Timer	14.95
DP8255	Prog. Peripheral I/O (PPI)	9.95
DP8257	Prog. DMA Control	19.95
DP8259	Prog. Interrupt Control	14.95
DP8275	Prog. CRT Controller	49.95
DP8279	Prog. Keyboard/Display Interface	19.95
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DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95

6800/6800 SUPPORT DEVICES

MC6800	MPU	14.95
MC6802CP	MPU with Clock and RAM	19.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.43
MC6828	Priority Interrupt Controller	10.95
MC6830L8	1024x8-Bit ROM (MC68A30-8)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus. Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N)	13.95
Z80A (780-1)	CPU (MK3880N-4)	15.95
CDP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU—4-Bit Slice (Com. Temp. Grade)	19.95
MC56502	MPU w/Clock (65K Bytes Memory)	11.95
INS8035N-6	MPU—8-Bit (6MHz)	16.95
INS8039N-6	CPU—Sgl Chip 8-Bit (128 bytes RAM)	19.95
INS8040N-6	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
P8085	CPU	19.95
INS8900	CPU—16-Bit	29.95
TMS9900JL	MPU—16-Bit	49.95

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MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402	256-Bit Dynamic	3.95
MM5013	1024-Bit Dynamic/Accumulator	1.95
MM5016H	500/512-Bit Dynamic	.89
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V (1404A)	1024-Bit Dynamic	3.95
2518N	Hex 32-Bit Static	4.95
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 Pass Filter	19.95
AF122-1CJ	Touch Tone Low Pass Filter	19.95
LM308AH	Super Gain Op Amp	1.00
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°)	4.95
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
DAC1008LCN	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	5.95

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	5.95
2114L	1024x4 Static 450ns Low Power	6.95
2114-3	1024x4 Static 300ns	7.49
2114L-3	1024x4 Static 300ns Low Power	7.95
2117	16,384x1 Dynamic 550ns (housemarked)	4.95
MM2147J	4096x1 Fast 70ns	19.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.25
MM5280/2107	4096x1 Dynamic	4.95
MM5290J-2(4116)	16K Dynamic 250ns (UPD416)	6.95
MM5298J 3A	8K Dyn. 200ns (lower ½ of MM5290J)	4.95
7489	16x4 Static	1.75
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	14.95
TMS4045	1024x4 Static	14.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	9.95
TMS2716	16K EPROM (-5V, +5V, +12V)	19.95
2716 intel (2516) TI	16K EPROM (Single +5V)	17.95
2732 intel (2532) TI	32K EPROM	49.95
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MM5230N	2048-Bit Read Only Memory	1.95

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MCM66750P	128x9x7 Alpha. Control Char. Gen	13.50

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

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INS2651N	Communication Chip	19.95
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COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
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AY-5-9200	Repertory Dialer	14.95
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AY-5-2376	Keyboard Encoder (88 keys)	11.95
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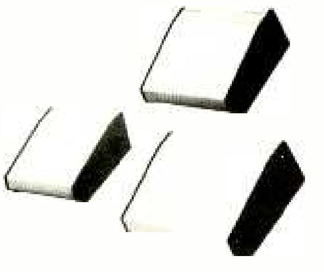
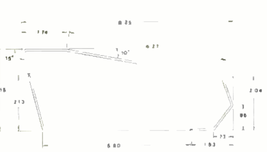
DESIGNERS' SERIES
Blank Desk-Top Electronic Enclosures



- High strength epoxy molded end pieces in mocha brown finish.
- Sliding rear/bottom panel for service and component accessibility.
- Top/bottom panels .080 thk alum. Alodine type 1200 finish (gold tint color) for best paint adhesion after modification.
- Vented top and bottom panels for cooling efficiency.
- Rigid construction provides unlimited applications.

CONSTRUCTION:
The "DTE" Blank Desk Top Electronic Enclosures are designed to blend and complement today's modern computer equipment and can be used in both industrial and home. The end pieces are precision molded with an internal slot (all around) to accept both top and bottom panels. The panels are then fastened to ¼" thick tabs inside the end pieces to provide maximum rigidity to the enclosure. For ease of equipment servicing, the rear/bottom panel slides back on slotted tracks while the rest of the enclosure remains intact. Different panel widths may be used while maintaining a common profile outline. The molded end pieces can also be painted to match any panel color scheme.



Enclosure Model No.	Panel Width	PRICE
DTE-8	8.00"	$29.95
DTE-11	10.65"	$32.95
DTE-14	14.00"	$34.95

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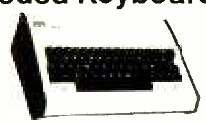


The JE610 ASCII Keyboard Kit can be interfaced into most any computer system. The kit comes complete with an industrial grade keyboard switch assembly (62-keys), IC's, sockets, connector, electronic components and a double-sided printed wiring board. The keyboard assembly requires +5V @ 150mA and −12V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

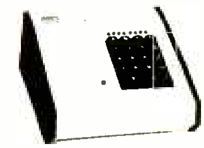
JE610 (Case not included) **$79.95**
K62 (Keyboard only) $34.95

Desk-Top Enclosure for JE610 ASCII Encoded Keyboard Kit
Compact desk-top enclosure: Color-coordinated designer's case with light tan aluminum panels and molded end pieces in mocha brown. Includes mounting hardware. Size: 3½"H x 14½"W x 8¾"D.

DTE-AK $49.95
SPECIAL: JE610/DTE-AK PURCHASED TOGETHER (Value $129.90) $124.95

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 a standard 16-pin IC connector. Only +5VDC required for operation.

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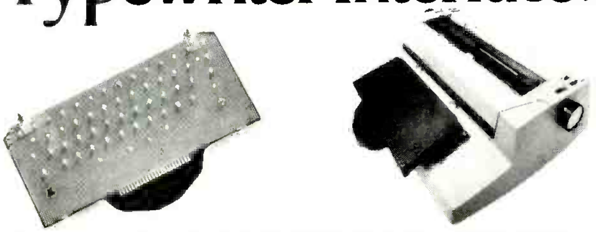

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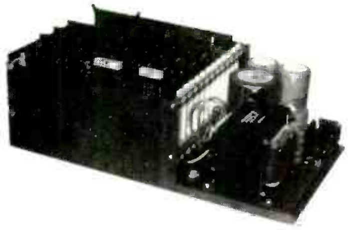

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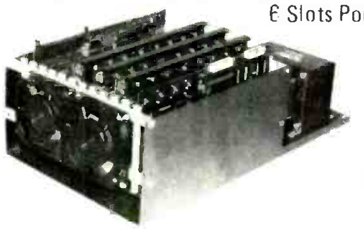

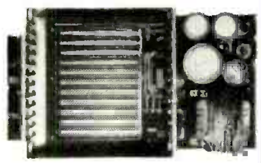

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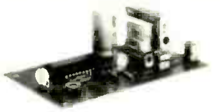

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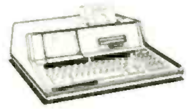
"C" stands for continuous memory



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4116	200ns	5.99	8085A		12.95

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LS SERIES

LOOK AT THIS LS PRICING!

74LS00	.32	74LS85	1.23	74LS175	1.09
74LS02	.38	74LS86	.45	74LS191	1.31
74LS04	.35	74LS93	.71	74LS195	1.39
74LS08	.38	74LS95	1.11	74LS221	1.28
74LS10	.32	74LS109	.49	74LS240	1.89
74LS20	.35	74LS138	.79	74LS241	1.89
74LS30	.35	74LS139	.79	74LS244	1.79
74LS32	.39	74LS151	.79	74LS283	1.03
74LS38	.39	74LS153	.79	74LS298	1.24
74LS42	.79	74LS157	.79	74LS367	.99
74LS51	.35	74LS158	.82	74LS368	.99
74LS54	.35	74LS161	.99	74LS373	1.85
74LS73	.44	74LS163	.99	74LS374	1.81
74LS74	.48	74LS174	1.19	74LS377	1.48

OTHER SPECIALS

7400	10/1.99	95H90	7.95
7404	10/1.99	RED LED	10/1.00
7447	5/2.49	GREEN LED	6/1.00
7490	5/1.99	YELLOW LED	6/1.00
7493	5/1.99	2N3904	8/1.00
74151	3/1.99	2N3906	8/1.00
74153	3/1.99	2N3055	.79
74157	3/1.99	4MHZ Crystal	2.00
74161	5/3.99	5MHZ Crystal	2.00
74163	5/3.99	10MHZ Crystal	2.00

LINEAR IC'S

LM301-8	.34	LM555-8	.39
LM310	.64	LM556	.69
LM3118	.64	LM565	.99
LM318-8	1.49	LM567	1.29
LM319	1.29	LM741-8	.29
LM324	.59	LM747	.79
LM377	2.29	LM1458-8	.69
LM380	1.29	LM1889	2.49

REGULATORS

7805T	.89	7905T	.99
7812T	.89	7912T	.99
7815T	.99	7905K	1.29

DIP SWITCHES

4 position	.99
5 position	1.02
6 position	1.06
7 position	1.09
8 position	1.14

IC SOCKETS

14 pin	10/1.49
16 pin	10/1.69
24 pin	4/1.00

IMSAI S-100 edge connector solder tail gold 2.49

MA1012A CLOCK MODULE

Complete alarm clock module with special transformer and spec sheets included. Just add switches 8.99 3/24

TERMS: Include $2.00 for shipping. $10.00 minimum order. Send SASE for complete catalog

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INTEGRATED CIRCUITS

7400TTL	
7400N	19
7402N	20
7404N	25
7409N	23
7410N	20
7414N	70
7420N	20
7422N	39
7430N	20
7442N	58
7445N	74
7447N	58
7448N	77
7450N	20
7474N	35
7475N	49
7485N	88
7489N	1 85
7490N	43
7492N	43
7493N	43
7495N	69
74100N	1 20
74107N	35
74121N	34
74123N	59
74125N	45
74145N	77
74150N	1 20
74151N	69
74154N	2 00
74157N	69
74161N	87
74162N	1 25
74163N	87
74174N	96
74175N	95
74190N	1 15
74192N	87
74193N	85
74221N	2 75
74298N	1 65
74365N	89
74366N	89
74367N	89
74LS00 TTL	
74LS00N	35
74LS02N	35
74LS04N	55
74LS05N	40
74LS08N	45
74LS10N	45
74LS13N	55
74LS14N	1 25
74LS20N	45
74LS22N	45
74LS28N	45
74LS30N	45
74LS33N	75
74LS38N	75
74LS74N	1 25
74LS75N	1 00
74LS90N	1 00
74LS93N	1 00
74LS95N	1 10
74LS107N	65
74LS112N	65
74LS113N	45
74LS132N	89
74LS136N	65
74LS151N	1 10
74LS155N	1 10
74LS157N	1 10
74LS162N	1 65
74LS163N	1 65
74LS174N	2 00
74LS190N	1 25
74LS221N	2 50
74LS258N	1 60
74LS367N	1 65
LINEAR	
CA3045	90
CA3046	1 10
CA3081	1 80
CA3082	1 90
CA3089	2 95
LM301AN AH	35
LM305H	87
LM307N	35
LM308N	1 00
LM309K	1 50
LM311H/N	90
LM317T/K	3 75
LM318	1 35
LM320K-5	1 50

LM323K 5	5 95
LM320K 12	1 50
LM320K 15	1 50
LM320T 5	1 35
LM320T-8	1 35
LM320T-12	1 35
LM320T-15	1 35
LM324N	1 40
LM339N	1 00
LM340K-5	1 35
LM340K-8	1 35
LM340K-12	1 35
LM340K-15	1 35
LM340K-24	1 35
LM340T-5	1 25
LM340T-8	1 25
LM340T-12	1 25
LM340T-15	1 25
LM340T-18	1 25
LM340T-24	1 25
LM350	7 50
LM377	3 50
LM379	5 00
LM380N	1 00
LM381	1 60
LM382	1 60
LM703H	65
LM709H	28
LM723H N	50
LM733N	85
LM741CH	35
LM741N	38
LM747H/N	75
LM748N	35
LM1303N	1 75
LM1304	1 10
LM1305	1 27
LM1307	2 00
LM1310	2 75
LM1458	47
LM1812	7 50
LM1889	3 00
LM2111	1 75
LM2902	2 25
LM3900N	60
LM3905	1 75
LM3909N	95
MC1458V	50
NE550N	1 00
NE555V	39
NE556A	85
NE565A	1 00
NE566V	1 50
NE567V	1 00
NE570B	4 75
78L05	60
78L08	60
78M05	85
75108	1 75
75491CN	50
75492CN	55
75494CN	89
A to D CONVERTER	
8038B	4 50
8700CJ	13 95
8701CN	22 00
8750CJ	13 95
LD130	9 95
9400CJV F	7 40
ICL7103	9 50
ICL7107	14 25
CMOS	
CD4000	25
CD4001	35
CD4002	35
CD4006	1 10
CD4007	35
CD4008	28
CD4009	45
CD4010	45
CD4011	35
CD4012	28
CD4013	47
CD4014	1 25
CD4015	1 00
CD4016	55
CD4017	1 05
CD4018	94
CD4019	45
CD4020	1 02
CD4021	1 35
CD4022	1 10
CD4023	28
CD4024	75
CD4025	28

CD4026	2 50
CD4027	66
CD4028	85
CD4029	1 35
CD4030	45
CD4035	1 35
CD4040	1 35
CD4042	85
CD4043	85
CD4044	85
CD4046	1 67
CD4049	45
CD4050	49
CD4051	1 13
CD4060	1 42
CD4066	71
CD4068	40
CD4069	40
CD4070	50
CD4071	45
CD4072	45
CD4073	45
CD4075	45
CD4076	1 65
CD4078	40
CD4081	35
CD4082	35
CD4116	47
CD4490	5 50
CD4507	1 00
CD4508	4 25
CD4510	1 02
CD4511	94
CD4515	2 52
CD4516	1 10
CD4518	1 02
CD4520	1 02
CD4527	1 51
CD4528	79
CD4553	3 50
CD4566	2 25
CD4583	2 35
CD4585	1 10
CD40192	3 00
74C00	35
74C04	40
74C10	35
74C14	1 95
74C20	35
74C30	35
74C48	2 25
74C74	85
74C76	1 75
74C90	1 75
74C93	1 75
74C154	3 00
74C160	2 00
74C175	1 35
74C192	2 25
74C221	2 50
74C905	6 00
74C906	75
74C914	1 95
74C922	6 00
74C923	6 00
74C925	7 50
74C926	6 95
74C927	6 95
INTERFACE	
8095	65
8096	65
8097	65
8098	65
8T09	1 25
8T10	4 50
8T13	3 00
8T20	5 50
8T23	3 10
8T24	3 50
8T25	3 20
8T26	1 69
8T28	2 75
8T97	1 69
8T98	1 69
MOS/MEMORY RAM	
2101-1	2 95
2102-1	95
2102AL 4	1 34
2102AN-2L	1 60
2104A-4	4 95
2107B-4	3 75
2111-1	3 75
2112-2	3 95
2114L 300ns	6 75
2114L 450ns	5 95

4116 200ns	7 95
8/4116 200ns	49 00
25138	6 30
MM5262	40
MM5280	3 00
MM5320	9 95
MM5330	5 94
PD411D-3	4 00
PD411D-4	5 00
P5101L	8 95
4200A	9 95
82S25	2 90
91L02A	1 50
HD0165-5	6 95
MM57100	4 50
GIAY38500-1	9 95
MCM66751A	9 95
9368	3 50
4100	10 00
416	16 00
CLOCKS	
MM5311	5 50
MM5312	3 90
MM5314	3 90
MM5359	2 10
MM5841	14 45
MM5865	7 95
CT7010	8 95
CT7015	8 95
MM5375AA/N	3 90
MM5375AG/N	4 90
7205	16 50
7207	7 50
7208	15 95
7209	4 95
DS0026CN	3 75
DS0056CN	3 75
MM53104	2 50
MICROPROCESSOR	
6502	10 95
6504	9 95
6522	9 95
6800	6 95
6802	11 95
6820	4 95
6850	5 95
8080A	5 95
8085	12 95
8086	75 00
Z80	9 95
Z80A	11 95
8212	2 90
8214	3 95
8216	2 90
8224	3 45
8228	4 95
8251	6 95
8253	15 00
8255	5 75
8257	10 95
8259	14 95
1802CP plas	13 95
1802DP plas	17 95
1861P	11 50
CDP1802CD	28 95
CDP1802D	35 00
CDP1861	15 95
UART/FIFO	
AY5 1013	5 50
AY5 1014	7 50
3341	6 95
PROM	
1702A	4 95
25138 upper case	8 75
2708	7 75
2716T1	18 00
2716 Intel	23 00
8/2716 Intel	160 00
2732	65 00
2758	22 50
8741A	60 00
8748	65 00
8748-8	60 00
8755A	55 00
N82S23	2 95
N82S123	6 50
N82S126	3 75
N82S129	8 50
N82S131	8 50
N82S136	8 75
N82S137	8 75
DM8577	2 90
8223	2 90

CONNECTORS

30 pin edge	2 50
44 pin edge	2 75
100 pin edge	4 50
100 pin edge WW	5 25

IC SOCKETS
Solder Tin Low Profile

PIN	1 UP	PIN	1UP
8	15	22	30
14	14	24	35
16	16	28	42
18	27	36	58
20	29	40	57

2 level 14 pin ww 20

WIRE WRAP LEVEL 3

PIN		PIN	
14	32	24	86
16	33	28	1 00
18	57	40	1 23

CRYSTALS

1 MHz	4 50
2 MHz	4 50
4 MHz	4 25
5 MHz	4 25
10 MHz	4 25
18 MHz	3 90
20 MHz	3 90
32 MHz	3 90
32768 Hz	4 00
1 8432 MHz	4 50
3 5795 MHz	1 20
2 0100 MHz	1 95
2 097152 MHz	4 50
2 4576 MHz	4 50
3 2768 MHz	4 50
5 0688 MHz	4 50
5 185 MHz	4 50
5 7143 MHz	4 50
6 5536 MHz	4 50
14 31818 MHz	4 25
18 432 MHz	4 50
22 1184 MHz	4 50

KEYBOARD ENCODERS

AY5-2376	$12 50
AY5 3600	17 95
AY5 9100	10 50
AY5-9200	16 50
74C922	5 50
74C923	5 50
HD0165-5	6 95
AY5-9400	10 50

D Connectors RS232

DB25P	3 62
DB25S	5 20
Cover	1 67
DE9S	1 95
DA15P	2 10
DA15S	3 10
Complete Set	9 50

Hickok 3½ Digit LED multimeter	**74.95**
Stopwatch Kit	**26.95**
Auto Clock Kit	**17.95**
Digital Clock Kit	**14.95**

8K 16K Eprom Kit (less PROMS)	$89 00
Motherboard	$39 00
Extender Board	$15 00

RESISTORS ¼ watt 5%

10 per type	03
25 per type	025
100 per type	015
1000 per type	012
350 piece pack 5 per type	6 75
½ watt 5% per type	05

Televideo Terminal

Model 912	$845 00
Model 920	$945 00

Tiny Basic Experimentors Kit $10 00

BSR Controller $39.95
Connect your computer to the BSR Home Control System. Computer controlled ultrasonic transmitter for your BSR. Software for 1802 user

KEYBOARDS

56 key ASCII keyboard kit	$67 50
Fully assembled	77 5
53 key ASCII keyboard kit	60
Fully assembled	70
Enclosure Plastic	14
Metal Enclosure	29

LEDS

Red TO18	15
Green Yellow TO18	20
Jumbo Red	20
Green Orange Yellow Jumbo	25
Cliplite LED Mounting Clips	8/$1 25

(specify red amber green yellow clear)

CONTINENTAL SPECIALTIES in stock
Complete line of breadboard test equip
MAX-100 8 digit Freq Ctr. $128 95

OK WIRE WRAP TOOLS in stock
Portable Multimeter $18.00

Complete line of AP Products in stock

SPECIAL PRODUCTS

MM5865 Stopwatch Timer with 10 pg spec	9 00
PC board	7 50
Switches Mom Pushbutton	27
3 pos slide	25
Encoder HD0165-5	6 95
Paratronics 100A Logic Analyzer	$425.00
Model 10 Trigger Expander Kit	$229 00
Model 150 Bus Grabber Kit	$369 00
Clock Calendar Kit	$23.95
2.5 MHz Frequency Counter Kit	$37.50
30 MHz Frequency Counter Kit	$47.75

TRANSFORMERS

6V 300 ma	3 25
12 Volt 300 ma transformer	1 25
12 6V CT 600 ma	3 75
12V 250 ma wall plug	2 95
12V CT 250 ma wall plug	3 50
24V CT 400 ma	3 95
10V 1 2 amp wall plug	4 85
12V 6 amp	12 95
12V 500 ma wall plug	4 75
12V 1 amp wall plug	6 50
10/15 VAC 8 16 VA wall plug	9 75

DISPLAY LEDS

MAN1	CA	270	2 90
MAN3	CC	125	39
MAN72 74	CA/CA	300	1 00
DL704	CC	300	1 25
DL707 DL707R	CA	300	1 00
DL727 728	CA CC	500	1 90
DL747 750	CA CC	600	1 95
DL750	CC	600	1 95
FND359	CC	357	70
FND500/507	CC CA	500	1 35
FND503/510	CC/CA	500	90
FND800/807	CC/CA	800	2 20
3 digit Bubble			60
4 digit Bubble			80
DG8 Fluorescent			1 75
DG10 Fluorescent			1 75
10 digit display			1 25
7520 Clairex photocells			39
TIL311 Hex			9 50
MAN3640	CC	30	1 10
MAN4610	CA	40	1 20
MAN4640	CC	40	1 20
MAN4710	CA	40	95
MAN4740	CC	40	1 20
MAN6640	CC	56	2 95
MAN6710	CA	60	1 35
MAN6740	CC	60	1 35

MA1002A	**8.95**
MA1002E	**8.95**
MA1012A	**8.95**
102P3 transformer	**2.25**
MA1012A Transformer	**2.25**

RCA Cosmac 1802 Super Elf Computer $106.95

Compare features before you decide to buy any other computer. There is no other computer on the market today that has all the desirable benefits of the **Super Elf** for so little money. The Super Elf is a small single board computer that does many **big** things. It is an excellent computer for training and for learning programming with its machine language and yet it is easily **expanded with additional memory, Full Basic, ASCII Keyboards, video character generation, etc.**

Before you buy another small computer, see if it includes the following features: ROM monitor; State and Mode displays; Single step; Optional address displays; Power Supply; Audio Amplifier and Speaker; Fully socketed for all IC's; Real cost of in warranty repairs; Full documentation.

The **Super Elf** includes a **ROM** monitor for program loading, editing and execution with **SINGLE STEP for program debugging** which is not included in others at the same price. With **SINGLE STEP** you can see the microprocessor chip operating with the **unique Quest** address and data bus displays **before, during and after** executing instructions. Also, CPU mode and instruction cycle are decoded and displayed on 8 LED indicators.

An RCA 1861 **video graphics** chip allows you to connect to your own TV with an inexpensive video modulator to do graphics and games. There is a **speaker system** included for writing your own music or using many music programs already written. The speaker amplifier may also be used to drive relays for control purposes.

A 24 key **HEX keyboard** includes 16 HEX keys plus **load, reset, run, wait, input, memory protect, monitor select** and **single step**. Large, on board displays provide output and optional **high and low address**. There is a 44 pin standard connector slot for PC cards and a 50 pin connector slot for the Quest Super Expansion Board. Power supply and sockets for **all** IC's are included in the price plus a detailed 127 pg. instruction manual which now includes over 40 pgs. of software info. including a series of lessons to help get you started and a music program and graphics target game. Many schools and universities are using the Super Elf as a course of study. OEM's use it for training and R&D.

Remember, other computers only offer Super Elf features at additional cost or not at all. **Compare before you buy. Super Elf Kit $106.95, High address option $8.95, Low address option $9.95. Custom Cabinet** with drilled and labelled plexiglass front panel **$24.95.** All metal Expansion Cabinet, painted and silk screened, with room for 5 S-100 boards and power supply **$57.00. NiCad Battery Memory Saver Kit $6.95.** All kits and options also completely assembled and tested.

Questdata, a software publication for 1802 computer users is available by subscription for $12.00 per 12 issues. Single issues $1.50. Issues 1-12 bound $16.50.

Tiny Basic Cassette **$10.00**, on ROM **$38.00**, original Elf kit board **$14.95. 1802 software;** Moews Video Graphics **$3.50.** Games and Music **$3.00**, Chip 8 Interpreter **$5.50.**

Super Expansion Board with Cassette Interface $89.95

This is truly an astounding value! This board has been designed to allow you to decide how you want it optioned. **The Super Expansion Board comes with 4K of low power RAM** fully addressable anywhere in 64K with built-in memory protect and a **cassette interface**. Provisions have been made for all other options on the same board and it fits neatly into the hardwood cabinet alongside the **Super Elf**. The board includes slots for up to 6K of **EPROM** (2708, 2758, 2716 or TI 2716) and is **fully socketed**. EPROM can be used for the monitor and Tiny Basic or other purposes.

A **1K Super ROM Monitor $19.95** is available as an on board option in 2708 EPROM which has been preprogrammed with a program loader/editor and error checking multi file cassette read/write software, (relocatable cassette file) another exclusive from Quest. It includes register save and readout, block move capability and video graphics driver with blinking cursor. Break points can be used with the register save feature to isolate program bugs quickly, then follow with single step. If you have the **Super Expansion Board** and **Super Monitor** the monitor is up and running at the push of a button.

Other on board options include **Parallel Input and Output Ports with full handshake**. They allow easy connection of an ASCII keyboard to the input port. **RS 232 and 20 ma Current Loop** for teletype or other device are on board and if you need more memory there are two **S-100** slots for static RAM or video boards. Also a 1K Super Monitor version 2 with video driver for full capability display with Tiny Basic and a video interface board. **Parallel I/O Ports $9.85, RS 232 $4.50, TTY 20 ma I/F $1.95, S-100 $4.50. A 50 pin connector set** with ribbon cable is available at $15.25 for easy connection between the **Super Elf** and the **Super Expansion Board.**

Power Supply Kit for the complete system (see Multi-volt Power Supply).

Announcing Quest Super Basic— *SECOND GENERATION*

A new enhanced version of **Super Basic** now available. Quest was the first company worldwide to ship a full size Basic for 1802 Systems. A complete function **Super Basic** by **Ron Cenker** including floating point capability with scientific notation (number range $\pm .17E^{38}$), 32 bit integer ± 2 billion, multi dim arrays, string arrays, string manipulation, cassette I/O, save and load, basic, data and machine language programs, and over 75 statements, functions and operations.

Enhancements include increased speed, built-in provisions for Stringy Floppy, Floppy Disc, Printer Driver, I/O, user definable command library and statement renumbering.

Easily adaptable to most 1802 systems. Requires 16K RAM minimum for Basic and user programs. Source listing for both Serial and Parallel I/O included.

Super Basic on Cassette $40.00.

Gremlin Color Video Kit $69.95

32 x 16 alphanumerics and graphics; up to 8 colors with 6847 chip; 1K RAM at E000. Plugs into Super Elf 44 pin bus. No high res. graphics. On board RF Modulator Kit **$4.95**

Elf II Adapter Kit $24.95

Plugs into Elf II providing Super Elf 44 and 50 pin plus S-100 bus expansion. (With Super Expansion). High and low address displays, state and mode LED's optional **$18.00.**

1802 16K Dynamic RAM Kit $149.00

Expandable to 32K. Hidden refresh w/clocks up to 4 MHz w/no wait states. Addl. 16K RAM **$63.00**

Super Elf 44 pin expansion board; 3 female and 1 male bus. Board plus 3 connectors **$22.95**

Tiny Basic Extended on Cassette $15.00 (added commands include Stringy, Array, Cassette I/O etc.)

S-100 4-Slot Expansion $ 9.95

Super Monitor VI.I Source Listing $15.00

Super Color S-100 Video Kit $129.95

Expandable to 256 x 192 high resolution color graphics. 6847 with all display modes computer controlled. Memory mapped. 1K RAM expandable to 6K. S-100 bus 1802, 8080, 8085, Z80 etc.

Editor Assembler $25.00 (Requires minimum of 4K for E/A plus user source)

1802 Tiny Basic Source listing $19.00

Super Monitor V2.0/2.1 Source Listing $20.00

PROM Eraser

assembled, 25 PROM capacity **$37.50** (with timer **$69.50**). 6 PROM capacity OSHA/UL version **$69.50** (with timer **$94.50**).

Z80 Microcomputer

16 bit I/O, 2 MHz clock, 2K RAM, ROM Breadboard space. Excellent for control. Bare Board **$28.50. Full Kit $99.00. Monitor $20.00.** Power Supply Kit **$35.00. Tiny Basic $30.00**

S-100 Computer Boards

8K Static Godbout Econo IIA Kit	145.00
16K Static Godbout Econo XIV Kit	285.00
24K Static Godbout Econo VIIA-24 Kit	435.00
32K Static Godbout Econo X-32 Kit	575.00
16K Dynamic RAM Kit	199.00
32K Dynamic RAM Kit	310.00
64K Dynamic RAM Kit	470.00
Video Interface Kit	**$135.00**

80 IC Update Master Manual $55.00

Comp. IC data selector, **2700** pg. master reference guide. Over 51,000 cross references. Free update service through 1980. Domestic postage $3.50.

Modem Kit $60.00

State of the art, orig., answer. No tuning necessary. 103 compatible 300 baud. Inexpensive acoustic coupler plans included.

LRC 7000+Printer $389.00

40/20 column dot matrix impact, std. paper. Interface all personal computers.
64/40/32/20 version **$405.00.** Optional cables available.

LRC 7000 printer interface cable for Super Elf with software $26.00

NiCad Battery Fixer/Charger Kit

Opens shorted cells that won't hold a charge and then charges them up, all in one kit w/full parts and instructions. **$7.25**

Rockwell AIM 65 Computer

6502 based single board with full ASCII keyboard and 20 column thermal printer. 20 char. alphanumeric display. ROM monitor, fully expandable. **$375.00.** 4K version **$450.00.** 4K Assembler **$85.00.** 8K Basic Interpreter **$100.00.**

Special small power supply for AIM65 assem. in frame **$54.00.** Complete AIM65 in thin briefcase with power supply **$499.00.** Molded plastic enclosure to fit both AIM65 and power supply **$47.50.** Special Package Price: 4K AIM, 8K Basic, power supply, cabinet **$599.00**

AIM65/KIM/VIM/Super Elf 44 pin expansion board, 3 female and 1 male bus. Board plus 3 connectors $22.95.

60 Hz Crystal Time Base Kit $4.40

Converts digital clocks from AC line frequency to crystal time base. Outstanding accuracy.

Video Modulator Kit $8.95

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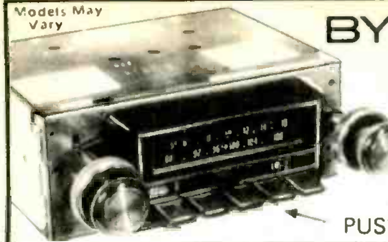

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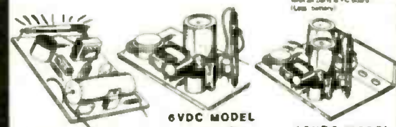

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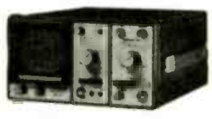

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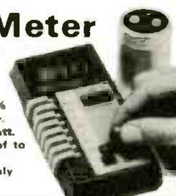

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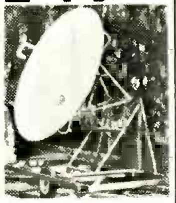

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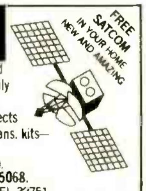

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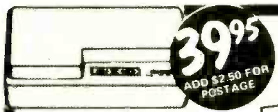

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START YOUR OWN Mailorder Business. Exclusive Cassette Program Explains How. Free information: Economail, 373 Fifth Avenue, Box 1060, New York, New York, 10016.

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THE SUPERMARKET OF ELECTRONICS—thousands of items for sale or trade each month. Free classified ad with subscription. Only $5.00 to Nuts & Volts, POB 1111-P, Placentia, CA 92670.

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Popular Electronics

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Personal Electronics News

YOU CAN RENT A ROBOT by the hour from Jerry Rebman Electronics if you live in the Houston, TX area. If you don't live in the area and can't afford to buy one of Jerry's radio-controlled robots (average price is $3000), you can buy Jerry's book for $50 and get construction details for building your own robot. The book gives full details for fabricating "Garcan," a radio-controlled robot that can be built into a steel garbage can. For more information, write: Jerry Rebman Electronics, 3530 Timmons Lane #155, Houston, TX 77027.

VCR OR VIDEODISC? According to a recent survey conducted by Venture Development Corp., more than two-thirds of consumers queried prefer one or the other system. Consumers who don't own video-playback equipment prefer VCRs to videodiscs by more than three to one, while about one-fifth of potential buyers want both systems. Another 23% express no preference but are certain that they would purchase only one of the two. The study also reveals that VCR owners have a greater interest in having both systems (almost 29%) than people who don't own a VCR. On the other hand, three out of five VCR owners express no interest in videodiscs.

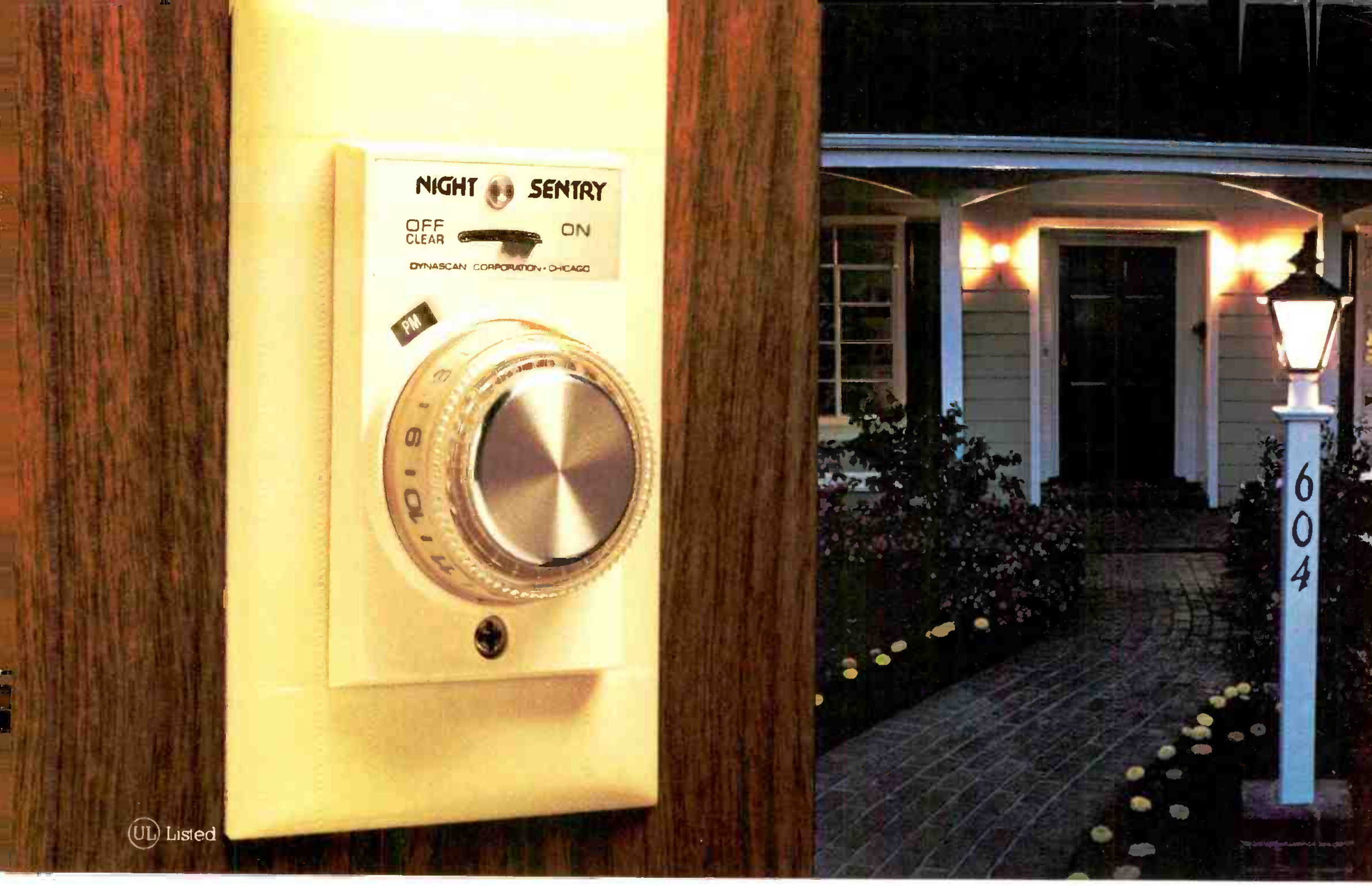
A "TALKING" AUTOMOTIVE DIAGNOSTICS WARNING SYSTEM, employing speech synthesis technology, has been demonstrated in prototype form by National Semiconductor Corp. It takes inputs from a microcontroller and gives audible warning messages, such as "low fuel," "low brake fluid," etc. The system employs National's speech processor and memory device containing the words and phrases to be spoken. An actual recorded voice is A/D converted and its code is compressed by a factor of 100 and stored in a ROM for individual word or phrase playback through the speech processor chip. Speech quality is claimed to be comparable to that of a high-fidelity magnetic tape recording and is related to the number of bits of memory used to store the speech.

DISK INSURANCE is now being offered by Micro Lab, Highland Park, IL, to microcomputer users who buy its Data Factory product lines. The insurance-policy package is sold with two locked versions of the master diskette. Should a master become damaged or blown during the policy period, the policy holder can simply return the inoperative disk for immediate free replacement. In addition, if an update in the program occurs, policy owners will be notified and older versions will be revised free of charge. Cost of the insurance policy (not disks) is $17.50 per year.

PAY-BY-PHONE IS A REALITY with Chase Manhattan Bank's "Bank-by-Phone" computer and a "Touch-Tone" telephone with * and # keys. Checking-account customers access the computer with a keyed-in-personal account number and security code. Then, using the phone's "dial" buttons, the computer is instructed to pay the specific merchants you have in mind and how much. You can even check your account balance, cancel a call in midstream, and send an SOS to get help. No Touch-Tone phone? . . . simply call, toll-free, and a Chase representative will relay bill-payment information to the computer.

UNCHECKED COMPUTER CRIMES may mean the loss of a billion dollars annually if The Federal Computer Systems Protection Act (S-240) is not passed says Philip R. Manuel, who drafted the legislation and is an investigative consultant in the area of white-collar crime. Computer crimes are now covered by "existing, but inadequate, laws dealing with crimes ranging from mail and wire fraud to obscene phone calls," observes Manuel. The new bill was drafted to put a clearer definition on computer crime and provide protection for computer systems of all types. It would also protect from fraud sophisticated electronic fund transfer systems. The bill was first introduced by Sen. Abraham Ribicoff (D-Conn.) in 1977, and was reintroduced in January 1979. It has prompted several states to pass similar legislation, but it is feared that the bill will die at the Federal level unless acted upon before Congress adjourns this Fall.

NATIONWIDE ELECTRONIC SERVICE FRANCHISING is the goal of a new company called "Tronics 2000" in Bloomington, IN. Sensing that the independent serviceman will be faced with increasing complexity and diversity in the future, the company intends to sell franchises to provide technical assistance through training courses, updated business techniques, national and local advertising, and volume buying. The headquarters will contain graphic arts and training departments, and a supervisor for every five franchises.



For less than $25, hire a full time Night Sentry to protect your home.

Night Sentry puts electronic timed lighting control where it belongs: on the wall...

Most home security experts agree that one of the most effective deterrents to intruders and burglars is lighting that creates the "lived-in" look while you're away. Now the new Dynascan Night Sentry enables you to easily achieve that lived-in look. Using a micro-computer that does the work of more than 10,000 transistors, it provides automatic control of indoor or outdoor light fixtures, including porch, post, kitchen, bathroom, and bedroom lights.

The amazing micro-computer's "memory" permits automatic self-programming (just use the Night Sentry as a conventional light-switch—after 24 hours, your pattern of light use will be repeated daily thereafter.) You also can program it manually in a matter of seconds! Up to 48 ON-OFF settings per 24-hour period are possible. Installs in minutes with only a screwdriver.

Comparison Chart

FEATURE	NIGHT SENTRY	OTHER TIMERS
1. Automatic programming	YES	NO
2. Manual programming	YES	YES
3. Built-in microprocessor/memory	YES	NO
4. Solid-state reliability	YES	NO
5. Silent operation (no motor)	YES	NO
6. 48 "ON-OFF" selections	YES	SOME MODELS
7. Variable "ON-OFF" times	YES	SOME MODELS
8. Easy pushbutton override	YES	NO
9. Easy 2-wire installation	YES	NO
10. Fits any single or multiple switch box	YES	NO
11. Usable with most standard or decorator switch plates	YES	NO
12. Attractive "low-profile" decorator styling	YES	NO
13. "Soft-start" triples bulb life	YES	NO
14. Available in 3-way model	YES	NO
15. Available in table model with dimmer	YES	NO

CIRCLE NO. 78 ON FREE INFORMATION CARD

Check these "never-before-available" features: No clock motor or gears to become noisy; easy override of program to use as conventional ON-OFF switch (no fumbling behind or under furniture to locate an override button); built-in variability of ON-OFF times to confuse intruders or burglars "casing" your home; usable in single or gang switch boxes; uses existing standard or decorator switch plates; available in 3-way version. Also available: table top model for controlling lamps plugged into wall outlets.

Visit your local hardware, home center, or department store and see the new Night Sentry. Suggested retail price under $25.

NIGHT SENTRY
Timed Light Control

From the people who brought you
COBRA Radios and Cordless Telephones

Write for color brochure.

DYNASCAN CORPORATION
6460 W. Cortland St., Chicago, IL 60635

Introducing a totally new concept in stereophones.


Koss HV/XLC

The new Koss HV/X high velocity stereophone represents a remarkable breakthrough in hear-thru stereophone design and performance. For the first time, Koss engineers have been able to create a lightweight, hear-thru stereophone that combines the transparency of high velocity phones with the superior bass performance of closed-type phones. The result is a breathtaking musical experience.

CONTOURED VARIABLE-DENSITY EARCUSHIONS

While most lightweight, hear-thru stereophones have earcushions that fit against the ear, the new Koss HV/X features a unique, contoured, variable-density cushion that fits around the ear. Not only does this unique earcushion design create a far more comfortable stereophone but it has also allowed Koss engineers to create a dramatically better element design as well.

These new variable-density earcushions are made up of a very porous material that is acoustically transparent at the perimeter of the earcushion yet compressed toward the center region. This varies the pattern of acoustic resistance over portions of the earcushions creating the proper seal for specific bass frequencies while allowing the flow of middle and high frequencies at the perimeter of the earcushions.

LIGHTWEIGHT ELEMENT

The uniqueness of the new variable-density earcushions made it possible for Koss engineers to design a lightweight element that reproduces a Sound of Koss you have to hear to believe. Incredibly, even though the overall weight of the element was reduced, Koss engineers were able to develop a magnet with enough magnetic density to drive an extra large diaphragm. With a response range of 15 to 35,000 Hz, the new Koss HV/X will drive you into ecstacy and our competitors nuts.

HEARING IS BELIEVING.

Slip into the new Koss HV/X or HV/XLC with volume/balance controls at your audio dealer soon. You'll like the best of both worlds: the open, airy, up-front sound of hear-thru stereophones and the deep, rich bass performance of closed-type stereophones.

And while you're with your audio dealer, listen to our full line of Koss stereophones and CM loudspeakers. There's no sound quite like the Sound of Koss.

For more information on the HV/X, our full line of stereophones and loudspeakers or our new Koss K/4DS digital delay system, write c/o Virginia Lamm.

KOSS® stereophones/loudspeakers

hearing is believing™

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