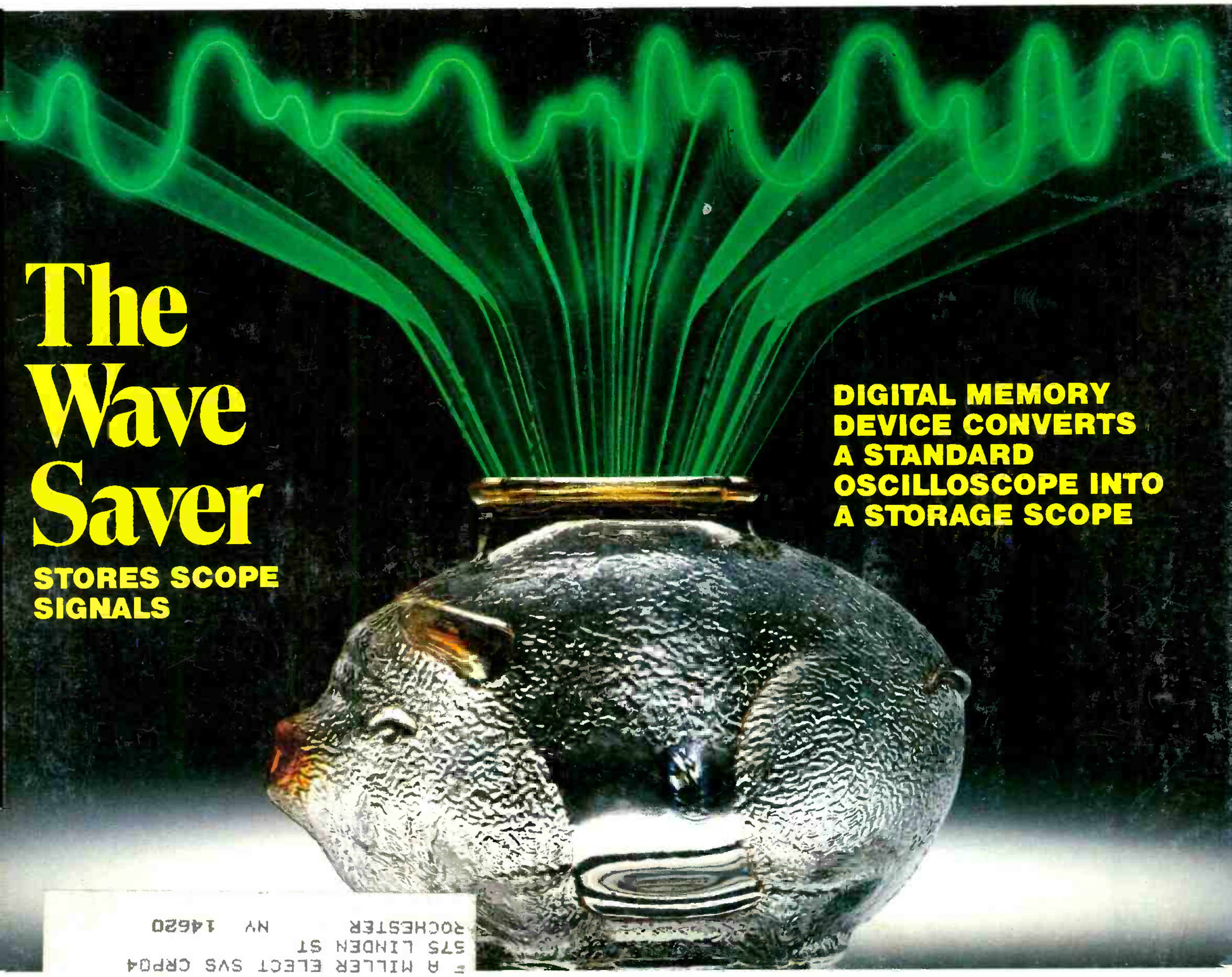
Popular Electronics®

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

Adapt a Turntable to Play 78-rpm Collector Records

How to Eliminate Data Loss in TRS-80 Personal Computers



The Wave Saver

STORES SCOPE SIGNALS

DIGITAL MEMORY DEVICE CONVERTS A STANDARD OSCILLOSCOPE INTO A STORAGE SCOPE

this issue:

Magnavox "Phoenix" 19" Color TV Receiver
Pioneer CT-8R Cassette Deck
Intelligent Systems Video Display Terminal

04
14024 14278

Make waves with an Apple.

If you'd like to spend more of your research budget on research and less on computer costs, consider the discoveries of Dr. John Lilly and the Human/Dolphin Foundation.

Dolphins vocalize at 2,000-40,000 Hz (compared with 300-3,000 Hz for humans) and "converse" 10-15 times faster than their bipedal brethren.

In 1968, Dr. Lilly's interspecies communication experiments stalled for lack of affordable computer power to bridge this gap. But today, with the help of Apple Personal Computers and a DEC® PDP/11, things are going swimmingly.

A new program called JANUS (Joint Analog Numeric Understanding System) uses a 48K Apple II Plus to generate dolphin-comprehensible wave forms matched to dolphin-

viewable symbols on an underwater screen. Dolphin responses are analyzed through a PDP/11. A second Apple monitors and analyzes data from all phases of the experiment.

The objective is to create an artificial language that is mutually intelligible to both species, with a beginning vocabulary of 48 sound/symbol morphemes associated with objects, locations and actions.

But, with all the micros available, why pick Apples?

Because they're inexpensive enough to allow the use of a stand-alone computing system for dedicated functions.

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And because they can be configured for many scientific applications with no special I/O devices. (Apple's IEEE-488 interface card will program and operate virtually any test, measurement or control instrument.)

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There's more software available for Apples than for any other microcomputer on the market. And more full service dealers worldwide.

Communicate with one and find out how an Apple can make waves for you, whatever your, ah . . . porpoise.

The personal computer. apple®

The Human/Dolphin Foundation is a non-profit research organization. For more information, write Dr. John Lilly, P.O. Box 4172, Malibu, CA 90265.
For the authorized Apple dealer nearest you, call (800) 538-9696. In California, call (800) 662-9238. Or write: Apple Computer Inc., 10260 Bandley Dr., Cupertino, CA 95014.

CIRCLE NO 6 ON FREE INFORMATION CARD

APRIL 1982 VOLUME 20, NUMBER 4

Popular Electronics®

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

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Construction Articles

Equipment Reviews

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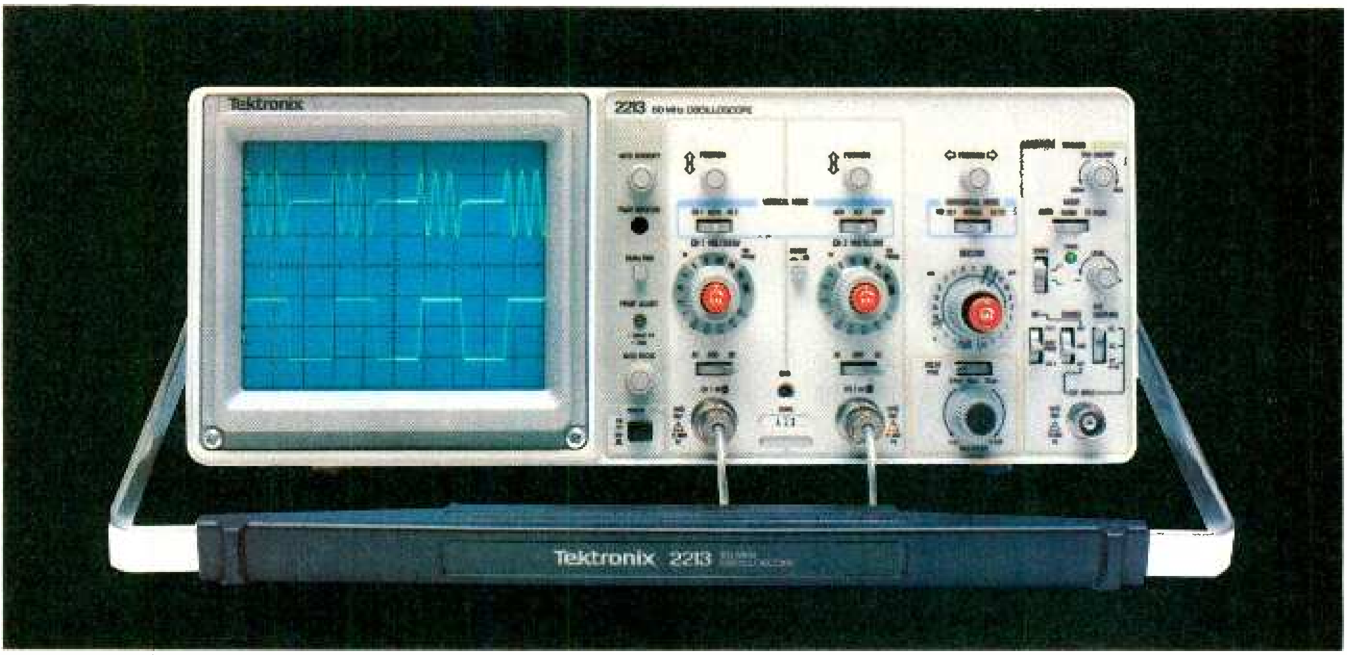

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The scope: the 2213. Its radical new design brings you Tektronix quality for well below what you would pay for lesser-name scopes.

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2213 PERFORMANCE DATA

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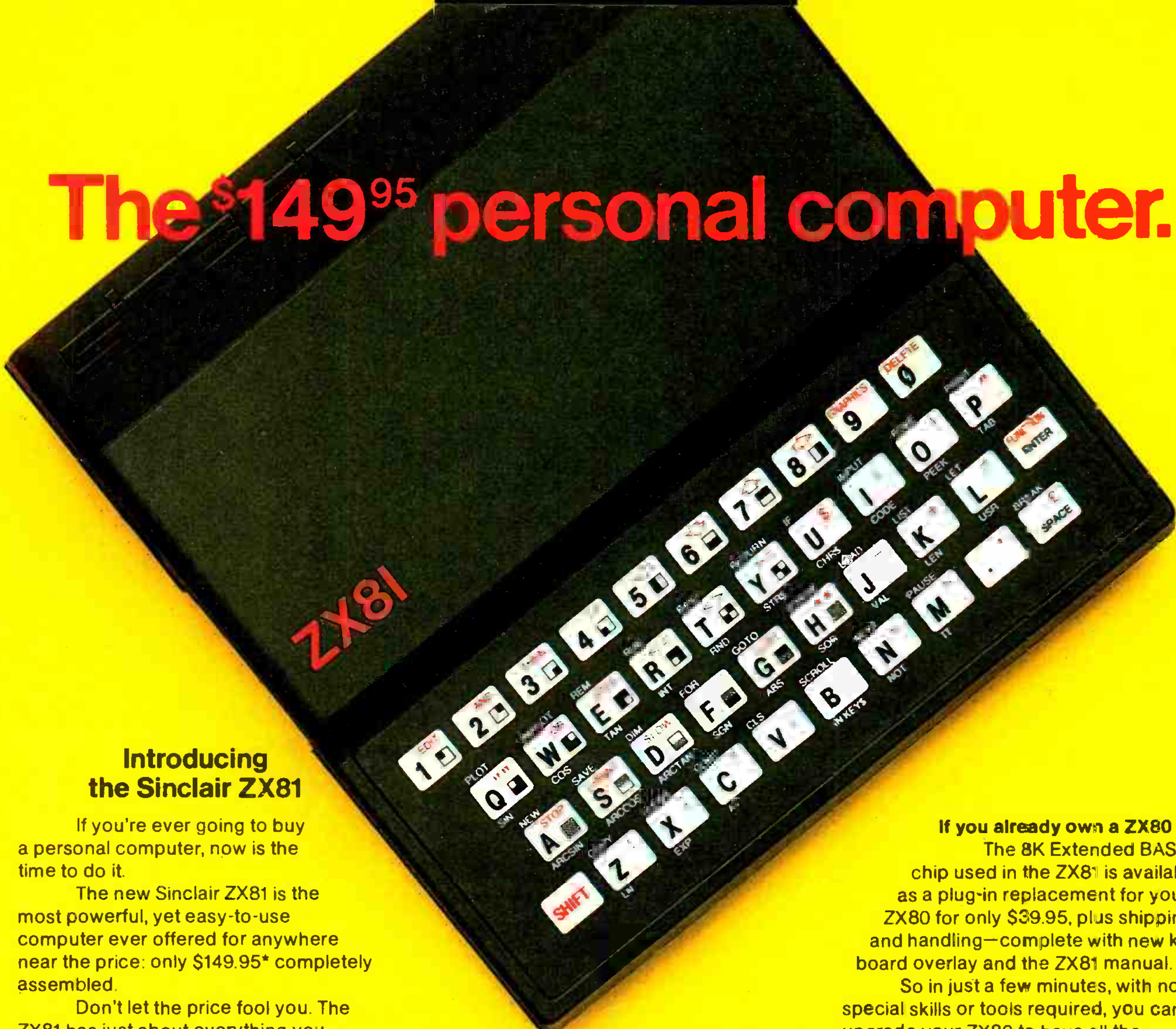


Introducing the Sinclair ZX81

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

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

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

A breakthrough in personal computers

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

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

Just look at what you get:

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

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

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

If you already own a ZX80

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

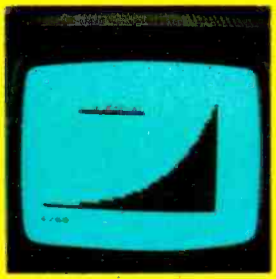
So in just a few minutes, with no special skills or tools required, you can upgrade your ZX80 to have all the powerful features of the ZX81. (You'll have everything except continuous display, but you can still use the PAUSE and SCROLL commands to get moving graphics.)

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

Warranty and Service Program**

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

**Does not apply to ZX81 kits.

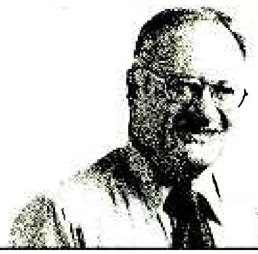


NEW SOFTWARE: Sinclair has published pre-recorded programs on cassettes for your ZX81, or ZX80 with 8K BASIC. We're constantly coming out with new programs, so we'll send you our latest software catalog with your computer.

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

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

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



EDITORIAL

Looking Backward

A small percentage of laboratory-brew developments wend their way into successful consumer products. Merit alone is not enough, however. Risk capital, backed by corporate courage and the profit motive, are the real driving forces. Even these do not assure success, though. A new product also faces a fickle public's acceptance.

Consumer video machines could serve well as a business management lesson. Industrialists and media experts touted the concept for almost a generation, but only now are tasting success. I authored a cover story in September 1965, for example, that trumpeted, "Home Video Tape Recorders Are Here!" All the right forces were combined, it seemed. Sony even incorporated a 9"-screen TV set into its unit. The price barrier of $3000+ was broken, with a round $1000 displacing it. Companies such as Sony, Panasonic, and Ampex had thrown their hats into the video ring, and there was talk of a $10-million first year in sales, with $100-million within five years. Rumors were rampant that other companies would soon enter the field—RCA, 3M, Rheem, Delmonico, among them. Notwithstanding this, it did not fly. The public evidently did not accept the absence of color-TV capability, there were no prerecorded tape companies beating the drum, every entry used a different system, video tape was reel-to-reel, and the $1000 price tag in 1965 was too high.

Five years later, play-only systems were introduced including a film system called Electronic Video Recording (EVR) from CBS, RCA's "Selecta Vision" video disc with 30 minutes play time, and A.E.G. Telefunken and Decca (Teldec) with a 12-minute-play time "Video Disc." At the same time, Avco demonstrated its "Cartrivision" video recording machine with color TV capability, and Ampex also introduced a cartridge machine called "Instavision."

About five years later, companies got their acts together and the present Beta and VHS tape systems were marketed. In another five years, RCA's CED and Philips' LaserVision disc systems reached the marketplace, with a VHD system expected later in 1982. All are incompatible, of course.

But it appears that we are off and running very well with all the machines marketed today. In fact, they're selling better than color TV receivers did in a comparable number of years after their introduction.

Not surprising, the rise of video recorders has taken its toll of 8-mm movie cameras, whose sales have been more than halved as more and more people have turned to VCRs. This trend promises to continue.

There are other video products and refinements that will reach the public in the future. Looking back at what transpired can be helpful in avoiding mistakes. To sustain the growth of video disc machines, it's clear prices will have to be reduced further to attract more people. Doubtlessly, this will occur, particularly with the CED play-only machine, as it is really a very simple design. Furthermore, discs hold the promise for much lower cost since they can be produced more expeditiously than can tape. The recording facility of the latter as well as the rental of prerecorded tapes will carry the day for tape machines, though.

Down the road you may look for tape recording facilities that are incorporated into video cameras, which would likely sound the death knell for 8-mm movie cameras. And you will certainly be able to get stereo-sound TV at some future time. I hope that the quality of sound that becomes available once a system is chosen from among those submitted to the FCC is "high-fidelity." After all, there's more to hi-fi than a 50-to-15,000-Hz frequency range.

Art Salsberg

Popular Electronics

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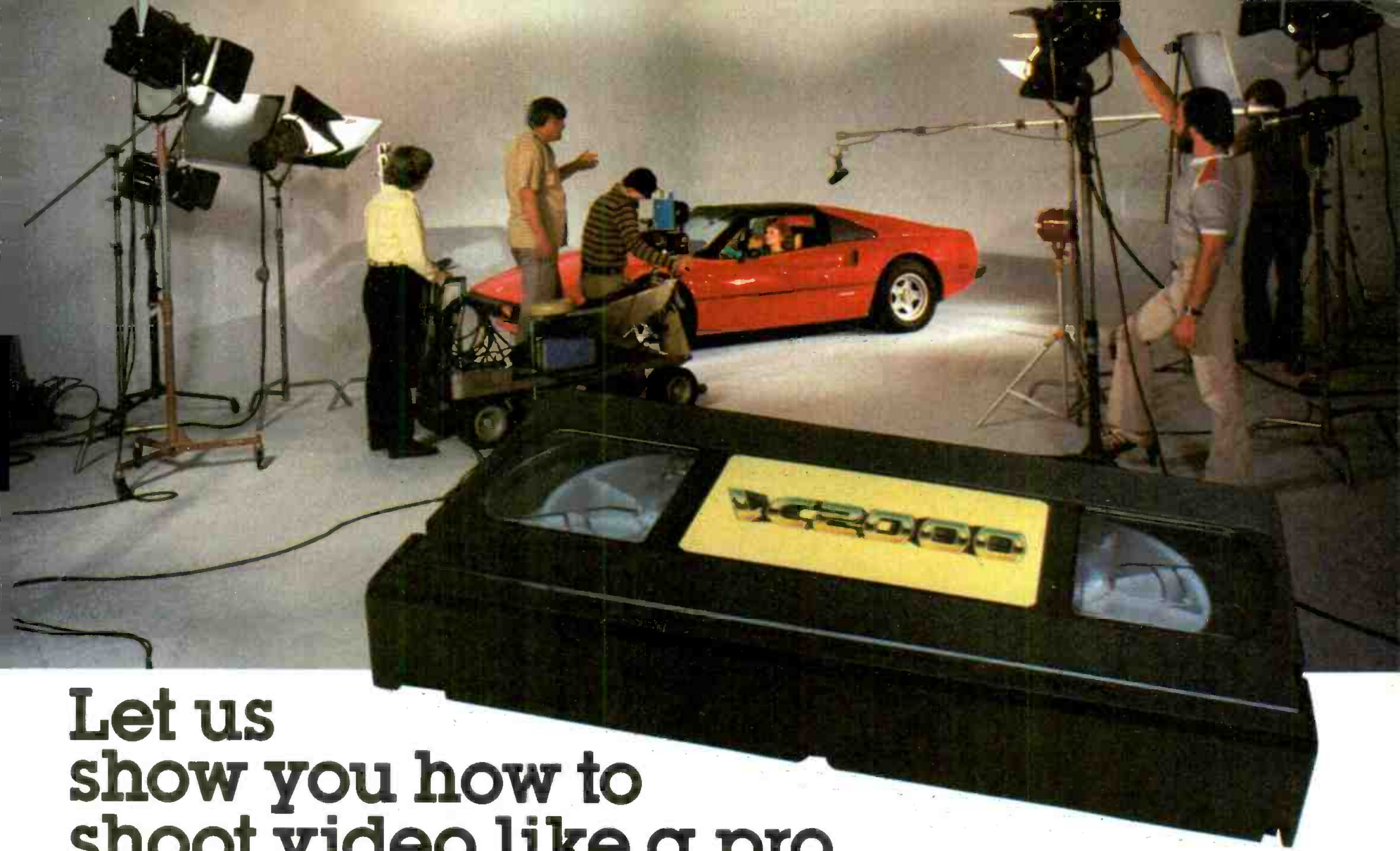

Let us show you how to shoot video like a pro

In my videotape production company, our crews turn out award-winning commercials, sales films, and features for some of the largest companies and television networks in the country. Now we would like to share our vast experience and award-winning capabilities to help you shoot your video with a professional-quality look—through an exciting new concept called VC 2000 An Association of Video Camera Owners.

Now, for a limited time, only when you join VC 2000, I'll send you FREE our one-hour instructional tape "Shooting Home Video: The Basics."

There's nothing like it on the market. In an entertaining, step-by-step format, our directors, cameramen, engineers and editors share their trade secrets. This could be the most valuable videotape a video enthusiast could ever own . . . and open up possibilities you never thought possible.

In one hour, I can demonstrate more techniques than you'd get from reading a dozen books.

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THE VIDEO CAMERA: How to use its full potential to make your tapes really come alive.

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Bill my ☐ VISA or ☐ MasterCard account. My account number is __________. Expires _____

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☐ I do not presently own a videotape camera but am interested in more information on VC 2000. For further information in a hurry, call toll-free: 1-800-428-6163 (except in Alaska or Hawaii), 1-800-692-6048 (in Indiana).

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NEW PRODUCTS

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

Numeric Keypad for Apple II

The Keyboard Company's Numeric Keypad is designed for use with the Apple II computer. One section of the unit is dedicated for arithmetic calculations. It has a standard keypad with double zero and decimal point, as well as operator keys for parenthesis, print, return, and the four basic arithmetic functions. The other section inputs Visicalc commands using three keys to control cursor movement: two for directional control, and a third to change cursor horizontal movement to vertical. Holding down either directional movement key initiates the auto-repeat mode, which moves the cursor across the screen until the key is released. A fourth key deletes entries. The keypad is coordinated with the Apple in color and design. Cost, with interface board, cord and directions, is $150.

CIRCLE NO. 87 ON FREE INFORMATION CARD

Programmable DMM

The Hewlett-Packard Model 3468A is a five-function 3½-to-5½-digit multimeter that offers the new Hewlett-Packard Interface Loop (HP-IL). HP-IL is a two-wire serial interface bus intended for field-portable and simple bench-top systems using portable controllers such as the HP 41C or HP 41CV handheld calculators. (A thermal printer can also be included in the loop.) The multimeter itself features an integrating multi-slope A-to-D converter that permits the trade-off of reading speed for resolution. The user can, from the front panel or remotely, increase resolution from 3½ to 5½ digits, but reading speed is reduced by a factor of about ten. The HP 3468A has four full-scale ac ranges from 0.3 V to 300 V. The ac accuracy at mid-range is given as 0.25%. Dc voltage is measured in four ranges from 30 mV to 300 V. Accuracy is 0.008%. Resistance encompasses six full-scale ranges from 300 ohms to 30 megohms, and one additional range down to 30 ohms. Resistance accuracy is 0.004%. The unit has one 3-A dc current range and two ac current ranges: 0.3 and 3.0 A. Bandwidth for the HP 3468A is 20 Hz to 300 kHz; crest factor is 4.1 at full scale. The multimeter also features electronic calibration with self-test; a 12-character, 14-segment alphanumeric LCD with 12 annunciators; and a single-piece silicone rubber keyboard. $695.

CIRCLE NO. 89 ON FREE INFORMATION CARD

100-dB S/N Tape Recorder

The TEAC X-1000R open-reel tape deck is reported to have a S/N of 100 dB through use of its built-in dbx noise-reduction system and the new Extra Efficiency tapes that the recorder can handle. The transport system uses dual-capstan, closed-loop drive, with full-tension servo control. Bidirectional record and playback facilities are included, using a six-head arrangement. Reel sizes up to 10½" can be accommodated. Transport functions are handled through a logic system that also permits "Search to Zero," "Search to Cue," and "Block Repeat" operations. A five-digit linear counter reads directly in hours, minutes, and seconds. An "Auto-Spacer" function is claimed to ensure noiseless, evenly timed transitions between recorded selections. Also included are adjustable pitch control and switchable external timer activation for either play or record modes, wide-range VU-type meters, full mic/line mixing, and separate-channel input and output controls. At 7½ ips, overall frequency range is given as 30 to 34,000 Hz with wow and flutter at 0.03%. At 3¾ ips, the range is from 30 to 24,000 Hz, with wow and flutter at 0.04%. $1400.

CIRCLE NO. 88 ON FREE INFORMATION CARD

Video Color Camera with Nikon Lens

The IK-1900 from Toshiba is the first video camera to incorporate a Nikon lens. The camera features a viewing system, called Tru Image, claimed to permit a user to see almost 100% of a scene, rather than a black-and-white electronic image. The system is said to eliminate the need for split-screen focusing by blurring the entire image when the camera is out of focus. The lens (Nikkor 12.5 mm—100 mm) includes a motorized 8X zoom. A balance adjustment permits user control of indoor and outdoor tint; and a boom-

NEW HIGHER PRINTING SPEED, NEW LOWER PRINTER PRICE

High-speed printer

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

Baud rates from 110 to 9600 are user-selectable.

Versatile printer

The 25 prints the entire 95-character ASCII set in upper case and lower case with descenders, in a 9x9 matrix. Also, 33 block graphic characters – which are compatible with the Heath/Zenith 89 All-In-One Computer and the 19 Smart Video Terminal – let you create graphs and charts. All functions and timing are microprocessor-controlled.

Plug-in ribbon cartridges make ribbon replacement a no-mess snap.

The 25 works with most computers and terminals – using an RS-232C Serial Interface or a 20 mA current loop with handshaking control signals.

Low-priced printer

The 25 has all the features you've been looking for in a high quality, high-speed dot matrix printer – for only $1095 in kit form, or for only $1595 assembled and tested.

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Pick the store nearest you from the list below. And stop in today for a demonstration of the new Heath/Zenith 25 Printer. If you can't get to a store, send $1.00 for the latest Zenith Data Systems Catalog of assembled commercial computers. We'll also send you a free copy of the latest Heathkit® catalog. Write to Heath Company, Dept. 010-884, Benton Harbor, MI 49022.

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215-288-0180

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412-824-3564

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2715 Ross Ave.
214-826-4053

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6825-A Green Oaks Rd.
817-737-8822

HOUSTON, TX
1704 W. Loop N.
713-869-5263

SAN ANTONIO, TX
7111 Blanco Rd.
512-341-8876

MIDVALE, UT
58 East 7200 South
801-566-4626

ALEXANDRIA, VA
6201 Richmond Hwy.
703-765-5515

VIRGINIA BEACH, VA
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SEATTLE, WA
505 8th Ave. N.
206-682-2172

TUKWILA, WA
15439 53rd Ave. S.
206-246-5358

VANCOUVER, WA
516 S. E. Chaklov Dr. #1
206-254-4441

MILWAUKEE, WI
5215 W. Fond du Lac
414-873-8250

†Heathkit is a registered trademark of Heath Company. Heath Company and Veritechnology Electronics Corporation are wholly-owned subsidiaries of Zenith Radio Corporation. Heathkit Electronic Centers are operated by Veritechnology Electronics Corporation.

CP-208

zoom microphone (included) fits onto the top of the camera. Weight is 4.4 lb. $995.

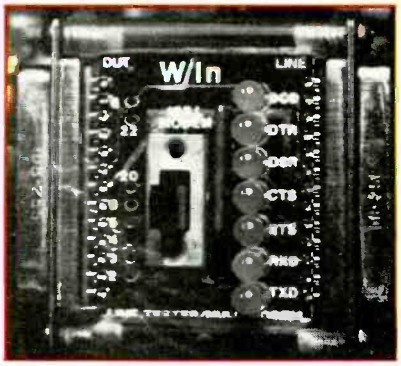
CIRCLE NO. 91 ON FREE INFORMATION CARD

Telephone with Built-In Cassette Recorder

The APF Electronics Save-A-Call Model 3226 telephone has a built-in microcassette deck that permits storing and playback of telephone conversations. In addition, the unit features a two-way speaker for hand-free operation. It also has a button for last-number redialing, a fast-rewind button, and a stop function. It measures 2″W x 7½″H plus a base width of 2¾″ and 4½″D. $180.

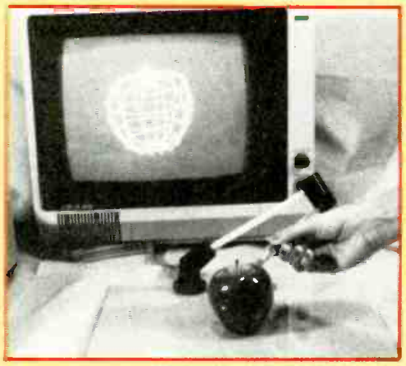
CIRCLE NO. 92 ON FREE INFORMATION CARD

Data Line Tester



The W-DLT from Warren Instrotech is said to be able to identify the seven most commonly used RS232 data lines in virtually any computer, peripheral, or cable and locate the source of faulty hook-up. The tester functions as a null modem between two outputs and eliminates the need for diagnostic rewiring as long as the computer or peripherals use the standard DCE or DTE signals. $60. **Address:** Warren Instrotech, Box 4500, Ogdensburg, NY 13669.

3-D Graphics Tablet



The "Space Tablet" from Penguin Software (hardware manufactured by Micro Control Systems, Inc.) is a three-dimensional graphics input device designed to interface with the Apple II microcomputer. The tablet consists of a clear, 16″ x 13″ two-dimensional workspace, approximately proportional to the Apple screen. An arm is located at the top center of the tablet, and is capable of rotating on all three axes, as well as up and down. When a user enters a line—either by tracing a real object or by arbitrary pointing of the arm, the three-dimensional coordinates of its endpoints are stored by the computer, which then connects the points with lines drawn in any of the Apple colors. Thus, a 3-D object can be displayed on a screen, rotated on any axis, scaled, edited, and stored in the computer memory. The tablet also has two buttons for additional input (connected to Apple via the paddle port). Software for the tablet permits standard 2-D graphics, as well; and includes machine language subroutines that can be added to other programs—allowing them to poll the tablet for coordinates. $395.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Wrapped-Wiring Tool

Vector Electronic's Model P184-1 is claimed to permit wrapped wiring without measuring, cutting, or stripping. Tefzel-insulated 28-gauge wire is routed through the tool's center past a knife-edge where the insulation is split lengthwise. As the tool is rotated, bare wire makes contact with the post. The P184-1 features a tension-regulated spool to reduce wire breakage, and set-screw mounted wrapping bits designed for easy replacement. A standard 50′ spool of wire is said to permit about 200 daisy-chained, or 150 post-to-post, seven-turn wraps with an average lead length of 2″. Cost with a 50′ spool is $39; an optional 300′ spool bracket is available at additional cost.

CIRCLE NO. 93 ON FREE INFORMATION CARD

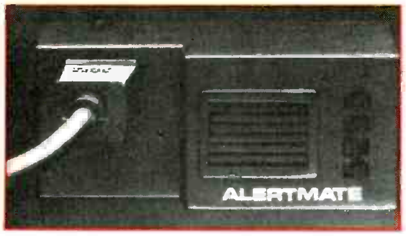
Water-Resistant Car Door Speakers

Clearance problems and potential water damage for door-mounted car stereo speakers are claimed to have been eliminated by the dual-cone TS-1644 speakers from Pioneer Electronics of America. The two-way 6½″ speakers have a mounting depth of 1⅝″—making it possible, according to Pioneer, to clear most door obstructions found in today's smaller automobiles. Constructed with a water-resistant low-distortion paper cone, the speakers are said to have a frequency range of 50 to 20,000 Hz, and a sensitivity of 91 dB. They feature 8.5-oz high-energy strontium magnets and are fitted with an acoustically transparent mesh grill in a heat-resistant plastic frame. The TS-1644 also has a horn tweeter with a 0.75-oz strontium magnet. Maximum input power is rated at 25 W. $90.

CIRCLE NO. 95 ON FREE INFORMATION CARD

Plug-In Theft Protection

The Alertmate from Biometric Systems is an electrical plug adapter to protect valu-

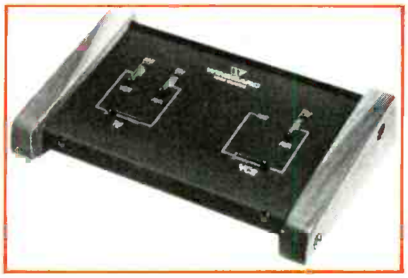


able equipment and appliances from unauthorized removal. The unit plugs into an ac outlet and receives the plug from the equipment you want to protect. Then the alarm is set. If the cord is cut or unplugged; or if Alertmate is unplugged without the proper code being dialed in, a loud noise will occur. Codes are preset at the factory, with 256 choices possible. $25.

CIRCLE NO. 96 ON FREE INFORMATION CARD

TV/VCR Video Switch

Winegard has introduced a new video selector, the Model VS-4002. The selector uses slide switches that permit the viewer to watch, record, and edit programming without connecting or disconnecting cables. Four 75–ohm inputs accept any combination of the following: cable TV, over-



the-air pay TV, outdoor antenna, VCR, disc, video games, earth station, computer terminals, etc. Viewers can watch any one of four inputs on the TV receiver while recording any one of three inputs on a VCR, as well as monitor and edit videotape on a second receiver. The selector reportedly has high-isolation circuitry to prevent interference. $125.

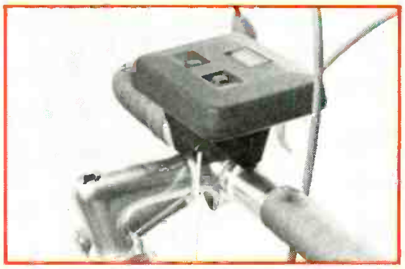
CIRCLE NO. 97 ON FREE INFORMATION CARD

Polk Speaker

The Monitor Four is Polk Audio's lowest priced speaker. Said to incorporate most of the design concepts of the larger Polks, the speaker has a 1″ soft-dome tweeter, a trilaminate polymer driver, moving-coil high-frequency radiator, and isophase crossover network. It also includes a computer-designed anti-diffraction grille frame. Some specs: sensitivity, 90 dB at 1 W/m; impedance, 8 ohms; frequency response (±3 dB), 70-20,000 Hz. Dimensions are 14½″H x 8½″W x 7½″ D; designed for either bookshelf or pedestal mounting. $100.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Instrument Panel for Bicycles



A digital display of three functions: distance, speed, and cadence is possible with the OSCar meter introduced by Hilgraeve

What makes this radar detector so desirable that people used to willingly wait months for it?

Anyone who has used a conventional passive radar detector knows that they don't work over hills, around corners, or from behind. The ESCORT® radar warning receiver does. Its uncanny sensitivity enables it to pick up radar traps 3 to 5 times farther than common detectors. It detects the thinly scattered residue of a radar beam like the glow of headlights on a dark, foggy road. You don't need to be in the direct beam. Conventional detectors do. Plus, ESCORT's extraordinary range doesn't come at the expense of more false alarms. In fact, ESCORT has fewer types and sources of false alarms than do the lower technology units. Here's how we do it.

The unfair advantage

ESCORT's secret weapon is its superheterodyne receiving circuitry. The technique was discovered by Signal Corps Capt. Edwin H. Armstrong in the military's quest for more sensitive receiving equipment. ESCORT's Varactor-Tuned Gunn Oscillator singles out X and K band (10.525 and 24.150Hz) radar frequencies for close, careful, and timely examination. Only ESCORT uses this costly, exacting component. But now the dilemma.

The Lady or The Tiger

At the instant of contact, how can you tell a faint glimmer from an intense radar beam? Is it a far away glint or a trigger type radar dead ahead? With ESCORT it's easy: smooth, accurate signal strength information. A soothing, variable speed beep reacts to radar like a Geiger counter, while an illuminated meter registers fine gradations. You'll know whether the radar is miles away or right next to you. In addition, the sound you'll hear is different for each radar band. K band doesn't travel as far, so its sound is more urgent. ESCORT keeps you totally informed.

The right stuff

ESCORT looks and feels right. Its inconspicious size (1.5Hx5.25Wx5D), cigar lighter power connector and hook and loop or visor clip mounting make installation easy, flexible, and attractive. The aural alarm is volume adjustable and the alert lamp is photoelectrically dimmed after dark to preserve your night vision. And, a unique city/highway switch adjusts X band sensitivity for fewer distractions from radar burglar alarms that share the police frequency while leaving K band at full strength.

Made in Cincinnati

Another nice thing about owning an ESCORT is that you deal directly with the factory. You get the advantage of speaking with the most knowledgable experts available and saving us both money at the same time. Further, in the unlikely event that your ESCORT ever needs repair, our service professionals are at your personal disposal. Everything you need is only a phone call or parcel delivery away.

Carrying case and visor clip included

Corroborating evidence

CAR and DRIVER . . . "Ranked according to performance, the ESCORT is first choice . . . it looks like precision equipment, has a convenient visor mount, and has the most informative warning system of any unit on the market . . . the ESCORT boasts the most careful and clever planning, the most pleasing packaging, and the most solid construction of the lot."

BMWCCA ROUNDEL . . . "The volume control has a 'silky' feel to it; in fact, the entire unit does. If you want the best, this is it. There is nothing else like it."

PLAYBOY . . . "ESCORT radar detectors . . . (are) generally acknowledged to be the finest, most sensitive, most uncompromising effort at high technology in the field."

PENTHOUSE . . . "ESCORT's performance stood out like an F-15 in a covey of Sabrajets."

AUTOWEEK . . . "The ESCORT detector by Cincinnati Microwave . . . is still the most sensitive, versatile detector of the lot."

The acid test

There's only one way to really find out what ESCORT is all about. We'll give you 30 days to test it for yourself. If you're not absolutely satisfied, we'll refund your purchase as well as pay for your postage costs to return it. In fact, try an ESCORT and any other detector of your choice. Test them both for 30 days and return the one you don't like. We're not worried because we know which one you'll keep. As further insurance for your investment, ESCORT comes with a full one year limited warranty on both parts and labor. This doesn't worry us either because ESCORT has a reputation for reliability. We know that once you try an ESCORT, radar will never be the same again. So go ahead and do it. Order today.

You don't have to wait

Just send the following to the address below:

- ☐ Your name and complete street address.
- ☐ How many ESCORTs you want.
- ☐ Any special shipping instructions.
- ☐ Your daytime telephone number.
- ☐ A check or money order.

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Visa and MasterCard buyers may substitute their credit card number and expiration date for the check. Or call us toll free and save the trip to the mail box.

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☐ CINCINNATI MICROWAVE
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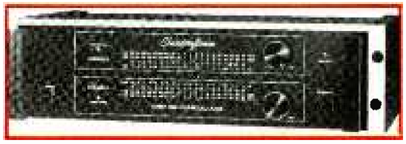
Inc. Designed for the serious cyclist, OS-Car (Odometer/Speedometer/Cadence) uses metal detectors to sense motion of the bicycle's spokes. The sensor is encapsulated in silicone rubber and is claimed to be immersible and impact-resistant. A 9-V transistor battery powers the unit, which offers continuous storage of the odometer reading. Accuracy depends on tire size and design and inflation pressure, but is said to be within ±1.5% for the speedometer and 1.3% for the cadence meter. $129.95. **Address:** Hilgraeve, Inc., Box 941, Monroe, MI 48161.

Microcomputer Enclosure

To convert the AIM 65 micro system from a "bare bones" unit to one with a finished look, an accessory enclosure, with or without an integral power supply, has been introduced by Rockwell International. The enclosure includes an on/off switch, a pushbutton reset switch mated to the AIM 65 reset switch, and pre-wiring with internal ac lines. Removable plugs in the cover allow access to the AIM 65 run/single-step and KB/TTY switches. The paper supply for the thermal printer is kept in an external holder to facilitate ease of replacement. The enclosure with power supply (Model A65-006) provides +5 V dc at 3 A and +24 V dc at 0.5 A. Model A65-002 (without power supply) costs $95. With power supply, cost is $165.

CIRCLE NO. 99 ON FREE INFORMATION CARD

Power Amplifier



Power MOSFETs are featured in the new LA2502 amplifier from Soundcraftsmen. The unit is said to be capable of delivering 380 W total at 4 ohms impedance, or 125 W/ch at 8 ohms in the stereo mode. Dual strings of 20 LEDs each provide calibrated metering at 1-3-dB intervals up to 500 W output. True Clipping LEDs are said to indicate the actual onset of waveform distortion. Also provided: speaker switching with A plus B capability, zero-to-maximum gain controls, and modular chassis construction with a 16-gauge steel wraparound main-frame and mounted handles. Specs: THD from 20-20,000 Hz, 0.05%; S/N, 105 dB (damping factor, 200); slew rate, 40 V/μs. $649.

CIRCLE NO. 100 ON FREE INFORMATION CARD

Duty-Cycling Thermostat

The SavIt, from Electronic Systems International, is an internally fused, preprogrammed thermostat that is designed to operate in series with an existing thermostat. It works through two closed relay contacts, said to be capable of switching up to two amperes at 50 V ac. The unit makes use of the principle of duty cycling—shutting off a central heater or air conditioner for a predetermined short interval to save electricity that would be needed to keep the equipment running constantly. There is a choice of six time functions—three each in the heating and cooling modes—that correspond to the low, medium, and high settings on a heater or central air conditioner. An internal circuit uses the 60-Hz waveform for timing control; and the current requirement is rated at 0.2 A. $298. **Address:** Electronic Systems International, Inc., 5600 Roswell Rd., Ste 200, Prado East Atlanta, GA 30342.

Receiver/Monitor Conversion Kit

The ACVM-2 from V.A.M.P. Inc. is a direct video conversion kit that can be installed in a B&W or color receiver for the purpose of eliminating ghosting, color shifting, r-f radiation, and signal interference. It works by bypassing the tuner and r-f sections of a conventional receiver, providing high-resolution displays of up to 80 characters in the monitor mode. Modes are shifted via a two-position switch. The ACVM-2 will work with any receiver currently on the market, except those whose chassis common is not directly connected to ac neutral. $35. **Address:** V.A.M.P. Inc., 6753 Selma Ave., Los Angeles, CA 90028.

Surge Suppressor

Manufactured by Advanced Electronics and marketed by National Field Sales, the Stedi-Watt, Jr. is a six-outlet surge suppressor that plugs into any standard three-wire, duplex receptacle to protect equipment against damaging voltage spikes. The unit responds to filter out transients of up to 6000 V within less than a ten-thousandth of a second. Continuous operation is indicated by an amber light. Available in ivory or dark brown. $59.50. **Address:** National Field Sales Inc., 2660 West Chester Pike, Broomall, PA 19008.

If you have put off learning more electronics for any of these reasons, act now!

- ☐ I don't have the time.
- ☐ High school was hard for me and electronics sounds like it may be hard to learn.
- ☐ I can't afford any more education.
- ☐ I have a family now.
- ☐ I'm here. You're there. I've never learned that way before. I'm not sure it will work for me.

Read the opposite page and see how you can get started today!

ENTERTAINMENT ELECTRONICS

By Len Feldman

Audio Goes Digital in Las Vegas

WHAT the recently concluded Winter Consumer Electronics Show (Las Vegas, NV) lacked in quantity of new product introduction, it made up for in quality. In the world of audio there was further evidence of a digital revolution. Here the big news was about tape recording, rather than discs, with significant product and price breakthroughs from both Sony and Technics. These two companies have taken different approaches to pulse code modulation (PCM) recording. Sony has introduced a third-generation PCM audio processor, while Technics showed an all-in-one PCM audio tape deck. (While much has already been written about compact digital discs, now promised for early 1983 by just about every major audio equipment manufacturer, some doubts about the date of delivery exist; largely because of difficulties in the production of software.)

Digital Audio from VCRs. By way of background, in the mid-1970s Sony produced the first digital audio processor for consumer use, the Model PCM-1. This rather bulky unit was designed to be used with the (then) newly introduced video cassette recorders such as Betamax, U-Matic and, later, the competing VHS format. The Sony processor converted an audio signal to digital pulse-code (14-bit "words" were used) so that, during playback, frequency response was ruler-flat to 20 kHz, distortion negligible, and wow or flutter was, for all practical purposes, nonexistent. This meant that millions of digital bits were stored on the tape every second. This information-density requirement was best met by video tape formats designed to handle video-signal (MHz) bandwidths.

So complex was the first PCM audio processor, that its suggested retail price was around $5000. Then there was the cost of a VCR (another $1000); hardly the sort of setup that audio recording enthusiasts were going to buy in droves. Other companies began experimenting with PCM recording tied into VCRs and it soon became clear that standards would be required if any inter-system compatibility was to prevail. After lengthy meetings, the Electronics Industry Association of Japan (EIAJ) formulated such standards and Sony introduced their *second* PCM processor, the Model PCM-10 in 1980. While the new processor adhered to the new EIAJ standards, it still cost around $5000. All of which makes Sony's introduction of the PCM-F1 PCM processor more significant; its suggested retail price is around $1900.

New large-scale integrated circuits (LSIs), some of them designed by Sony, enable the PCM-F1 to be one-eighth the volume and one-fifth the weight of earlier processors. In fact, the PCM-F1 weighs less than nine pounds, can be powered from ordinary ac, an optional rechargeable battery, or a car/boat battery adapter, and measures only 8½ in. by 3⅛ in. by 12 in. While it will work with *any* available VCR format, Sony is promoting its use with its portable SL-2000 "BetaPak." The PCM-F1/SL-2000 combination is a state-of-the-art audio recording system that weighs only 18 pounds!

Sony executives feel strongly that the PCM-F1 (combined with a VCR) offers an attractive alternative to the best open-reel audio deck—even decks that handle the new "EE" tape formulations. And the $1900 price may well attract audiophile, semiprofessional, and even professional recordists. Newly developed LSIs were essential to obtaining size and weight reduction for the new processor according to the PCM-F1 block diagram.

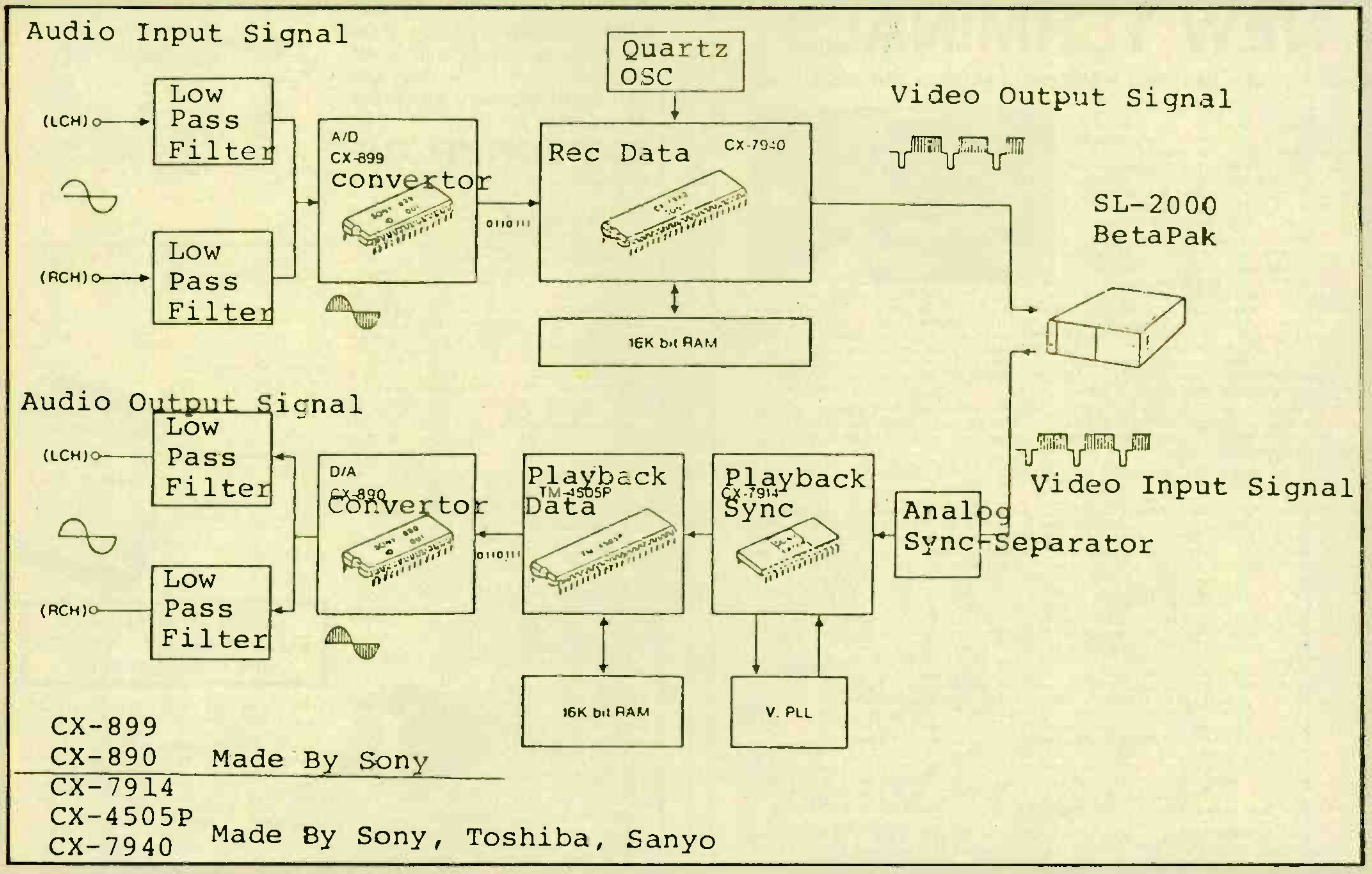
The Technics approach to PCM digital recording involves a new all-in-one digital tape deck (reminiscent of the analog Elcaset deck in configuration). The new deck (Model SV-P100), uses VHS video cassettes and conforms to the EIAJ standards for VCR-related digital audio recording. And the SV-P100's built-in tape transport is fundamentally the same as the transport systems used in VHS video recorders. But by building a one-piece, dedicated *audio* product (instead of adapting a video recorder), Technics can offer several convenience features that are particularly suited to sound recording. For example, the SV-P100 can be programmed to "skip over" specified selections during playback. Moreover, its four-digit tape counter allows precise cueing, rudimentary editing, etc. Unlike the Sony PCM-F1, however, the SV-P100 is strictly a homebound machine—operable only from 120 volts ac and weighing about 50 pounds.

A roundup of new digital audio technology at the Winter CES would not be complete without mentioning the first prototype of an upcoming product that the people at Acoustic Research were demonstrating. Called an Adaptive Digital Signal Processor, the device performs a computer analysis of sound reproduction at any location in a room and then, after making about four million calculations in a minute and a half, "designs" the reciprocal filter needed for a "flat" speaker-and-room response—even if that filter involves fifty or more wide and narrow peaks and dips in its own response curve! The ADSP is likely to be a consumer product within a few months.

Video Forefront. This year at CES there was relatively little new to report concerning video disc players and video cassette recorders, with the exception of a surprise introduction by Technicolor. They have cleverly combined a color video camera with a new, more compact version of its ¼-inch micro-video tape recording mechanism to create an "almost-in-camera" VCR system—well ahead of many larger video-product companies.

Meanwhile, Henry Kloss of Kloss Video Corporation, who can always be relied upon to come up with products that his competitors have dismissed as technically "impossible," demonstrated his legendary finesse again this year. Kloss's new Novabeam® Model Two is a compact, portable television projector that produces a bright 3′ by 4′ color-TV

Sony's PCM-F1 Digital Audio Processor



Block diagram showing basic operation of the Sony PCM-F1 Digital Audio Processor.

Technics Model SV-P100 Digital Audio Cassette Recorder

Kloss Novabeam Model Two Portable Projection TV

picture directly on any flat white wall. No special curved projection screen required! This Novabeam picture can be watched from any point in a darkened room at full picture brightness. However, ambient light must be kept low. The projector unit is placed four feet away from the wall "screen."

Pricing has been set at around $2000, but please note that the system does *not* include a TV tuner. A video signal from an already-available VCR (which contains a multi-channel tuner) must be fed to the input of the Novabeam Model Two. With the current trend toward separate video components and the surge of interest expected when the FCC approves stereo TV audio, Kloss's introduction of an easy-to-use and easy-to-position projection TV monitor couldn't have come at a better time. With its lid closed, the unit measures only 21½" high by 24½" wide by 12" deep. It weighs about 60 pounds.

For at least two years, everyone's been talking about the pending "marriage" of audio and video. While no one manufacturer can yet be credited with pulling off the ceremony, Kenwood certainly qualifies as one of several "matchmakers" with its introduction of the Model KVA-502 audio-video integrated amplifier. This 50-watt per channel amplifier can serve as the control center of a home audio-video entertainment room. Key features and operating capabilities include extended audio and video dubbing facilities, sound mixing, TV/video sound enhancement (simulated stereo effect), noise reduction for video tapes, picture quality enhancement, and straight dubbing of pictures and sound from one VCR (or video-disc player) to another VCR. All this is in addition to the KVA-502's usual function as an integrated audio amplifier for handling audio program sources. The unit will carry a suggested retail price of $400.

Soup and Sonatas. What do music and supermarkets have in common? Nothing I was aware of until I visited Casio's winter CES exhibit. There I was intrigued by a latter-day player piano—an electronic, computerized keyboard. No coded paper rolls here. The user simply passes an optical scanner (light-

Casio CT-701 electronic computerized player piano uses a tune printed in bar code.

Kenwood Model KVA-502, with a VCR, makes an audio/video center and also provides an amplifier for stereo audio.

Visitors at Winter CES sending telegrams to Congress in support of the right to tape record video programs.

wand) over a printed bar code and an encoded tune is instantly put into the keyboard's memory. Casio has taken regular sheet music and converted it into bar codes—like those you see on soup cans and breakfast cereal packages.

I was ready to regard the computerized keyboard as an amusing novelty until discovering that, in addition to playing back the stored melody, complete with chords and a multitude of instrument voices (organ, flute, piano, etc.), the keyboard can also be used as a learning tool. It contains a "melody guide" of tiny lights, identifying the correct keys to be pressed, note by note. Students needn't be able to read music! As the unit silently displays a memorized melody, you simply follow the lights and press the corresponding key. Best of all, if you hit a wrong (unlighted) key, it will *not* sound! Could this be the beginning of a whole new way to learn about music? As a Casio demonstrator pointed out, bar-coded representation of a melody is really no more arbitrary than the "accepted" musical score notation.

The Right to Tape. Though CES events are normally nonpolitical, the recent decision of the Ninth District Court of Appeals (Los Angeles, CA) ruling against the home videotaping of TV broadcasts is of such far-reaching importance (audio taping might soon be affected) that the Electronic Industries Association (CES sponsors) opted for direct action. They set up a booth at the show encouraging visitors to send telegrams to their congressmen and senators supporting pending legislation favorable to home (noncommercial) videotaping. Such legislation, if enacted, would effectively bypass the court decision by amending the copyright act of 1976. (The appeals court based its ruling—a reversal of a lower court decision favorable to home taping—on the copyright act.) If you feel that in-home videotaping of programs for later viewing doesn't make you guilty of criminal activity, you might want to make *your* feelings known to your own legislators, too. After all, anyone owning or planning to buy a VCR has a stake in this important, home-entertainment issue. ◇

MAXELL IS PLEASED TO PRESENT AN EVEN HIGHER PERFORMANCE TAPE.

If you're familiar with Maxell UD-XL tapes you probably find it hard to believe that any tape could give you higher performance.

But hearing is believing. And while we can't play our newest tape for you right here on this page, we can replay the comments of Audio Video Magazine.

"Those who thought it was impossible to improve on Maxell's UD-XL II were mistaken. The 1981 tape of the year award goes to Maxell XL II-S."

How does high bias XL II-S and our normal bias equivalent XL I-S give you such high performance? By engineering smaller and more uniformly shaped epitaxial oxide particles we were able to pack more into a given area of tape. Resulting in a higher maximum output level, improved signal-to-noise ratio and better frequency response.

To keep the particles from rubbing off on your recording heads Maxell XL-S also has an improved binder system. And to eliminate tape deformation, XL-S comes with our unique Quin-Lok Clamp/Hub Assembly to hold the leader firmly in place.

Of course, Maxell XL II-S and XL I-S carry a little higher price tag than lesser cassettes.

We think you'll find it a small price to pay for higher performance.

IT'S WORTH IT.

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

Audio Product of the Month

CHOSEN BY THE EDITORS OF POPULAR ELECTRONICS

Pioneer Model CT-8R Cassette Deck

THE Pioneer CT-8R is a three-head, three-motor machine featuring built-in Dolby B and Dolby C noise-reduction systems and bidirectional playback with auto-reverse operation. Its style matches that of other current Pioneer audio components, finished in satin gold with a dark brown center panel on which are displays of the signal path through the machine and the exact operating mode being used.

The CT-8R has a number of unusual tape transport functions and operating features, controlled through an internal microprocessor system. These include automatic tape bias and equalization optimization, a logic-controlled solenoid operated tape transport, and an elaborate program-search-and-selection system based on sensing unrecorded tape segments.

Overall dimensions of the Pioneer CT-8R are approximately 16½″ W × 12⅝″ D × 5⅛″ H. It weighs 14 lb 5 oz. Suggested retail price is $575.

General Description. The front panel of the Pioneer CT-8R is divided into three essentially equal parts. On the left is a bottom-hinged door containing the cassette guides. It opens at the touch of the nearby EJECT button. The right third of the panel contains almost all the operating controls, consisting of four small knobs and a number of rectangular buttons of different sizes and shapes. The center section (in contrasting dark brown) contains illuminated displays of tape transport mode, signal path, and the internal operating conditions of the machine.

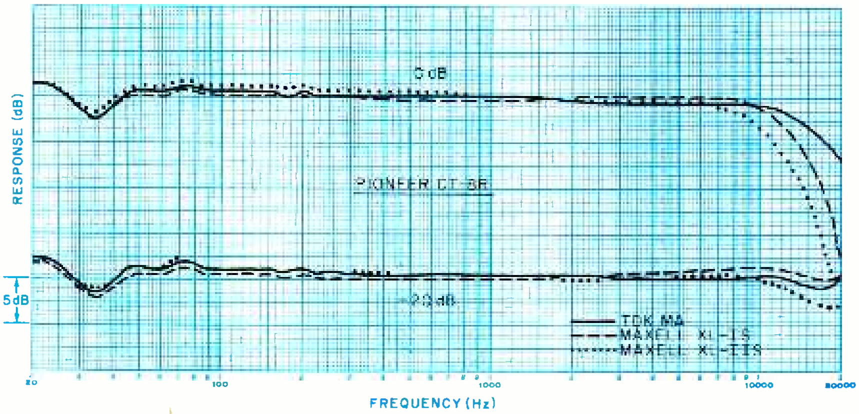
The CT-8R tape transport uses three miniature direct-drive motors to turn the capstan and the two tape hubs. The motors' speeds and torques are controlled by ICs to provide a smooth, even wind on the hubs.

The head movement required for bidirectional play is accomplished by a rotating head turret, whose design allows the playback head azimuth to be adjusted separately for each direction of tape motion. The combination record/playback head (two separate heads in a common housing) is shaped to insure close, stable contact between the tape and the head during operation.

The heads themselves are made of Sendust alloy, formed into a ribbon by a proprietary Pioneer process. According to Pioneer, its Ribbon Sendust head has a very low loss and high permeability, which is largely responsible for the machine's excellent performance characteristics. Data offered by Pioneer to compare the magnetic and physical properties of the Ribbon Sendust head with conventional Sendust, Permalloy, and ferrite core heads shows a modest but definite superiority for Ribbon Sendust in most cases.

Automatic tape optimization systems have been available for a few years, and this feature is now offered in at least some models from almost every cassette recorder manufacturer. They vary somewhat in operating details and their criteria for setting the bias, equalization, and recording level; but all of them are capable of extracting the maximum performance from almost any kind of tape.

Early automatic tape optimizing systems (actually, it is the *recorder* rather than the tape that is optimized) required as much as 20 to 30 seconds to perform their adjustment cycle, but in the Pioneer CT-8R, this time has been reduced to about 8 seconds! When the AUTO BLE ("bias, level, equalization") button is pressed, the tape is first recorded with a 1-kHz test signal and the output from the playback head is measured. If the output is absent or too low, the sequence stops; otherwise the recording level is set roughly and the bias is stepped through



Frequency responses for three different types of tape.

a sequence of levels until the output meets an (unstated) criterion for correctness. If that condition cannot be met, the adjustment is terminated and the recorder is automatically set to its internal reference bias setting for that type of tape.

When the correct bias has been determined, its value is set into the computer memory and the final level setting is made. Again, if the optimum value cannot be reached, the machine reverts to its internal preset value. The third automatic adjustment is of recording equalization, with the same default procedure if the tape cannot be optimized. When all three key parameters have been set for flattest frequency response and correct output level, they are stored in the computer memory, and the AUTO BLE light (which has been blinking during the process) remains on. The tape rewinds to the point at which the process started and the machine stops, ready for use.

Although Dolby B noise reduction has been universally adopted by manufacturers of cassette recorders, the newer Dolby C system is only now beginning to appear in regular production recorders. It is very similar in concept to the B system, but operates at lower signal levels and extends its noise reduction to lower frequencies. The final result is an overall noise reduction of about 20 dB, compared to the 10 dB of the Dolby B system. A certain degree of compatibility exists between the two systems, so that tapes recorded with Dolby C can be played (if necessary) on any Dolby B machine with about the same degree of success as would occur if a Dolby B tape were played without any Dolby decoding in the playback. The "incompatibility" in either case is a slightly brighter sound. However, a properly decoded Dolby C tape will sound dramatically quieter than a Dolby B tape, as well as having the correct frequency response.

Laboratory Measurements. Although the AUTO BLE system should make the Pioneer CT-8R usable with practically any tape, we measured its frequency response with a number of tapes, including TDK D, OD, SA-X, and MA, as well as Maxell XL-IS and XL-IIS. The AUTO BLE adjustment was used for each tape before making any measurements.

Frequency response differences between all the tapes were exceedingly small, typically 2 to 4 dB of variation from 10,000 to 20,000 Hz at a −20-dB recording level. The only exceptions to this pattern were the Maxell XL-IS (a "normal" ferric tape) and TDK MA (metal), both of which gave an extremely flat response all the way to 20,000 Hz. All the tapes had the same mid- and low-frequency response, with moderate "head bumps" visible between 20 and 40 Hz. The overall response was typically ±2.5 dB from 20 to 20,000 Hz (±2 dB with the XL-IS and MA tapes). If the low-frequency variations are averaged out, the overall response with XL-IS or MA was within ±1.5 dB from 20 to 20,000 Hz, which is superb performance for any cassette deck. For our full tests of the CT-8R, we used Maxell XL-IS (normal), Maxell XL-IIS (CrO_2) and TDK MA (metal).

When the response was measured at a 0-dB recording level, the differences between the tapes were slightly more visible. However, one of the most unusual characteristics of the frequency response was that the 0-dB curve did not intersect the −20-dB curve, up to 20,000 Hz, with any of the tapes. This indicates the superior quality of the Pioneer recording head, which evidently requires less recording equalization boost at high frequencies than do less efficient heads (and thus produces less tape saturation). The MPX filter, designed to remove any 19-kHz pilot carrier from an FM signal being recorded, was highly effective. It had virtually no effect on the response up to about 16,500 Hz, and cut off rapidly above that frequency.

The playback equalization of the CT-8R was checked using the new standard calibration tapes from BASF, whose recorded frequencies span from 31.5 to 18,000 Hz (previous tapes were limited to 12,500 Hz). The 70- and 120-μs playback responses were essentially identical, within ±1.5 dB from 31.5 to 12,000 or 14,000 Hz, and rising 4 or 5 dB at 18,000 Hz. A check with our previous tape (the TDK AC-337) showed a ±1.5-dB frequency response from 40 to 12,500 Hz.

At the maximum gain setting, a 0-dB recording level indication required a line input of 63 mV. The microphone sensitivity was 0.27 mV, with overload occurring at 48 mV. Since plugging in one microphone jack replaces only its corresponding line input, it is not possible to make a mono recording from a single microphone unless an external "Y" connection is used.

The playback output from a 0-dB signal was in the range of 0.64 to 0.68 V, depending on the tape used. The third harmonic distortion in the playback from a 0-dB, 1000-Hz recorded reference signal was down 41 to 42 dB for Maxell XL-IIS and TDK MA, and 47 dB for Maxell XL-IS. To reach a reference playback distortion of 3% (third harmonic down 32 dB) we had to record at 5.5 dB above reference with XL-IIS and at 7 dB above reference with the other two tapes.

Referred to the playback from those recording levels, the unweighted S/N in the output was 50.5 dB (XL-IS), 51.5 dB (XL-IIS) and 52.5 dB (MA). With CCIR/ARM weighting and using Dolby B noise reduction, those readings improved to 62.2, 66.2, and 66.4 dB. Finally, with Dolby C, the S/N readings were impressively high, respectively 73, 74, and 74.5 dB for the three tapes.

The Dolby tracking (the change in overall record/playback frequency response with Dolby on or off, at various recording levels) was excellent. With Dolby B, the response changes were visible only above 10,000 Hz and did not exceed 1 dB up to 15,000 Hz, for recording levels between 0 and −30 dB (TDK MA tape). The results with Dolby C were also good, with smooth variations in output (1.5 to 2 dB) at various frequencies up to 15,000 Hz.

A standard Dolby level-test tape produced a +3-dB reading on the CT-8R's LED display. The LEDs responded very rapidly, giving the same readings on steady signals or on 0.3-second tone bursts. The tape transport, which ran about 0.65% fast, moved a C60 cassette from end to end in 110 seconds (fast forward) or 114 seconds (rewind). The weighted peak flutter (CCIR) was ±0.05% and the weighted rms flutter (JIS) was 0.03%, both very low readings for a cassette deck.

User Comment. The recording and playback performance of the Pioneer CT-8R are so outstanding that little additional comment is needed. Recording and playing back records, FM programs, and even interstation FM tuner hiss did not reveal any significant difference in sound between the incoming program and the playback. This was the case even at indicated recording levels of 0 dB, which normally result in dulled high-frequency output due to tape saturation. We have never used a cassette deck that could surpass this performance, and very few can even come close to matching it. Even without considering the many special operating features of the CT-8R, its basic performance alone would justify its price.

Not long ago, the better open-reel home-type tape recorders could not match the flutter readings of the CT-8R, even at 15 inches per second. None of the several automatic tape optimizing systems we have used were any more effective than the AUTO BLE, and all of them were much slower in operation.

We found only one operating flaw in the CT-8R. Cassettes lacking rear notches to identify the tape type cannot be used properly in this machine (they will be automatically assigned the 120-μs playback equalization). We have a number of early Advent chromium-dioxide tapes that will never sound right on the CT-8R because there is no way to select the 70-μs equalization manually. There was a similar problem in trying to test the machine with different metal tapes, since few of our early samples had the rear keying holes. A manual tape selection override would have been a most desirable feature on this deck.

The proximity of the EJECT button to the edge of the cassette door requires considerable care when opening the door, which can easily be blocked by the tip of the finger that is pressing the button. Left-handed operation of the button would be extremely awkward.

Experience with other recent Pioneer components featuring the same styling as the CT-8R has left us with strong positive feelings about the informative center display panel. The signal flow and function display is both attractive and useful. In view of the many special control features of the CT-8R, a clearly visible display of its operating modes would seem to be a virtual necessity.

We used all of the special features of the CT-8R to verify their operation. Everything worked exactly as described in the instructions. However, this is not a machine that can be used to full advantage without a careful study of the manual, and considerable practice. Until the use of all the buttons becomes automatic on the part of the user, the CT-8R can be a formidable challenge.

Fortunately, it can be used as a perfectly conventional cassette deck, without bothering about its various search and fast-scan modes. We chose to do just that, since it became obvious that sustained practice would be needed to use any of these modes effectively.

The "bottom line" of our evaluation of the Pioneer CT-8R is that it is one of the finest cassette recorders we have used and is an exceptional value in its price range. Its basic performance—frequency response, distortion, S/N, and flutter—would be very difficult to surpass at any price. And once its special tape-handling features are mastered, it offers another good reason to choose the CT-8R. The unit earns top honors as a superb cassette recorder at a surprisingly low price.—*Julian Hirsch*.

PIONEER CT-8R CONTROLS AND INDICATORS

Front Panel Knobs

INPUT	Concentric L and R channel recording level controls.
OUTPUT	Playback program level control.
MODE	Three-position switch for normal stop at end of tape, auto-reverse (playback only), and auto-reverse with four complete plays before stopping.
TIMER	Three-position switch (OFF, REC, PLAY) for unattended operation with external ac power switched by timer.
Operations Switches	Flat plates for fast forward, rewind and reversing tape direction, identified by arrow symbols. PLAY and STOP controlled by pressing opposite ends of a single large plate.

Pushbuttons

EJECT	Opens cassette door.
POWER	Controls ac line power to recorder.
AUTO BLE	Activates automatic system for optimizing tape bias, level, and equalization.
CLEAR	Clears AUTO BLE data, replacing with reference values built into machine.
BLANK SEARCH	Puts tape in fast forward until a nonrecorded segment of at least 8 seconds is encountered. At that point, tape stops and is positioned to play following section.
PAUSE	Alternate pressures stop and start tape without affecting operating mode (not operative in fast speeds).
REC	Single red button initiates recording mode of operation.
REC MUTE	While held in during recording, removes incoming program from recording head to add silent interval to tape.
MS/SKIP	When set to ON, pressing the fast-forward or rewind control moves the tape to beginning of next recorded selection and resumes play from that point. Cancelled by second operation.
INDEX SCAN	Causes tape to scan in fast speed in direction set by operations switch. Stops at each recorded section, plays 7 seconds, and resumes scan until either PLAY or STOP is pressed.
MUSIC REPEAT	Pressing during playback causes selection to be repeated up to 8 times (or until cancelled by pressing one of the operations switches).
MEMORY	Push to ON to engage AUTO STOP at 000 counter reading in fast speeds.
MONITOR	Connects line outputs to TAPE or SOURCE.
DOLBY NR	Three small buttons turn on Dolby system, select B or C system, and engage the MPX filter.

Display Panel Features

COUNTER	Three-digit mechanical index counter with reset button.
LEVEL	Two vertical rows of LEDs reading instantaneous program levels from −20 to +8 dB.
AUTO REVERSE	Green, lighted arrows and bar pattern to show travel/stop status of tape. Rate of light movement shows speed and direction. Arrows show when machine is set for auto-reverse.
RECORDING MODE	Lights show REC, PAUSE, and REC MUTE status. Arrows show whether MONITOR is set to TAPE (playback) or SOURCE.
TAPE AUTO SELECT	Lights show NORM, CrO_2, METAL selection of bias and playback EQ according to index holes on the back of the cassette.
AUTO BLE	Green AUTO DATA light flashes while automatic tape optimization is in progress, speeding up as it continues and remaining on when it is complete.
DOLBY TYPE	Letters B or C illuminate showing the Dolby system in use.

Jacks

MIC (L and R)	These 1/4" jacks automatically replace the rear line inputs when microphone plugs are inserted (mono recording not possible with single microphone).
PHONES	Stereo headphone jack.

Rear Panel

LINE IN, LINE OUT	Phono jacks.

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8″ DSDD Soft Sector (Unformatted)	**3102**	3.14
8″ DSDD Soft Sector (128 B/S, 26 Sectors)	**3115**	3.34
8″ DSDD Soft Sector (1024 B/S, 8 Sectors)	**3104**	3.34
8″ DSDD Burroughs B-80 Comp., 32 Hard Sector	**3092**	3.34
5¼″ SSSD Soft Sector (Unformatted)	**3401**	1.94
5¼″ SSDD Soft Sector w/Hub Ring	**3481**	2.34
5¼″ SSDD 10 Hard Sector w/Hub Ring	**3483**	2.34
5¼″ SSDD 16 Hard Sector w/Hub Ring	**3485**	2.34
5¼″ DSDD Soft Sector w/Hub Ring	**3491**	3.09
5¼″ DSDD 10 Hard Sector w/Hub Ring	**3493**	3.09
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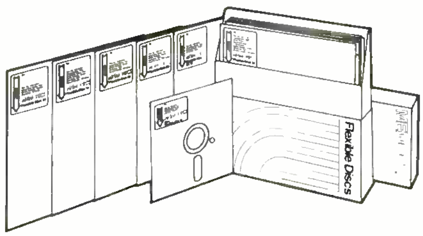

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Magnavox 19" Color "Phoenix" Chassis

THE "Phoenix" chassis has arrived. This new modular chassis will first be installed in the company's existing T809 and T815 cabinets, until the entire line is converted during model year 1982. It represents an overall advance in Magnavox's fine earlier chassis.

General Description. We reviewed the BB4242WA01 19-inch table model, which already uses the new Phoenix chassis. It has an MV19VMFP22 90° Sylvania picture tube; 10-key direct-address, frequency-locked and synthesized tuner with 105 uhf/vhf/CATV channels; light-dependent resistor for tracking room lighting changes; tone and volume controls; and a "V-Matic" arrangement for those who can't manage manual tuning. Under the front apron are thumbwheel controls for brightness, picture, tint, and color. Around back you'll find sharpness, vertical hold, and a normal/CATV switch.

Up front, inside the cabinet, is a 4-by-6-inch oval speaker; separate, shielded tuner packages with controls; a plug-in comb filter; and aluminum heat sinks for horizontal, vertical, and audio outputs. There are also trimmers for sub brightness; red, blue, and green drives and cutoffs; vertical height; horizontal hold; volume; and the 3.58-MHz oscillator. Focus and G2 potentiometers are on a separate board. Suggested retail price is $550.

The signal board is the larger of the set's two main pc boards. It holds three integrated circuits, 13 transistors, three plug-in tuner packages (and their controls), the i-f amplifiers, and a comb filter. Five hex-head screws and several plastic connectors remove tuner and controls, allowing the signal board to be easily extracted. The board includes the sound processor, the sync processor, and the chroma luminance processor, as well as discrete vertical outputs, RG&B amplifiers, and a horizontal pre-driver. Let's briefly discuss some of the ICs.

The sync processor is a Sanyo LA1460 containing the vertical and horizontal oscillators, sync separator, vertical SAW and vertical pre-driver outputs, burst-gate pulse, automatic frequency control, and video inputs and outputs. Obviously, this 22-pin IC is fairly complex, and uses differential amplifiers as well as gates, flip-flops and diodes. It does not, however, possess a separately tuned high-frequency oscillator for the IC counter. Thus, both horizontal and vertical holds are included. Vertical hold is a customer control.

The chroma/luma processor is the major chip in the set, with 28 pins and a number of separate video and color functions. The IC is designated μPC1352C or AN5310 by Nippon Electric and Matsushita, respectively. All oscillator and interstage transformers have been eliminated; there is diode protection against stray transients; and color and contrast controls are interlocked.

A Philips TDA2541 chip contains a gain-controlled, wide-band amplifier with video preamplifier, synchronous video detector, agc circuit with noise-prevent gating, and automatic fine tuning that can be switched on and off by dc levels. It is preceded by a surface-wave acoustical filter and preamplifier that effectively rejects most CB intrusion and other interference.

Inputs to the TDA2541 enter a gain-controlled amplifier, which supplies midpoint 44-MHz i-f frequencies to both a synchronous video demodulator and tuned reference amplifier. The automatic fine tuning receives a 45.75-MHz video carrier from the reference amplifier and delivers a filtered dc correction voltage to the tuners, restoring any frequency deviation from assigned channels. Full-wave detected video (free of spurious high-frequency transients) then reaches the video preamplifier and its white spot (peak reduction) inverter. The signal then returns to a combined automatic gain detector and noise inverter, where filtered dc voltages prevent i-f and tuner overloads.

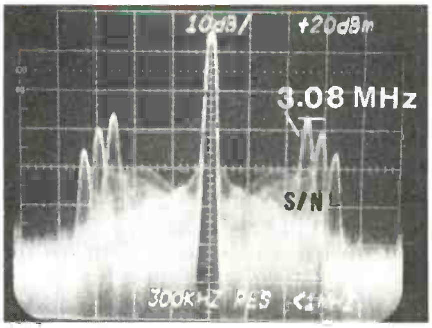
Plugged into the Signal Board is a "high-resolution filter" that's a simplified version of comb filters used in other Magnavox units.

The power board, as its name implies, delivers ac into the receiver, where it is rectified. The board is protected against high-voltage spikes by a metal-oxide sink and a 5-A fuse. A startup transformer and rectifier supply initial poten-

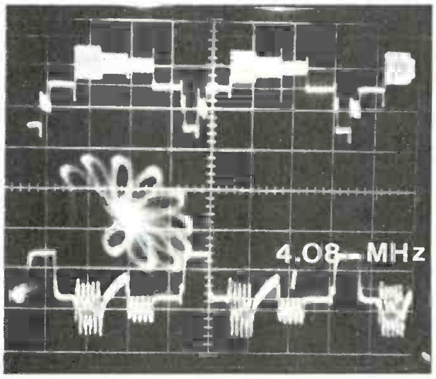
MAGNAVOX 19" MODEL BB4242WA01 LABORATORY DATA

Parameter	Measurement
Tuner/receiver sensitivity (before snow):	vhf (Ch. 3): −8 dBmV uhf (Ch. 20): −3 dBmV
Voltage regulation (with signal applied and ac varied between 105 and 130V):	Low voltage: 12-V supply—98.6% 110-V supply—97% High voltage: 25-kV supply—96.2%
S/N ratio at CRT:	42 dB
Dc restoration:	83%
Luminance bandpass at video detector:	4 MHz
Luminance bandpass at CRT:	4 MHz
Agc swing from saturation to cutoff:	63 dB
CRT color temperature:	7400°K
Horizontal overscan:	11%
Convergence:	98%
Power requirements (signal applied):	100 W (avg.)

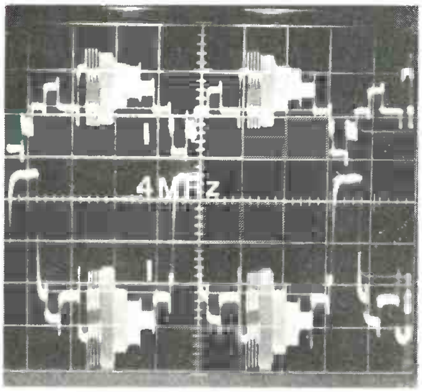
Note: Instruments used in these measurements are: Tektronix 7L12/7L5 spectrum analyzers; Telequipment D66, D67A oscilloscopes; Sadelco FS-3D VU f/s meter; Winegard DX-300 amplifier; Data Precision 245, 258, 1750 multimeters; B & K-Precision 1250 and 3020 NTSC and sweep/function generators and PR57 power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



Spectrum analysis of video at the cathode ray tube shows an excellent S/N.



Chroma and vector patterns are good. The 4.08-MHz trace at CRT shows some loss of signal strength.



Multiburst shows 4-MHz luma response at video detector (top) and at CRT (bottom).

tial for horizontal driver kickoff and then a switch-mode power supply with SCR regulator takes over as soon as flyback operation begins at 15,734 Hz. A three-transistor comparator, latch, and shutdown circuit protects the receiver from excess high-voltage runaway. On this board there are no ICs.

Comments. Totally modular (including the removable U/V/CATV tuners and tuner controls), this receiver is equally serviceable in the home or shop, and features highly identifiable stenciled test points. Its well-regulated voltages, sharp convergences, full agc swing, good tuner sensitivity, color temperature, and signal-to-noise measurements allow us to confidently applaud the design and performance of this set.

If we had any criticism, it would be in the 4.08-MHz chroma roll-off, and somewhat wide vector petals. You won't notice it in the video pictures, however. The waveform photos show some degradation at the higher chroma frequencies, but the vector indicates nothing more than a slightly extended chroma bandpass. This results in rise and fall times that are a bit longer than optimum. Otherwise, as both oscilloscope and spectrum analyzer illustrate, luma and chroma, including a full 4-MHz bandwidth at the CRT, are considerably better than most high-end competition, and represent a real improvement over just about any set in this price range.

—*Stan Prentiss*

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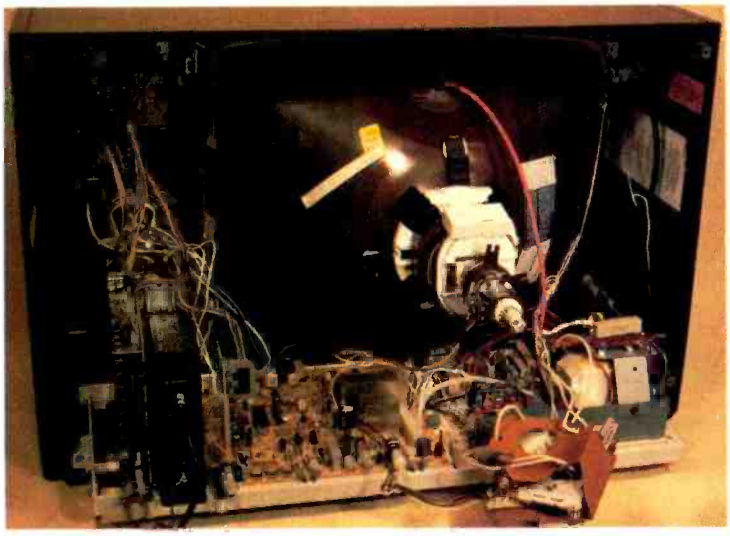
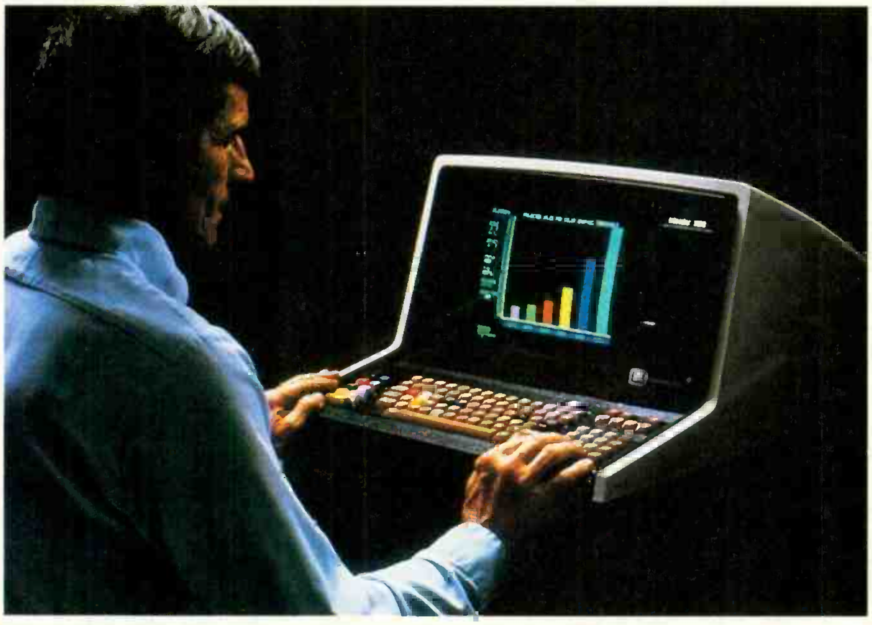
The modular chassis construction is easily serviceable at home or in the shop with well-identified test points.



Popular Electronics Tests



Intelligent Systems Model 3651 Microcomputer System

FITTING into a unique class of equipment called intelligent terminals, the Model 3651 desktop microcomputer system from Intelligent Systems Corp. features an 8080 microprocessor, 5048 CRT controller, built-in single-density 5.25-in. floppy disk, RS-232 serial port, and expansion port. Typical pricing for the Model 3651 with a 72-to-117 incremental keyboard, 32K bytes for RAM, and a single-density disk drive is $2355. For software such as FORTRAN, Editors, Assemblers, and games, expect to pay from $20 to $300. You can use any soft-sectored 5.25-in. diskettes with the system, but ISC charges only $4 for formatted diskettes. Buy them directly and save up to $20.

The 13-in. diagonal CRT can display eight foreground and eight background colors: red, green, blue, yellow, magenta, cyan, black, and white. The display format is 64 ASCII characters arranged in a 5 by 7 matrix using a 6 by 8 character cell. There are 64 characters per line and 32 lines per screen (or when operating with double-sized characters, 16 lines per screen). In addition, the unit displays 64 special graphics characters in a 6 by 8 matrix and offers a resolution of 128 by 128 for vector-style graphics. Although the unit has the ability to display upper/lower case, as configured only upper case is supported. You can either write your own PROM or order a full upper/lower case character generator from ISC.

The 8080 microprocessor operates at 2 MHz and can address up to 64K bytes of RAM, however, the unit under evaluation had only 32K bytes. In addition to RAM, the unit sports 16K bytes of ROM that contains the operating system and BASIC. An additional 8K bytes of ROM can be added for plot-function keys which was the case in the unit tested.

The Model 3651 arranges memory with 4K bytes of RAM used for CRT screen refresh, 4K bytes for disk buffer, and up to 32K bytes for user programs. Although the latter memory space may appear as a restriction, it isn't since the system is designed to work in concert with a larger system as a graphics display and input terminal.

To support the function as a terminal and to work as a stand-alone unit, the Model 3651 has a user-programmable RS-232 serial port for connection either to a printer or modem and can operate from 110 to 9600 baud. The 50-pin extension bus permits interfacing to a variety of equipment including an STD Z80 bus.

Software Features. The Intelligent Systems computer has a number of built-in software features that make it an exciting machine. Editing functions, for example, include a page-roll mode which permits paging of large listings, and the ability to erase a line or a page (insert/delete).

Included in the ROM code is an extended disk BASIC that uses 27 statements. Because the Model 3651 is designed to handle graphics, 18-math functions are included, as well as nine string functions.

Not CP/M. Although the ISC system does support disk I/O, the control program isn't CP/M. For this model, ISC elected to employ a file control system that permits twelve functions: COPY, DELETE, DEVICE, DIRECTORY, EXECUTIVE, INITIALIZE, LOAD, READ, RENAME, RUN, SAVE, and WRITE. It will backup, duplicate, merge, print, and file files, and it also has the unique ability to save or load a graphics screen. This latter attribute makes it possible to call a graphics screen off the disk in a background operation, and have it displayed instantly rather than redrawing it.

Should you be more comfortable with CP/M, ISC offers other intelligent terminals that use this popular operating system.

The 3651 can support up to three 5.25-in. drives and four 8-in. drives. The former is single-density with 92,160 bytes per drive or 184,320 bytes for the double-density version. The 8-in. models handle 295,680 bytes single-density and 591,360 bytes in double-density.

The 3651 is housed in a plastic package that measures 13.75 in. high by 19.75 in. wide by 27 in. deep including the built-in keyboard. Total weight of the system is 51 lb.

Evaluation. The Model 3651 under test came with a printed warning that it has not been tested for compliance with FCC rules for RFI or EMI emissions, and may cause interference. The system does in fact generate interference that was found to cover a broad spectrum of channels, including 2, 3, 4, 7, 13, and 32. On opening the unit, we found no serious attempt at shielding or adequate signal grounding. Interestingly, though, we found no ringing on the bus while the processor was active, nor any interference to the integrated disk drive. However, we did notice some slight ballooning of the display on disk access.

At turn-on (rear-apron switch), the system immediately comes up in BASIC. The manual warns that the cap lock key must be down to enter upper-case characters. In the lower-case mode, you get the 64 special characters—as previously mentioned, no lower case.

Reset is accomplished by depressing the RESET key on the upper right-hand corner. Doing so results in a green-and-cyan display in normal-height characters saying: CRT MODE V9.80. When first turned on, however, the system comes up in BASIC giving the version (in this case 9.80) and the number of unused bytes available (32,094). You can achieve the same result by holding down the COMMAND key on the left-hand auxiliary keypad and depressing RESET.

The CONTROL, or COMMAND, key on the auxiliary keypad is used to switch the foreground and background colors. This is accomplished by depressing either key and the appropriate color key. To select a black background, for example, tap either of the previously mentioned keys and either the black key on the auxiliary keypad or the P key. To select a foreground color, tap the FLG ON/FLG OFF function key on the top row and again depress CONTROL or COMMAND and the desired color key.

We employ a single-speed test to show the power of a microsystem. This test is designed to push the contents of memory onto the system stack until memory limits are reached, pointers are lost (a condition that occurs in many two-level BASIC implementations), or an error is produced.

The test consists of entering one BASIC statement—10 GOSUB 10—running it, and noting the time elapsed before an error or out-of-memory condition is produced. In the case of the ISC unit we tested, 1.9 seconds were required for the out-of-memory error to display. Although neither the system, nor its BASIC can be considered fast, this creates no problem since the machine isn't intended to be used as a number cruncher or a speed demon.

Surprisingly, this speed limitation is least critical for graphics display. Most of the high-speed calculations are done on a host with the ISC system serving as an output device. The plotting speed is directly related to the stack operation and (as such) is slow—but with very good resolution.

Normally, we test a unit's file-handling capability using specialized programs that check the read/write channels, error capability of the machine, and so forth. We ran these programs and found the disk handling to be slow but accurate. We also discovered that ISC likes to rely on memory-resident data for display, and treats disk systems almost as very slow virtual memory.

Conclusion. The 3651 shouldn't be confused with systems designed specifically for business. It should, however, be looked on favorably as a graphics input/output terminal device for use in special applications.

The unit we reviewed reminded us of the CompuColor Imagination Machine, which was discontinued because of RFI problems. The 3651 appears to be the Imagination Machine repackaged in a unitized enclosure. And the software supplied is identical to that made available with the previous design.

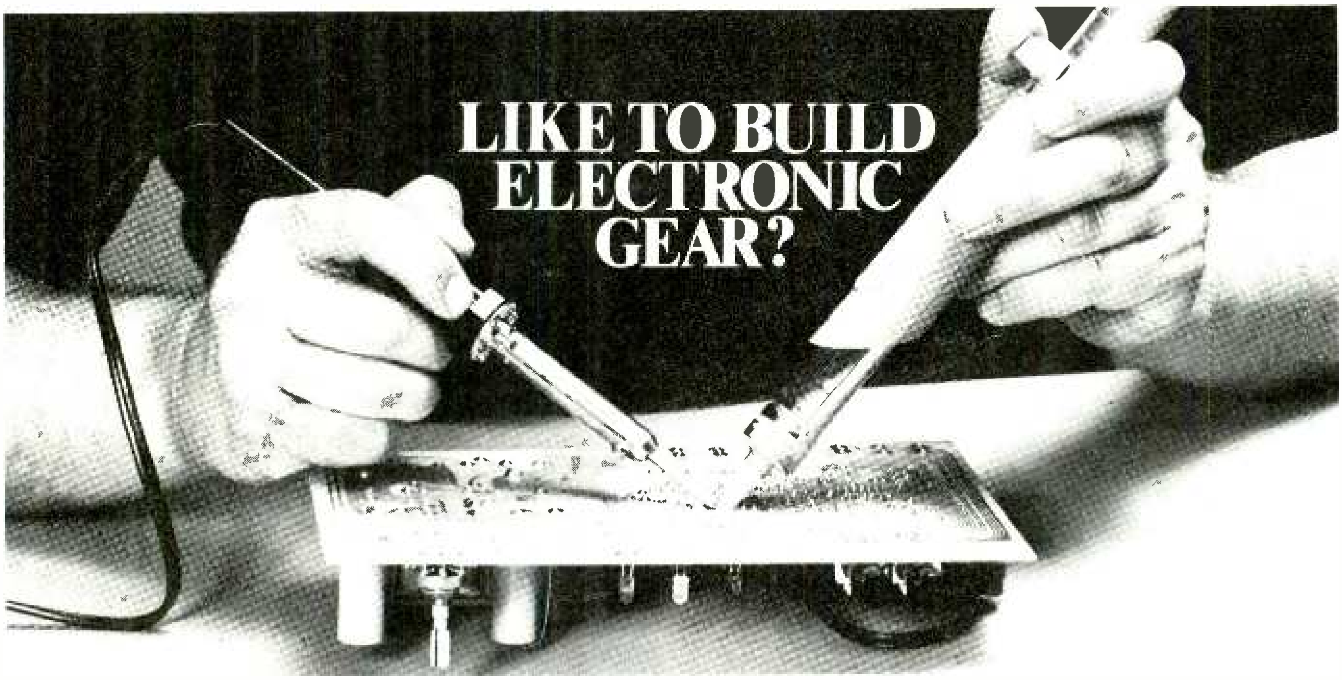
We are intrigued that ISC chose the mature and extremely economical 8080 microprocessor for the 3651's CPU, and that the 3651 contains a low-level file management system when the trend is toward more powerful operating systems—even for "intelligent" graphics terminals. However, we felt that upper/lower case should have been standard, and it would be nice to have an LED display on the disk drive so activity can be observed.

We did like the way the keyboard was laid out and the use of special keys to handle mundane tasks like resetting, booting, clearing the screen and so forth. Here, improvement over the Imagination Machine was quite noticeable. Furthermore, we really liked the 3651's ability to rapidly change foreground/background colors, to set up nine scrolling windows, and to generate well over 4000 color shades.

The 3651 is a powerful color graphics system with exceptionally good video presentation for data. Its NTSC raster scan was exceptionally tight and sharp and free of flicker. ISC offers a full range of options to make the machine even more powerful, including a CP/M update, and a host of user-oriented applications such as a full-featured word-processor package.

Should you be interested in computer graphics, approach the buying decision carefully. If color capability is really important then you can't go too far wrong with the ISC Model 3651. Be aware, though, that ISC offers many options and it's up to you to specify the correct mixture.—*Carl Warren*

CIRCLE NO. 102 ON FREE INFORMATION CARD



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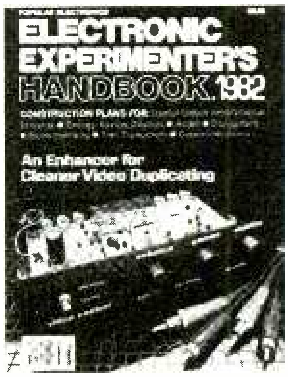

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COMPUTER BITS

By Carl Warren

Training Tools and System Add-Ons

IF you're interested in learning more about digital electronics, you might consider the E&L Instruments Inc. LD-1 Pencil Box Logic Designer.

The Pencil Box sports such features as 2 pulsers, 8 LED readouts, 8 logic switches, and an E&L SK-10 solderless breadboarding socket.

Power to the unit is supplied via four 1.5-V C cells or you can purchase an optional ac adapter. The Pencil Box is available as a kit for $86 as part number 325-4301 or assembled for $114., part 325-1301 from E&L Instruments, 61 First St., Derby, CT 06418.

The unit weighs 1 lb, 6 oz and measures 10" x 7.5" x 2.5", making it small enough to carry in a briefcase. The onboard 1-kHz clock is user variable with an external capacitor and permits a logic 1 at 3.25 V or a logic 0 output at 0.25 V, both at 10 mA.

The pulsers are fully debounced pushbuttons with logic true and complementary outputs with a logic 1 output current being 400 μA at 2.4V and a logic 0 current 16 mA at 0.4V.

The 8 LEDs serve as output ports or monitors and are driven by two 4-bit latches with separate enables. These can be used in concert with a microprocessor to serve as bit indicators of addresses or data depending on how you implement the design.

The basic kit takes about 2 hours to build and check out. Everything is mounted on a single, well-marked circuit board, and all that is necessary is to follow the instruction manual.

Further enhancing the Pencil Box are a set of books—Technibooks I and II, *Logic and Memory Experiments Using TTL Integrated Circuits* by Dr. Peter R. Rony. These books guide you through basic digital designs and are chock full of experiments.

The Pencil Box, coupled with the books, make excellent items to add to your bag of tricks if you're teaching a basic digital design course. The nice thing is that it won't cost you or your students an arm and a leg to get going. Moreover, the Pencil Box can serve as an excellent design station for those quickie designs you may be working on, where you have to check out a circuit.

For that system you already have, you might want to add a printer. A couple that you should consider, are from C.Itoh Electronics, 5301 Beethoven St., Los Angeles, CA 90066.

Since dot-matrix printers provide a great deal of capability, including near-letter quality printing, take a look at the Model 8500. This $775 printer is in C. Itoh's Prowriter series and sports 80-column capability at 100 cps, single and bidirectional printing, compressed- or double-width character sizes and the ability to do proportional spacing.

In addition you can have friction or tractor feed at the flip of a switch. The unit comes with parallel and serial interfaces that are dip-switch configurable.

We checked this printer out under some fairly hard printing conditions and found that it performed well. Furthermore, compared to similar printers, we found that the 8500 was very quiet mechanically.

The 8500 is also very easy to configure. We set it up for 1200-baud serial operation and the only difficulty we had was understanding the manual. Although very complete, it is a little confusing since C. Itoh forgot to spell out the exact location of the baud-rate switches as opposed to the function switches.

In configuring, you can set up the desired protocol, DC1, DC2, ACK/NAK, the busy and the default signals.

We especially liked being able to plug the 8500 into the parallel printer port on either the Atari 800 or TRS-80 Model III and get it to work without special drivers. We also were surprised at the wide array of character sets available. And the printer attaches directly to the RS-232 output of a Microterm ACT 1A terminal and sends escape codes to get any desired function including reverse line feed, an italics-like print set, and full-raster-style graphics.

Should you be using an Apple with a serial or parallel interface, you can do a screen dump to the printer by setting graphics mode and control-Q in the command mode. Whatever resides in high memory will be dumped to the printer.

And for that unique networking or multiuser application, the 8500 can be daisychained (up to four printers) with each printer having its own unique address. You don't have to have special software to use this function, only be sure to send the proper escape sequence to toggle the desired printer. Although we weren't able to daisy-chain a group of printers, we were able to toggle the select line of a single printer in both a parallel or serial operation.

As capable as the 8500 is, you might elect to have a fully-formed character printer on your system. C. Itoh has also introduced a new line of daisy wheels Models F10-40/55. The F10-40 runs at 40 cps, handles 136 columns in pica pitch, and 163 columns in elite; the F10-55 runs at 55 cps and sports the same column-handling capability.

Both daisy wheels have print spacing of 1/120-in. and a line feed spacing of 1/48-in. The F10-40, which we had under test, has a slower carriage return than the F10-55, taking 900 ms versus 500. In addition, the F10-40 will accept only a single color cartridge and will handle an original plus 2 copies, the F10-55 handles an original plus 5 copies.

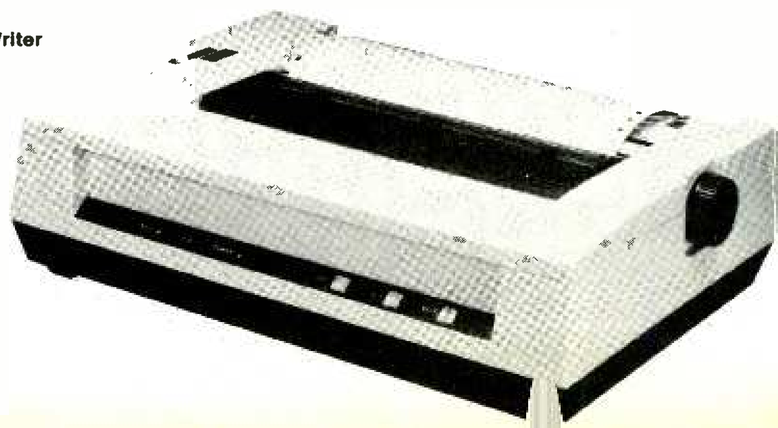
Other differences include: the F10-40 will operate at a maximum data rate of 2400 bps while the F10-55 will operate at 9600 bps. Both units use XON/XOFF, or ETX/ACK protocol, and can be configured, via dip switches or software control, to emulate virtually any other daisy wheel printer available.

We found that with the F10-40, we were able to emulate an NEC Spinwriter and Diablo Model 630 merely by setting the dip switches. We also found that the throughput equaled a Qume Sprint III, and that, while using Wordstar in the spooling mode, the printer was not requiring a handshake all that frequently. The reason was that the model we reviewed had the optional 2K buffer rather than a 136-character one-line buffer. This appears to make a world of difference when in a spooling mode.

The unit we tested used a friction feed which, surprisingly, clamped the paper well enough so continuous forms could be used. We printed well over 100 pages without loosing registration which speaks well of the mechanism. You can, however, obtain a tractor feed or an automatic BDT 160 single-sheet feed.

The manufacturer's suggested retail prices for the F10-40/55 range from about $1300 to $1500.

(Continued on page 40)



C. Itoh Pro/Writer Series 8500

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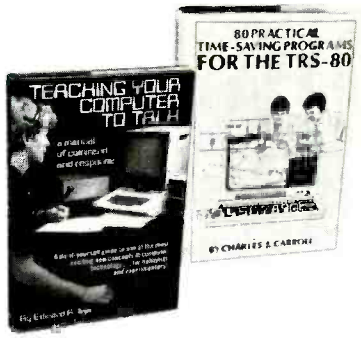

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CIRCLE NO. 44 ON FREE INFORMATION CARD

(Continued from page 38)

For That Total System Approach to communications, there is Computer Development Inc., 6700 SW 105th, Beaverton, OR 97005, with the Microcom system. The Microcom employs a Zenith Z-89 as the basic building block, but incorporates a built-in smart modem. This modem employs firmware protocol and error-checking control. Furthermore, it operates at either 300 or 1200 baud, and sports auto answer and dial functionality. Coupled with the Term software package, the user has the ability to send Image-formatted documents, hook into remotes systems, stand as a remote system, or serve in a Local Area Network environment. This latter function permits up to 2000 ft between repeaters, can support up to 255 stations and will operate at 56K baud on a single coax line.

Currently, the Microcom is priced at under $6000 for a 64K byte system, with Digital Research's CP/M operating system, Image, and Term, modem, and dual 5.25-in. single-density floppy disk drives. In addition, CDI is offering 5M-byte hard-disk add-on bringing the price up to about $10,000.

CDI is presently unbundling the software and modem. Prices for the individual products are: Image wordprocessor, $495; Forms, a specialized forms generator, for $295; the Term communication package, $295. The modem should be available soon for under $600 (single unit). All the software packages, should be available in most computer stores, or through local distributors. You'll need to contact CDI directly for specifics on who has the products.

The Image wordprocessor permits the use of graphics in the generated text. Furthermore, the graphics can be printed on a daisy-wheel printer. Currently, CDI offers drivers for the NEC Spinwriter and will later provide drivers for most daisy wheels.

If you're planning on getting the IBM personal computer, you can expect Image software for it by mid year, and by NCC time in June, Zenith is expected to introduce the Z-100 system that uses the 8088, the MSDOS operating system (the same one used on the IBM machine), and CP/M-86. In addition, the new machine is expected to give you the option of color graphics as well as full-featured monochrome. And CDI is expected to offer Image software with elements that support the new machines unique display attributes.

Looking for a Tape-to-disk Driver? Then drop a note to E. Mark Mears at Cheerhart Cleaners, 122 Woodman Dr., Dayton, OH 45431. He has developed a tape/disk system for the Meca Alpha-I tape system and Meca disk drives using MDOS. This driver integrates the disk drives into the Alpha Microsoft extended BASIC, thus giving you the best of both worlds.

The table printed here is a list of the commands used, and apparently Mr. Mears is offering the software free to any user of the Meca Alpha-I system.

A Controller Update. This past December, we reviewed the double-density controller from Magnolia Microsystems. We incorrectly told you that you couldn't change the density of the drives under software control. We were only partly correct.

You can't change the density of the 5.25-in. standard Heath drives, but you can change the 8-in. from single to double or vice versa. You do this by using the SET command. A typical command would look like: SET D:DD. On entering, the CRT will respond that the drive is now set for double density. Unfortunately, however, the controller won't sense the density of the diskette on insertion; you must supply this information. We think this is a slight shortcoming based on the reliability of the controller. Ours has been in use for over 8-months with no failures. ◇

MECA ALPHA-I COMMAND TABLE

```
/MDOS   BASIC -- DISK (") AND TAPE COMMANDS
*LOAD NN"  TO *LOAD NNNNN"
*LOAD NNNN" AAAA   OR *LOAD NNNN" :X AAAA
*LOAD NNNN  :X AAAA         NOT *LOAD NNNN AAAAA (TAPE).
SHOULD NOT LOAD ASSY PROG THAT WILL OVERLAY(BASIC
AREA) BUT THEY CAN BE FORCE-LOADED  IN HIGH MEMORY.

CLOAD "NNNN"  TO CLOAD "NNNNN"   NOT CLOAD "NNNN" AAAA
CLOAD "NNNN  :X  OR CLOAD "NNNN" :X (TAPE OR DISK)
     FNAME MUST HAVE 4/5 CHARACTERS.

CLOAD "NNNNN :X +  TAPE PROG ADDED TO END OF CURR PROGRAM.
CLOAD "NNNNN" +    DISK PROG ADDED TO END OF CURR PROGRAM.
FOR DISK, DRIVE CONTROL CAN BE 'REM* DIRE :DX ' IN PROGRAM
PRIOR TO MERGING PROGRAMS.  CHAINING PROGRAMS IS THE SAME.

CLOAD "*R NNNNN" :X   IS RECOMENDED OVER  CLOAD "*R NNNNN"
CSAVE "*R NNNNN" :X  WILL PROMPT AND WAIT FOR CR
FOR ARRAY FILES, THE VARIABLE MUST HAVE BEEN 'DIM'ED
PRIOR TO ARRAY CLOAD.


FOR CSAVE'S AND CSAVE ARRAY'S TO DISK.   THE DISK WILL
BE MOUNTED (IF NOT CURRENT DR) AND OPERATOR PROMPT WILL
WAIT FOR CR.  IF ANY KEY ENTERED, FILING IS SKIPED.
THIS K/B INPUT(STOPPING) CAN BE SKIP'ED BY THE AF1C
CHANGE LISTED BELOW.

PROMPT =  NNNNN  AAAA BBBB    OK F = CR ?
ANY INPUT BUT CR  WILL ABORT FILING

*DIRE :0  OR *DIRE :1  ARE THE SAME(TAPE).
*DIRE :D   WILL READ CURRENT DIR IN OS.
*DIRE :D1  WILL FORCE DISK READ OF THAT DIR.
REM* DIRE :D1    - IS VALID BASIC COMMAND.

OVER-RIDE OPTION.  'S', '9' AND DIRECTORY  ERRORS CAN
BE OVERIDEN.  THE NATURE OF THE ERROR WILL CONTROL
THE SUCESS OF  THIS.

AF1C - 44828 - 35  NO DISK SAVE OPTION   30  NORMAL
B68C - 46732 - 195 NO DISK DIR UPDATE    205 NORMAL
48D7 - 18647 - 201 NO TAPE DIR UPDATE    200 NORMAL
4517 - 17687 - 51  NO WIN IN TAPE DIR    102 NORMAL
BEFC - 48892 - 122 NO WIN IN DISK DIR    191 NORMAL
ABE0 - 44000 - HOLDS LAST OS ERROR CODE
B001 - 45057 - HOLDS # OF FILES IN DISK DIR
3B39 - 15161 - HOLDS # OF FILES IN TAPE DIR #0
3971 - 14705 - HOLDS # OF FILES IN TAPE DIR #1
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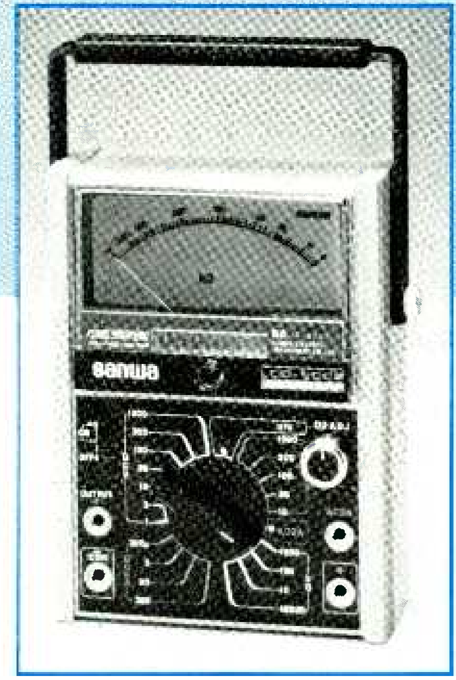
Popular Electronics Tests

Sanwa LCD-900 Multitester



THE Sanwa LCD-900 Multitester is an analog multimeter with a difference, and as they say, "Vive la difference!" Although this instrument is an analog device, using a circuit that has proven itself over many years, its "meter" is a unique LCD display. Each of its 21 scales—one for each position of the function/range switch—is displayed only when required, with each independent scale provided with its own numerical display and function identifier. Unused scales do *not* appear, so there is no confusion as to which scale is in use at any moment. This action is similar to what happens to the face of a digital watch as the function button is operated to change the readout.

The analog meter movement has a sensitivity of 17.5 μA full scale, having a deflection angle of 98°, and it features spring-back jewel bearings and diode overvoltage protection. When the function/range switch is in the OFF position, the meter movement is shorted, thus highly damped. This makes it safe to carry the meter around without pegging the needle and possibly bending it.

The high-impact plastic case is 4½″ W × 6″ H × 2¼″ D, and it weighs 28 oz. Two 1.5-volt cells are used for making resistance measurements, and a single 9-volt battery drives the LCD readout. When operated between −10 and 50°C, LCD lifetime is estimated at 50,000 hours. An optional carrying case is available. The suggested list price is $162.50.

General Description. The LCD-900 is provided with four input connectors—COM(−), +, OUTPUT, and AC3A (amperes); and three manual controls—0Ω ADJ, power ON/OFF (which also doubles as a polarity inverter), and a 21-position function/range switch having color-coded ranges. The OUTPUT terminal is used to measure ac voltages riding on a dc level. The carrying handle doubles as a tilt stand.

Dc voltage ranges are 1, 3, 10, 30, 100, 300, and 1000 volts, ±3% full scale at an input resistance of 50,000 ohms/volt. The ac voltage is selected from 10, 30, 100, 300, and 1000 volts, ±4% full scale and at 10,000 ohms/volt. The dc current ranges include 0.3, 3, 30, and 300 mA, ±3% full scale, while the ac current range is limited to one range of 3 amperes ±6% full scale. Three resistance ranges cover 1, 10, 100, and 1000 kilohms within ±3% of arc.

Four rubber bumpers on the underside keep the instrument from slipping off the work surface. The carrying handle/tilt stand is also provided with a skidproof rubber fitting.

Comments. The Model LCD-900 was checked by the Lockheed Electronics Instrumentation Measurement Labs (Plainfield, NJ) against standards traceable to the National Bureau of Standards. After the tests, the IML issued a certificate attesting that the LCD-900 met or exceeded its published specification in all respects.

The LCD-900 was put to work on the bench, and immediately made a lot of friends, mostly due to the unique "meter" display. For the first time, we were able to use an analog meter without having to worry about which scale we had to look at. Interestingly enough, since only one scale at a time appears on the display, we found that we could make more accurate numerical readings since there were no extraneous scale distractions. If you use analog instruments (and there are some benefits, such as reading a jittery voltage), take a look at the LCD-900. You will like this novel approach to an old reliable measuring instrument.

—*Les Solomon*

CIRCLE NO. 104 ON FREE INFORMATION CARD

ADD WAVEFORM STORAGE TO YOUR OSCILLOSCOPE

Converts any scope with external trigger input into a digital storage unit

BY JONATHAN WANG AND DENNIS MURPHY

HAVE you ever wished you owned a storage oscilloscope to see those transient waveforms and random events that escape you? Now you can savor these signals without spending thousands of dollars. Moreover, you can enjoy the advantages of digital storage as compared to analog (CRT) storage, all for about $228.

Called the "Wavesaver," this black box can convert virtually any conventional oscilloscope that has an external trigger input into a digital storage scope. Its 1K x 8 memory stores random or repetitive analog waveforms with a vertical resolution of 256 discrete steps (8 bits), sampling to a 500-kHz rate. It features pretriggering to capture signals before the trigger occurs, as well as post-trigger viewing. In conjunction with an ordinary oscilloscope, you can view signals as they occur or save them for later examination. Furthermore, the Wavesaver can save waveforms to obtain hard copy when used in its plot mode since interfacing is built in for use with a chart recorder.

How It Works. The Wavesaver combines A/D (analog-to-digital) and D/A (digital-to-analog) converters with RAM (random access memory) to significantly enhance a conventional single-trace oscilloscope. It also has digital storage features that provide "sampling" and "quantizing." Sampling involves obtaining voltage levels representing an analog input signal at discrete points in time and quantizing is the transformation of these values into binary numbers by an A/D converter. You determine how often this process occurs by using a very precise digital clock. Once the data is in the digital memory, it can be read out at a fixed rate and reconstructed for displaying. (See box.)

In the Wavesaver, sampling and quantizing are performed so that every voltage sample derived from a series of very narrow contiguous time slots is converted to a binary number using an A/D converter. The binary data is then stored in a 1024 by 8-bit RAM with each time-slot's value stored as one 8-bit byte. The process continues until all 1024 bytes in the RAM are filled. The digital data can then be read out of the memory and passed through a D/A converter, which reconstructs the original analog waveform for application to the conventional single-trace oscilloscope. Since the RAM can be nondestructively read out indefinitely, the reconstructed display will remain on the CRT screen as long as the user desires.

Besides the previously mentioned A/D, D/A, and RAM features, the Wavesaver, shown in block diagram form in Fig. 1, also has provisions for driving an external plotter or other digital system.

Three operating controls—TIME PER POINT, ± VOLTS, and TRIG LEVEL—can be compared to the scope sweep speed, vertical gain, and sweep trigger controls respectively. Signals can be sampled up to 500 kHz (2 μs) producing 256 data points, enough to make a very smooth waveform. This sampling can be selected in 1-2-5 steps from 2 μs to 100 ms, via the crystal-controlled internal clock or an external clock. Input sensitivity is

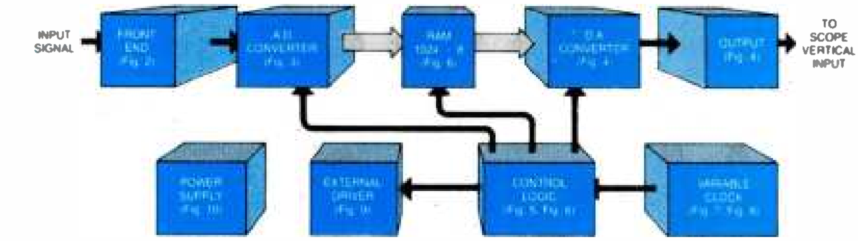


Fig. 1. Block diagram of the Wavesaver system from the input signal to the scope's vertical input.

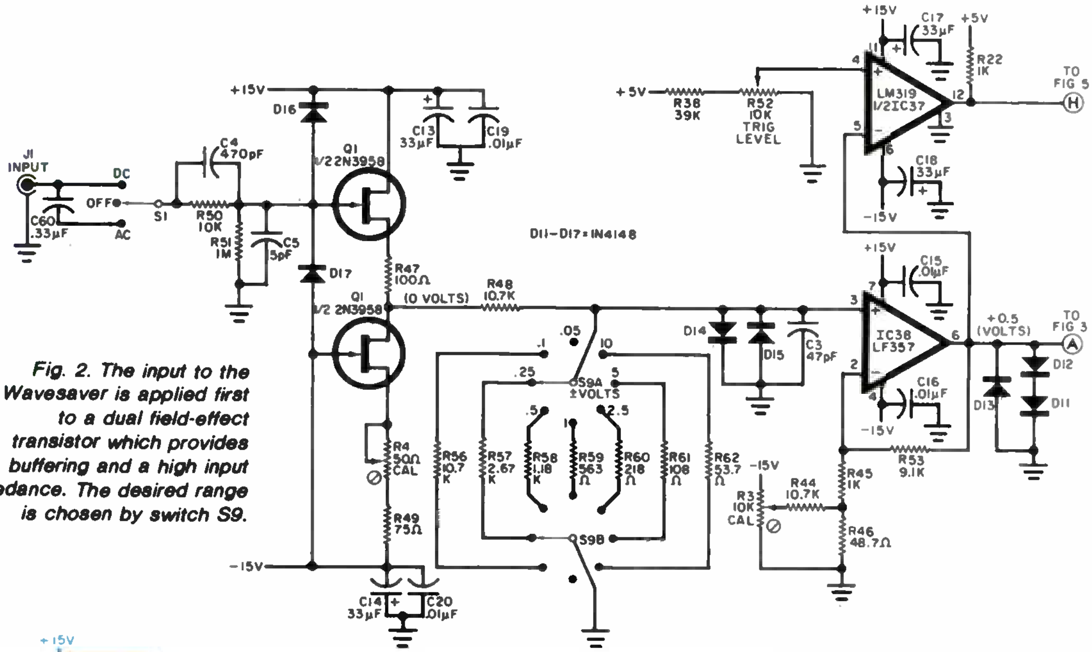


Fig. 2. The input to the Wavesaver is applied first to a dual field-effect transistor which provides buffering and a high input impedance. The desired range is chosen by switch S9.

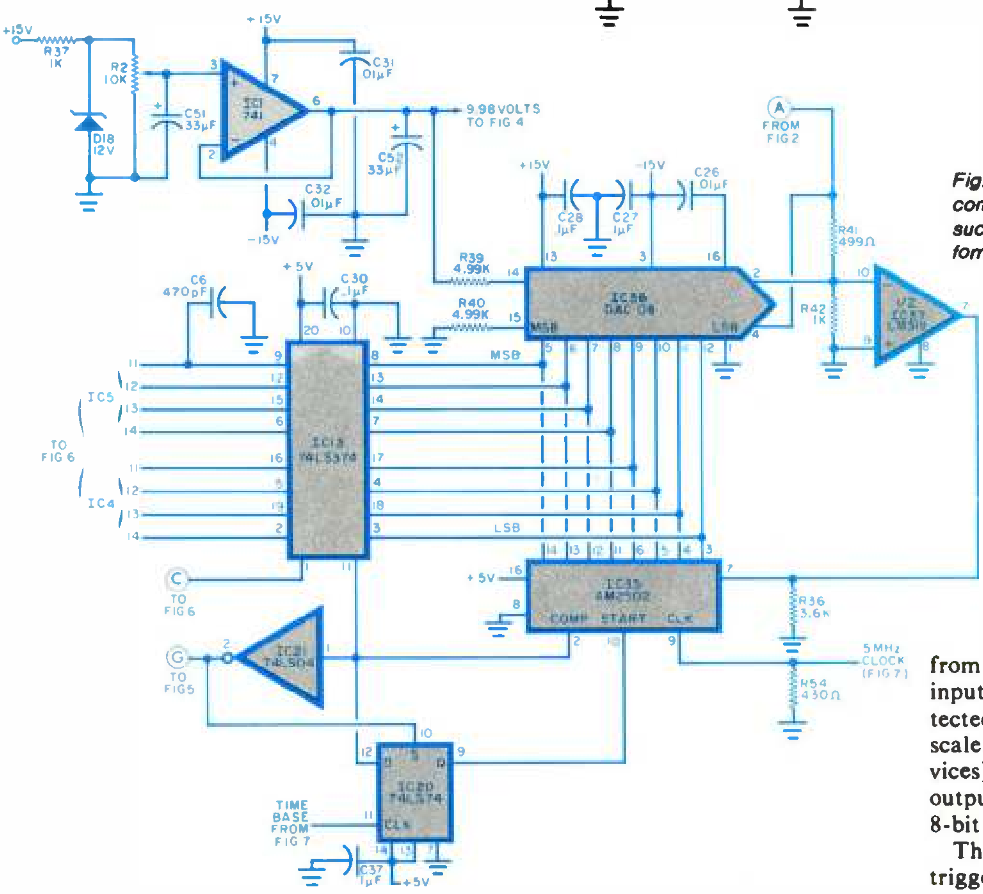


Fig. 3. The analog/digital converter is an 8-bit successive-approximation circuit formed by IC35 and IC36.

from 50 mV to 10 volts at one-megohm input impedance and is overload protected. The analog output is 8 volts full scale, trigger output (for external devices) is at TTL level, and the digital output for the external digital system is 8-bit parallel, TTL, word serial.

The Wavesaver has three different triggering modes. The first uses the setting of the front-panel TRIG LEVEL control to preset an input level and polarity so that, when the viewed signal exceeds these parameters, the system starts storing data. In this mode the system can monitor ("babysit") a signal line, allowing you to leave the equipment and go about other business. If the event occurs during your absence, it will be recorded. At your convenience you can "see" what went on before the event, the event itself, and a short period after the event. This is great for observing "glitches."

The second trigger mode, AUTO, updates the stored data every two seconds. The stored image can be "frozen" on screen as long as the user desires. In the third trigger mode, the system is operated manually via a front-panel pushbutton. The data remains on screen until the manual pushbutton is depressed. This is ideal for detailed study of a waveform of interest.

The digital storage technique used in the Wavesaver allows direct connection to a computer for further signal processing, or storage on a diskette. The data can also be passed to a plotter that can generate permanent records for later study.

Circuit Description. As shown in Fig. 2, the signal to be observed is applied via ac/dc input selector switch *S1* to dual FET *Q1* that provides input buffering and a high input impedance (1 megohm). Potentiometer *R4* determines the zero offset, while diodes *D16* and *D17* protect the input stage against excessive

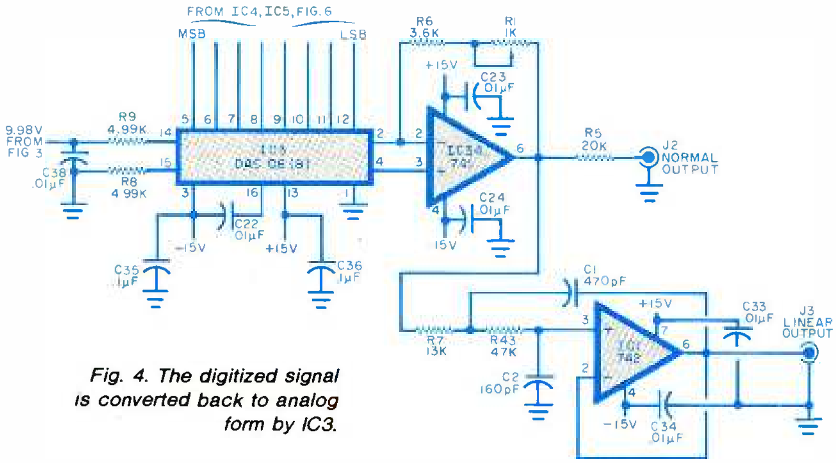


Fig. 4. The digitized signal is converted back to analog form by IC3.

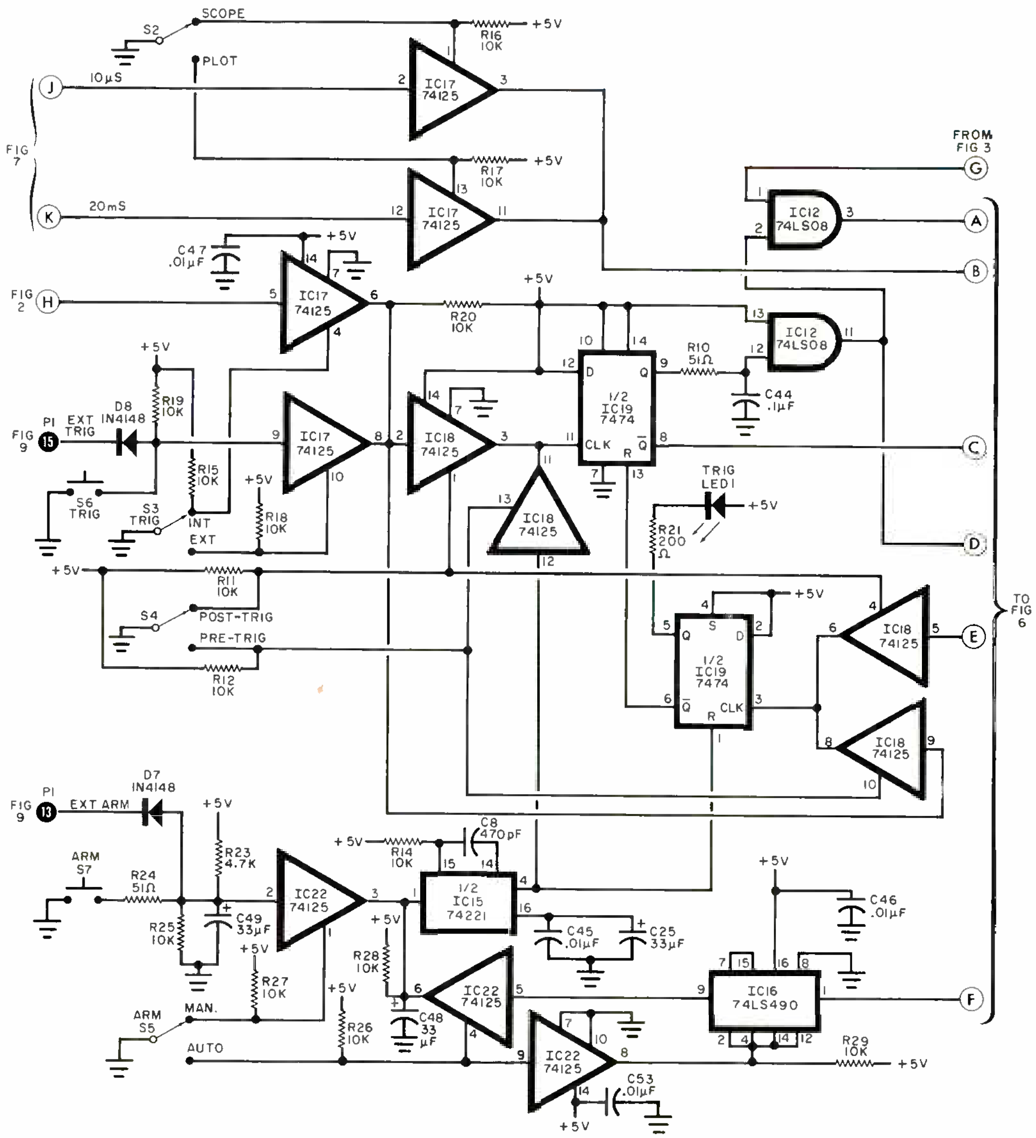


Fig. 5. The control logic is shown here and in Fig. 6 on the next page. The combination of IC18 and IC19 supplies the actual start and stop signals of the recording mode.

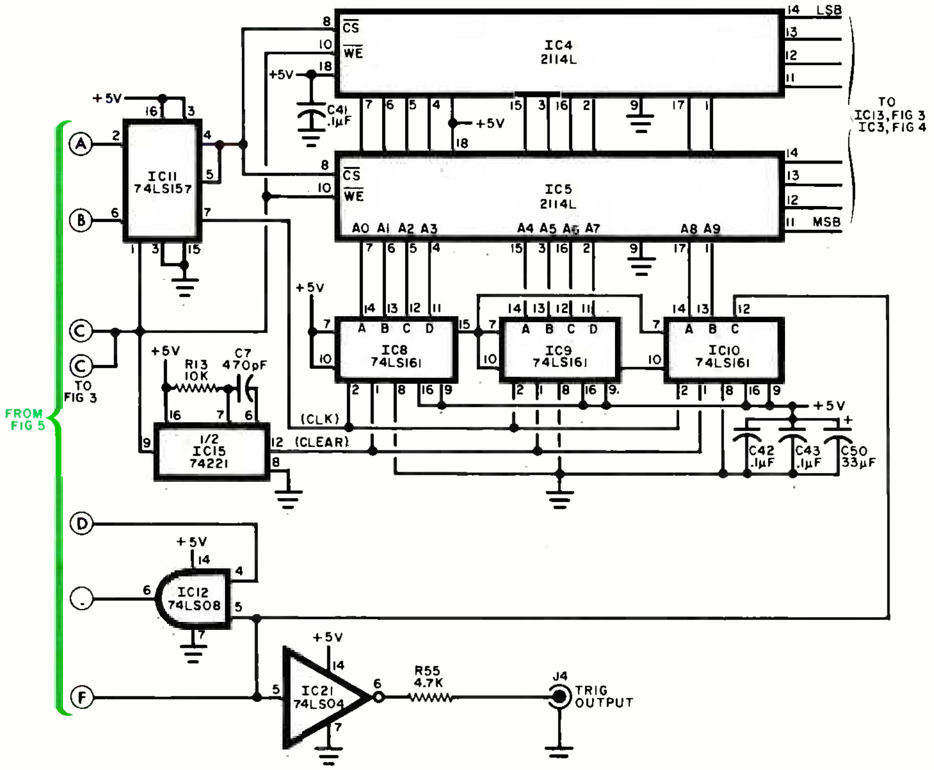


Fig. 6. Random-access memory is contained in IC4 and IC5, with IC8, IC9, and IC10 serving as address counters.

signal levels. The network consisting of *R48* and a resistance selected by the ±VOLTS switch (*S9*) provides the desired signal input range. Diodes *D14* and *D15* protect the *IC38* input against damage from high-level signals. The signal is amplified in *IC38* to provide the A/D converter (Fig. 3) with the correct levels, while diodes *D11* through *D13* act as level clamps to protect the A/D converter. The output of *IC38* also drives half of *IC37*, to provide the trigger signal for the control logic (Fig. 5).

The A/D converter of Fig. 3 is an 8-bit successive-approximation type formed by successive-approximation register *IC35*, current-sensing A/D converter *IC36*, and half of *IC37*. It takes nine clock cycles for each conversion, with *IC21* and *IC20* acting as a start/stop enabling circuit. On completion of each conversion, the data at the output of *IC35* and latched into *IC13* on the rising edge of the signal and then passed to the memory (*IC4*, *IC5*, Fig. 6) on the trailing edge of the waveform. Integrated circuit *IC1* and its associated components develop the reference current required by both D/A converters (*IC36* and *IC3*). In Fig. 6, *IC8*, *IC9* and *IC10* serve as the address counters for RAMs *IC4* and *IC5*, and are "clocked" by *IC11*. Pin 12 of *IC10* generates a "memory full" signal for the system, and after inversion by a portion of *IC21*, supplies the "sync" signal for the oscilloscope.

Selection of the Wavesaver's display or record mode is determined by the state of *IC11* (Fig. 6). An element within *IC17* (Fig. 5) selects either the SCOPE or PLOT mode via *S2*, while another element within *IC17* operates in conjunction with TRIGGER switch *S3* to determine whether INT or EXT triggering was selected. The combination of *IC18* and *IC19* supplies the actual start and stop signals of the recording mode. A dual-decade counter (*IC16*) provides the auto-arm function and disables the manual-arm feature (Fig. 5).

The crystal-controlled clock oscillator is formed by elements of *IC28* and its 5-MHz output is used to clock the A/D converter (Fig. 7). It also drives a chain of eight decade counters (*IC23* through *IC26*, and *IC29* through *IC32*) arranged in a 1-2-5 sequence to produce time pulses from 2 μs to 100 ms. Multiplexers *IC27* and *IC33* of Fig. 8 accept these timing signals while the 16-position TIME PER POINT switch (*S10*) determines the sampling rate.

To display the stored waveform on a

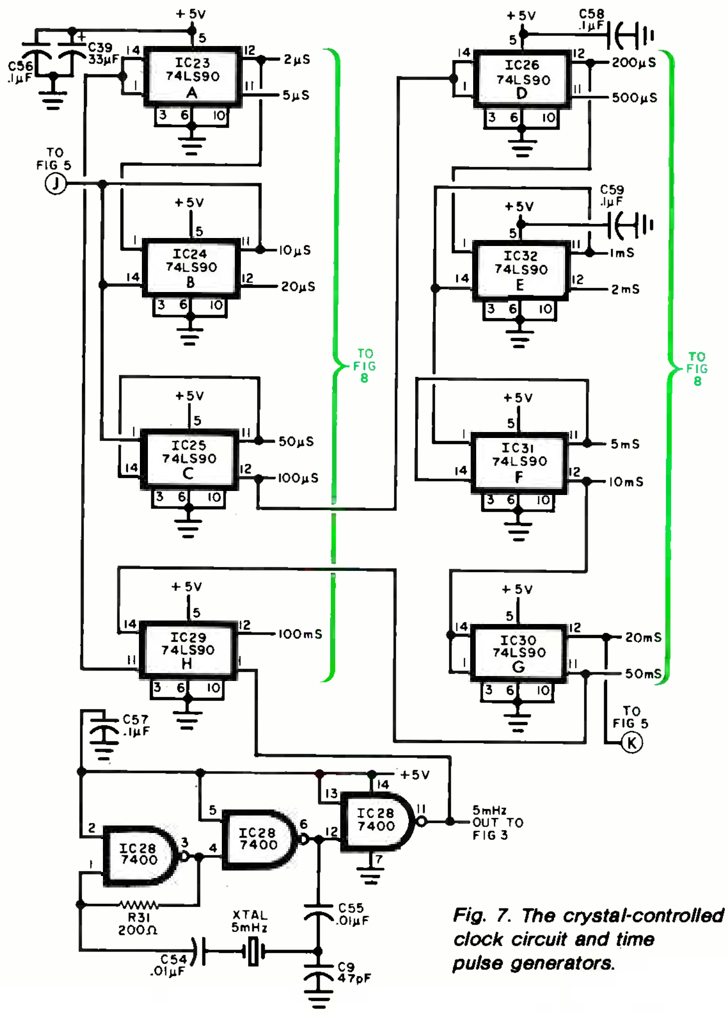


Fig. 7. The crystal-controlled clock circuit and time pulse generators.

INSIGHTS TO DIGITAL STORAGE

There are two digitizing techniques that you shouldn't confuse: real-time sampling and equivalent-time sampling. Digital storage scopes use real-time sampling so that they can capture both repetitive and single-shot signals. Sampling scopes use equivalent-time sampling and are limited to capturing repetitive signals. Equivalent time sampling—random or sequential—builds up a picture of the input waveform by capturing a little bit of information during each signal repetition. Eventually enough information is available to reconstruct the entire waveform. Among the drawbacks of analog-type storage is fading or blooming of the recorded waveform, which does not exist with digital storage.

Accuracy vs. Resolution. The digital storage scope's A/D converter must be able to "resolve" (discriminate between) different input signal levels. Here, resolution is determined by the number of "bits"

Accuracy, on the other hand, means that if you apply exactly 150 volts to the instrument, it should display 150 and nothing else. If you do apply exactly 150 volts, and the display indicates 147, the accuracy of the instrument is 2% (3 divided by 150) at 150 volts. Accuracy cannot be better than the resolution.

A Unique Error. Pushing a digital storage scope past its upper frequency limit results in an error different from that encountered with an analog scope used under similar conditions. The error is called aliasing, as illustrated in (B) and there is only one way to avoid it: always digitize more than twice as fast as the highest frequency in the analog input signal. If a suitable digitizing rate is not available, you can use an anti-aliasing filter to eliminate frequencies above the Nyquist limit. That avoids aliasing, but it also removes any indication that higher-frequencies are present in your input signal.

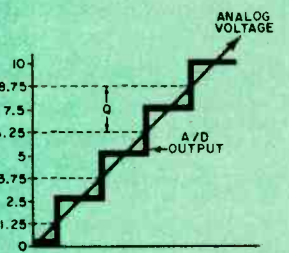


Fig. A. In an A/D converter, the analog input is sampled at the midpoint of each quantization level, the distance between levels being denoted by Q, the bit size.

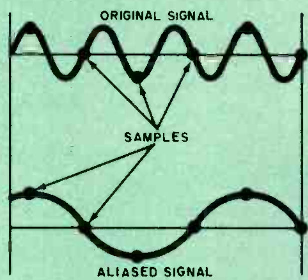


Fig. B. If a signal is digitized less often than necessary, aliasing results. Here a 120-Hz signal digitized at 160 Hz; gives an aliased waveform at 40 Hz.

(binary digits) that will be used to approximate the analog input signal. For example, a 2-bit number that forms all combinations of 1 and 0 produces 11, 10, 01, and 00. If the analog input range to be measured is 10 volts, as shown in (A), the four possible sub ranges must be 0-2½, 2½-5, 5-7½, and 7½-10 volts (each bit will switch half way up its input level—not very smooth). Thus, the more bits, the better the resolution. In the Wavesaver's 8-bit converter there are 256 levels with each level representing 0.3906% of the input voltage, or 3906 parts per million.

Accuracy and resolution are not the same thing. Resolution is the distinguishing of individual elements, while accuracy is another term for repeatability—conformity to an indicated value with repeated measurements. For example, assume your DMM has just 3 digits (2½ digits if you're fussy). If you apply any level from 149½-150½ volts dc to it and the display always indicates 150 V, the resolution of this particular DMM is 1 volt. It cannot distinguish between smaller voltage differentials.

Anti-aliasing filters have at least 12-dB/octave rolloff, while bandwidth-limiting filters are 6 dB/octave.

Once you know the maximum digitizing rate of a digital storage scope, you can determine if the instrument will meet your needs by applying sampling theory. Application of the theory shows that any signal with a frequency denoted by *f* must be digitized *more than 2f* times to be fully recovered (exactly two times won't do).

Another way of stating the same rule uses the Nyquist frequency (half the digitizing frequency). No frequency at or above it can be recovered without error.

Remember, a digital storage scope is not the same as a sampling scope. A digital storage scope captures the entire signal—be it repetitive or single occurrence—in one shot, while a sampling scope requires many "shots" at a *repetitive* signal before it can build up a usable image. Thus, a sampling scope cannot be used to observe non-repetitive random events, but it is not constrained by aliasing when examining high-frequency inputs. ◇

scope, requires that the digitized signal be converted back into analog form. This is the purpose of *IC3* in Fig. 4. This chip accepts an 8-bit digital data stream from the RAM and, using a fixed reference voltage, generates the analog equivalent at its output. (Since the D/A converter is a "current" device, *IC34* is used as a current-to-voltage converter.) A simple active filter (*IC2*) smooths the reconstructed waveform. The digitized signal, as well as certain "handshake" signals, are also available from connector *P1* (Fig. 9). The digitized signal is buffered by *IC6* and *IC7*, with the handshake signals available for flexibility when direct interfacing with external digital devices is involved. The power supply is shown in Fig. 10.

Construction. It is recommended that the Wavesaver be constructed using the dual-sided pc board shown in Figs. 11 and 12. Component installation is shown in Fig. 13, and external elements are connected as shown in Fig. 14.

To avoid possible static damage, mount *Q1* only after its associated components are installed. Rectifier diodes *D3* through *D6* are mounted on the underside of the board so that transformer *T1* can be properly installed. The dot on *T1* specified in the Parts List indicates pin 1, and sockets should be used for all semiconductors. After completion, the board can be mounted within a selected metal enclosure.

Other than *S9* (the ±VOLTS rotary switch mounted on the pc board to protrude through the front panel), switches *S3* through *S7* along with *LED1* (TRIG), *LED2* (POWER), and INPUT connector *J1* are mounted on the front panel of the selected enclosure. Each front-panel element should be identified with press-on type.

The three BNC output connectors—*J2* (NORM), *J3* (LIN), and *J4* (TRIG), along with *S2* (SCOPE/PLOT), fuse *F1*, and the power line cord should be on the rear panel of the enclosure. The 15-pin external connector *P1* should be mounted on the pc board to protrude through a slot cut in the rear panel.

Calibration. A high-input-resistance dc voltmeter (preferably a 3½-digit DMM), an oscilloscope, and an audio signal generator should be used to calibrate the Wavesaver. When power is applied, the POWER indicator (*LED2*) should glow. Check that 5-, 15-, and −15-volt supplies are delivering the correct voltages.

To set the reference level, connect the dc voltmeter between test point A (Fig. 13) and ground. Adjust *R2* for 9.92 volts (given as 9.98 on the schematics to com-

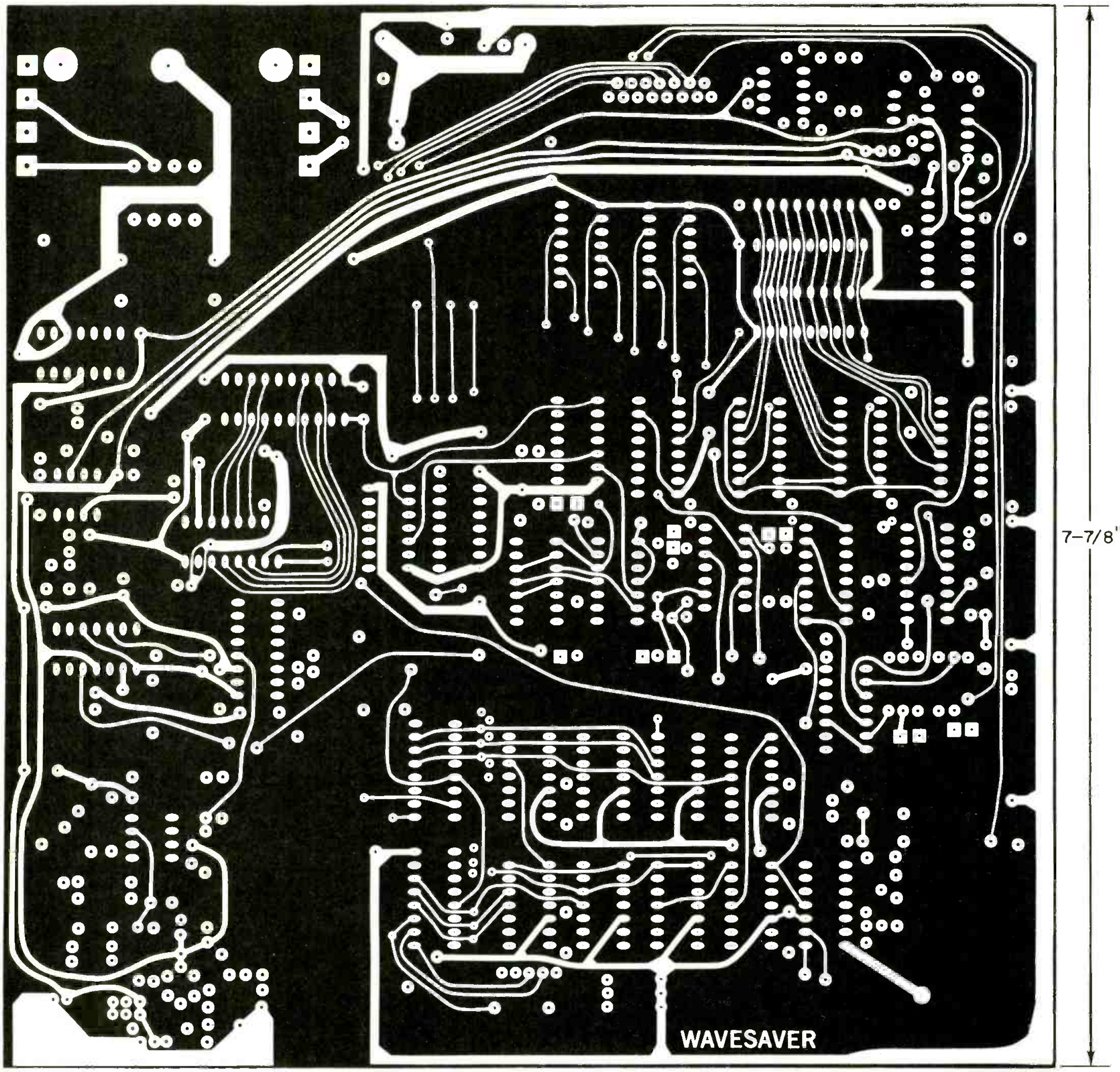


Fig. 11. Reduced pattern for foil side of the double-sided pc board. Note correct size.

4. Use either the ARM pushbutton switch (*S7*) or pin 13 of the rear panel *P1*. *LED1* above the TRIG LEVEL control should glow if arming is successful.

5. After arming, the data recording process will begin instantly and can be stopped only by triggering the system.

6. If INT trigger was selected, after the correct signal level (determined by the TRIG LEVEL control) is detected, the system will trigger automatically. If EXT trigger was selected, the system has to be triggered either manually with the TRIG pushbutton (*S6*), or via pin 15 of *P1*. After detecting the trigger, the data recording will stop immediately.

7. If the ARM toggle switch is in the AUTO position, the system will be automatically armed after two seconds of display time elapses. If it is desired to "hold" a waveform, flip the ARM toggle switch to the MAN position before the two-second interval has elapsed.

8. During pre-trigger recording, if the trigger occurs before the entire sweep of the memory has elapsed, the display might include a portion of the previously recorded waveform if not erased. To erase the memory, place the TRIGGER toggle switch in the EXT position before arming and after the time interval determined by 1024 times the setting of the TIME PER POINT switch. After erasing, place the TRIGGER switch back to the desired position.

Post-Trigger Mode:

1. Select the desired TIME PER POINT, ± VOLTS, TRIG LEVEL (if INT trigger is selected), INPUT coupling, and either MAN or AUTO arm (as required).

2. If MAN arm is selected, use either the front-panel ARM pushbutton or pin 13 of *P1*.

3. After detecting the trigger, the recording will begin, and after the RAM has accepted one full sweep, the system will go to the display mode. Until a new ARM signal is applied, the data just

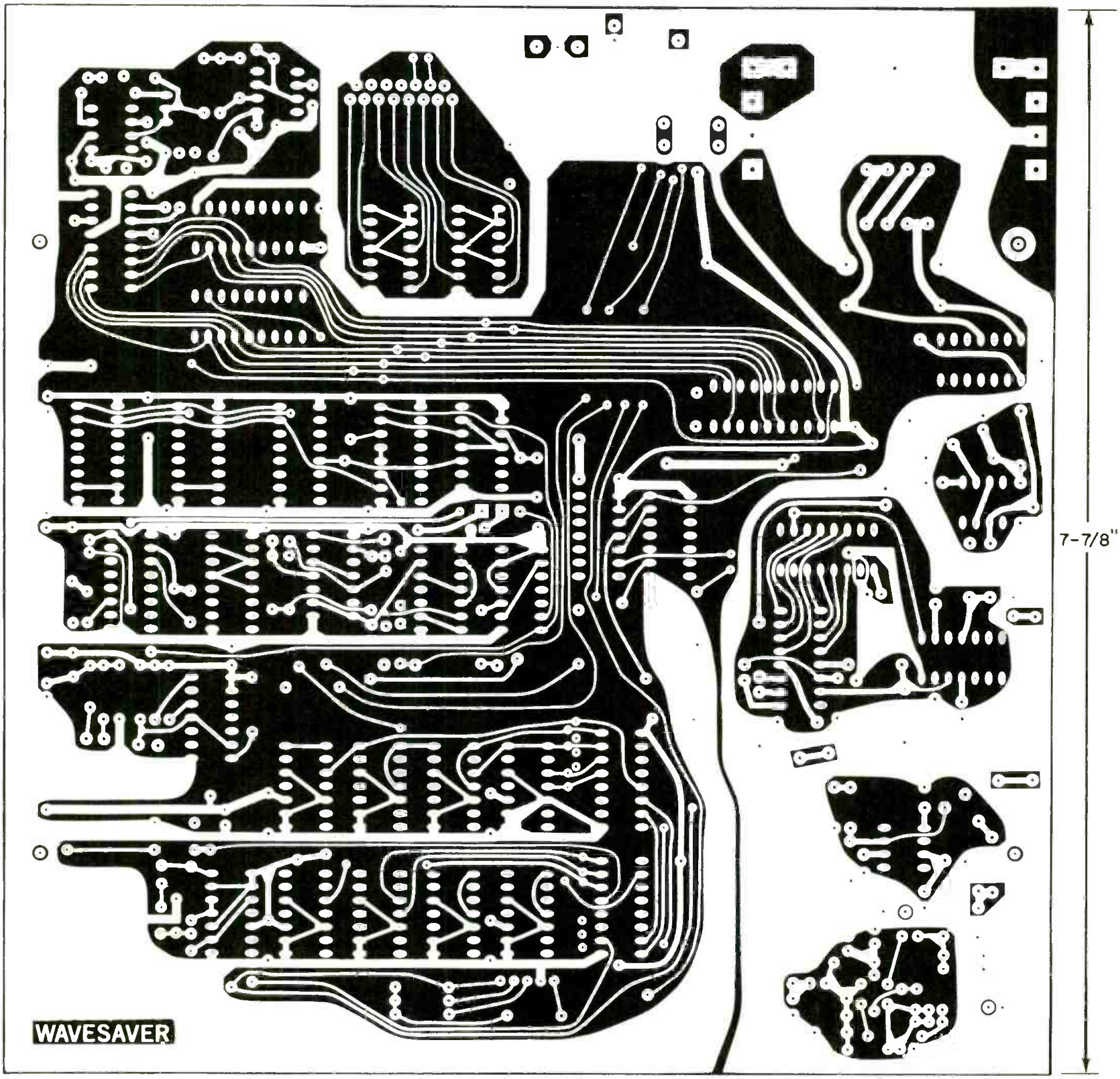


Fig. 12. Reduced foil pattern for component side of pc board. Note correct size.

stored in the RAM will be continuously displayed.

4. In the AUTO arm mode, the system arms itself after displaying the data stored in the RAM for two seconds. After two seconds, any new trigger will automatically initiate updating the RAM with new data.

5. To retain a waveform when operating in the AUTO mode, place the ARM toggle switch in the MAN position.

Waveform Voltage Level:

1. Although the ±VOLTS switch can be set as desired, the analog output level of the Wavesaver is always 8 volts for a full-scale display.

2. If the recorded waveform measures two graticule divisions, the scope vertical sensitivity is set at 2 V/division, and the ±VOLTS switch is set at 0.5 volt, the recorded signal has an amplitude of 0.5 volt.

Plotter Use:

1. When SCOPE/PLOT switch *S2* is placed in the PLOT position, this enables connector *P1*.

2. On *P1*, pins 1 through 8 are digital data with pin 1 the most significant bit and pin 8 the least significant bit. Pin 9 is ground, pin 10 is sync (or data valid), pin 11 is the input for an external clock, and pin 12 is a 50-Hz pulse that can be used as the "write" pulse to an external computer. If the Wavesaver's internal clock is used, pin 11 and pin 12 must be shorted together. Pins 13 through 15 are external inputs for remote arming, triggering, and then clocking data into memory. All signals to *P1* must be TTL, and pins 1 through 8 can drive three 74LS (low-power Schottky) loads.

Applications. Uses for a storage oscilloscope are many. The test instrument presented here, for example, enables the user to see events before triggering. This is useful in solving a variety of problems before they would normally occur, such

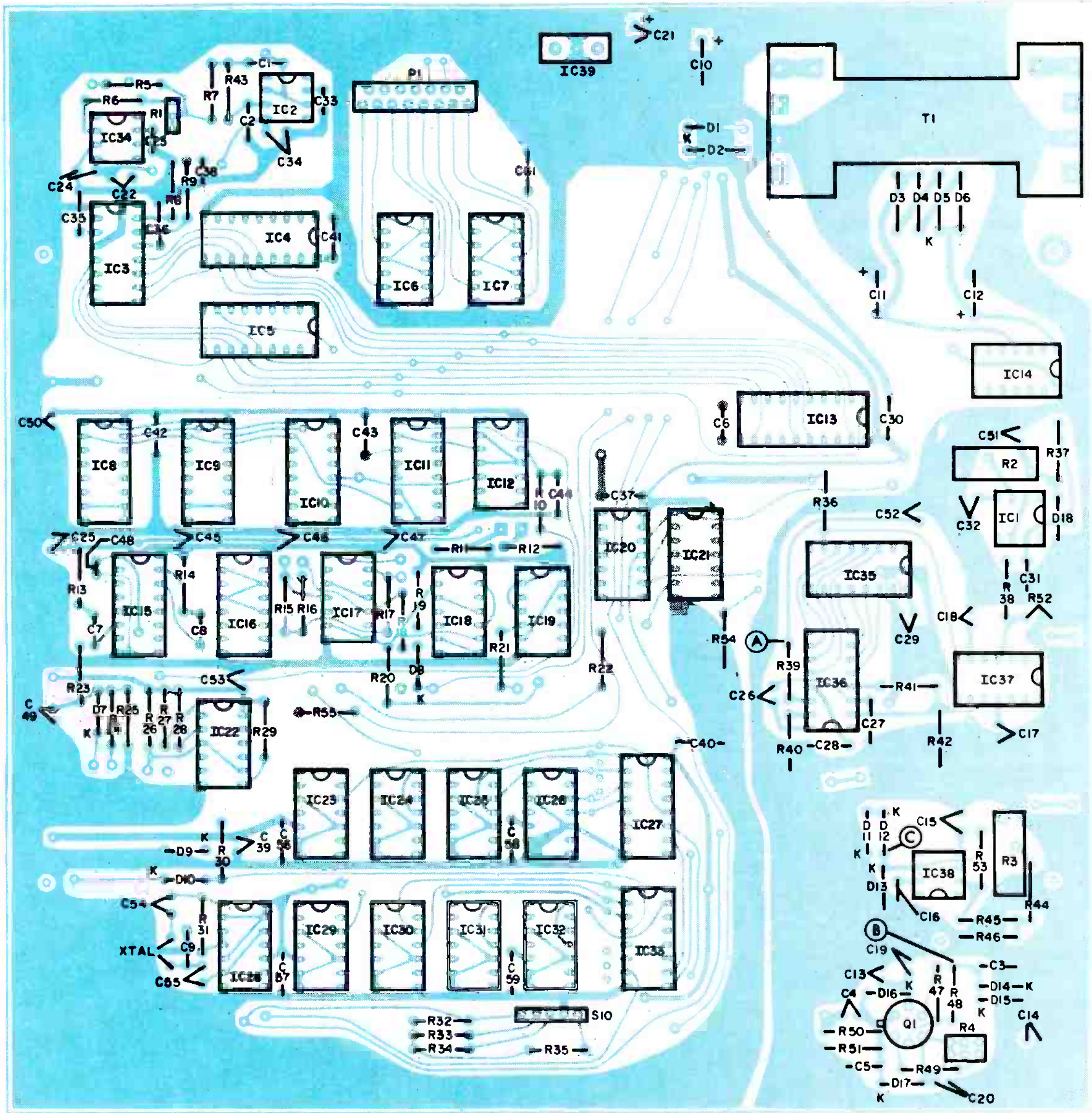


Fig. 13. Component layout for the pc board.

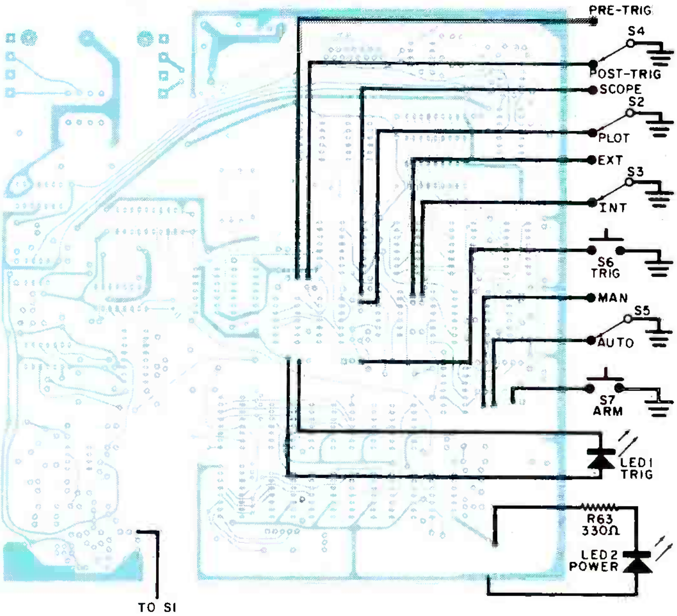


Fig. 14. Connections to external components from the pc board.

as witnessing a glitch that blows a fuse. With post-trigger only, it would be too late. You can record events while you're out having a cup of coffee, since the instrument has an automatic mode. In the manual mode, you can catch those fleeting one-shots. And the digital output interface enables you to plug in the stored information to a computer for analysis.

Here's a sampling of applications: switch-bounce testing, microphone performance, speech synthesis, loudspeaker analysis, television servicing, audio system testing, automotive engine performance, logic-circuit testing, capacitor characteristics, and so on. Clearly, the Wavesaver can open up new horizons on your test bench. ◇

Innovations

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CIRCLE NO. 2 ON FREE INFORMATION CARD

ADD A DISTINCTIVE EXTENSION PHONE RING TO YOUR TELEPHONE

BY MARK FORBES

THE low-cost (approximately $12) telephone-line-powered tone ringer described here will enable you to add an extension ringer in your garage or other area where the telephone ring cannot be heard. It will also make the ringing sound of a standard phone more pleasant.

The tone ringer is based on *IC1* (Fig. 1) a two-tone oscillator whose power supply and interface were designed specifically to be used with the telephone system (so no dc power supply is required). Up to four tone ringers can be used on a single telephone line, and a remote can be used on a 25-foot extension.

Circuit Operation. On a non-busy telephone line, about 50 V dc is present between tip and ring (red and green wires, respectively). As shown in Fig. 1, capacitor *C1* blocks this dc voltage in the normal "hung-up' state. To ring the telephone, an ac voltage between 85 and 125 volts (peak-to-peak) is applied between tip and ring (the "ring wire" is not to be confused with the "ring voltage"). This ac signal is coupled by *C1* and *R1* (which acts as a current limiter) to *RECT1*, a diode bridge, then filtered by *C2*. Thus, the supply voltage for *IC1* is provided by the phone line, and is present only when the ac ring signal is present. A threshold circuit is provided within the IC to prevent "chirps" on the ringer often heard when another phone on the same line is being dialed.

When *IC1* is on, it generates an audio tone of approximately 575 Hz modulated between 510 and 640 Hz at a 10-Hz rate to simulate a bell ringer. The center frequency (575 Hz) is determined by RC network *R3* and *C4*. This frequency can be varied somewhat by the selection of components. For the given value of *C4*, resistor *R3* can range from 180 to 330 kilohms. The modulating frequency is determined by the *R2-C3* combination and with the given value of *C3*, the range for *R2* is roughly 120 to 180 kilohms. With proper selection of these components, several telephones can be differentiated by different tones.

Capacitor *C5* couples audio to the speaker. The *IC1* manufacturer recommends the use of a 1000-to-8-ohm transformer with a 15-kilohm resistor across the primary. Acceptable performance has been obtained with the direct connection illustrated in Fig. 1. If a slight volume increase is desired, the transformer may be used.

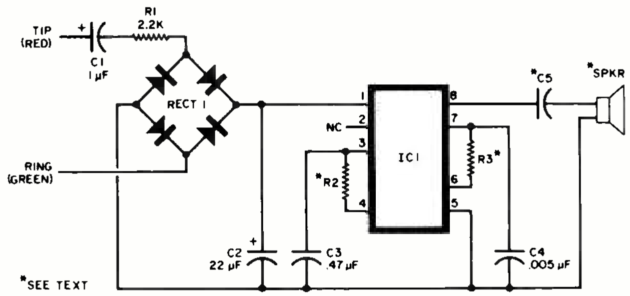


Fig. 1. The tone generated by ICl is about 575 Hz.

PARTS LIST

C1—1-µF, 100-V, capacitor
C2—22-µF, 35-V, capacitor
C3—0.47-µF, capacitor
C4—0.005-µF, capacitor
C5—0.22-µF disc capacitor
IC1—ML8204 tone ringer (MITEL)
R1—2.2-kΩ, ½-watt resistor
R2—See text
R3—See text
RECT1—Diode bridge (Radio Shack 276-1161, or similar)
SPKR—8-ohm loudspeaker

Note: The ML8204 (IC1) is available for $5 from Mark Forbes, 1000 Shenandoah Drive, Lafayette, IN 47905.

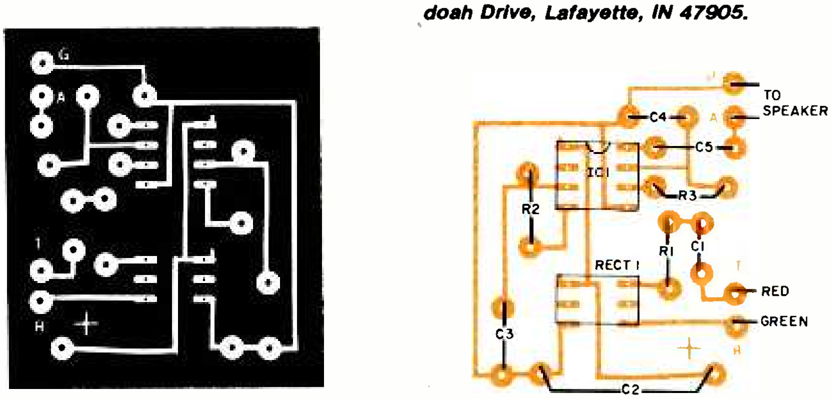


Fig. 2. Actual-size foil pattern and component layout are shown above.

Construction. The simple circuit can be assembled on a perf board or a small pc board such as that shown in Fig. 2. Double-check the polarity of all components before soldering in place.

When used with a miniature loudspeaker, the entire ringer can be mounted within a small plastic enclosure which can be mounted near the telephone, or up to 25 feet away as a remote ringer monitor.

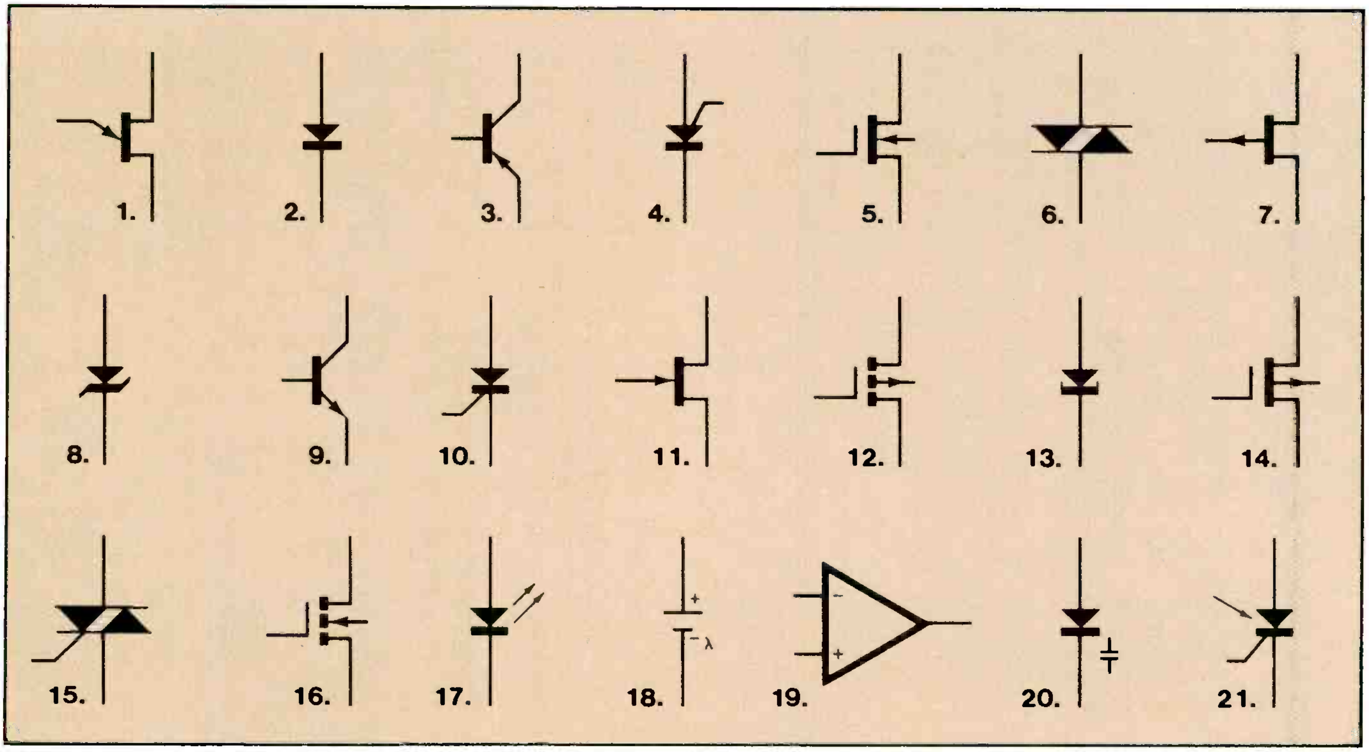
Keep in mind that some telephone companies require that you inform them that you are using one of these circuits. ◇

LEARNING QUIZZES FOR ELECTRONICS

BY FREDRICK W. HUGHES

Device Symbol Quiz

Match each of the following solid-state device schematic symbols with its proper name.



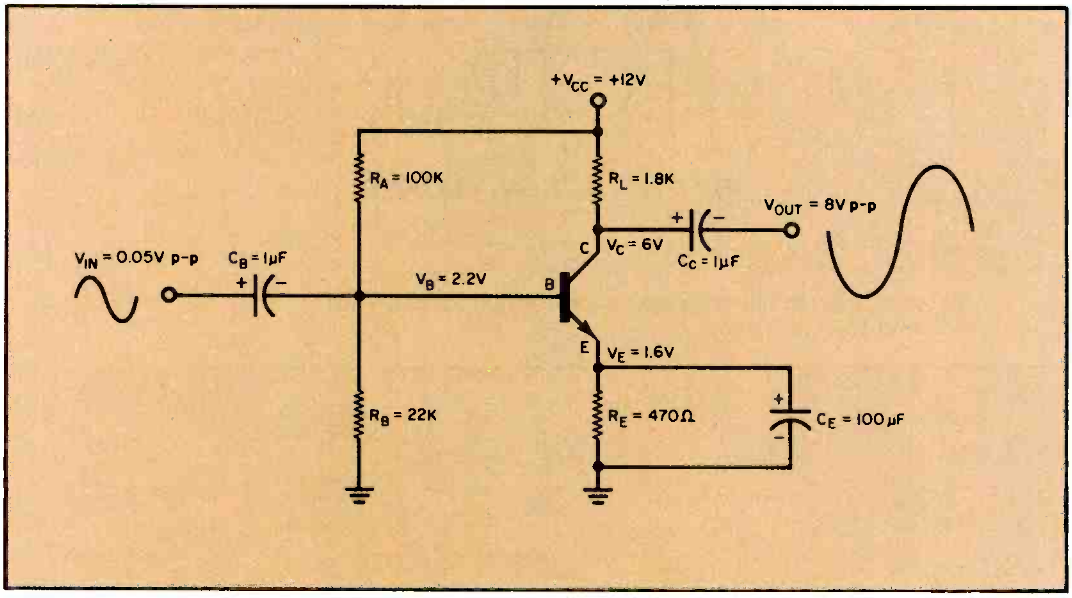
Choices:

a. diode
b. zener diode
c. LED (light emitting diode)
d. tunnel diode
e. capacitor diode
f. SCR (silicon-controlled rectifier)
g. DIAC (diode ac semiconductor device
h. TRIAC (triode ac semiconductor switch)
i. PUT (programmable unijunction transistor)
j. LASCR (light activated SCR)
k. UJT (unijunction transistor)
l. NPN bipolar transistor
m. PNP bipolar transistor
n. N-channel JFET (junction-field-effect transistor)
o. P-channel JFET
p. N-channel depletion-type MOSFET (metal-oxide-semiconductor FET)
q. P-channel depletion-type MOSFET
r. N-channel enhancement-type MOSFET
s. P-channel enhancement-type MOSFET
t. solar cell
u. OP AMP (operational amplifier)

Answers: 1. k, 2. a, 3. m, 4. i, 5. p, 6. g, 7. o, 8. b, 9. l, 10. f, 11. n, 12. s, 13. d, 14. q, 15. h, 16. r, 17. c, 18. t, 19. u, 20. e, 21. j.

Transistor Troubleshooting Quiz

Troubleshooting transistor circuits is done by comparing dc voltages of the transistor leads (V_C, V_B and V_E) with the values of a normally operating circuit. Generally, when a transistor is conducting heavily its V_C will be low. If it is cut off, V_C will equal $+V_{CC}$. A change in the transistor characteristics or a change in the biasing components can affect the dc operating voltages. Normal operating voltages are shown on the circuit. Each question indicates the operating voltages measured. Select the condition of the component from the voltage indications given.



1. V_C = 12 V, V_B = 0 V, V_E = 0 V
- **a.** R_A open
- **b.** R_B open
- **c.** R_L open
- **d.** C_E open

2. V_C = 3 V, V_B = 2.8 V, V_E = 2.2 V
- **a.** R_A open
- **b.** R_B open
- **c.** R_E open
- **d.** C_E open

3. V_C = 12 V, V_B = 2.4 V, V_E = 1.8 V
- **a.** R_L open
- **b.** R_E open
- **c.** C_E shorted
- **d.** C_E open

4. V_C = 0 V, V_B = 0.7 V, V_E = 0 V
- **a.** R_L open
- **b.** R_E open
- **c.** C_E shorted
- **d.** R_A open

5. V_C = 6 V, V_B = 2.2 V, V_E = 1.6 V, V_{out} = 2 Vp-p
- **a.** R_A open
- **b.** R_B open
- **c.** R_E open
- **d.** C_E open

6. V_C = 1 V, V_B = 0.7 V, V_E = 0 V
- **a.** R_B open
- **b.** R_L open
- **c.** C_E open
- **d.** C_E shorted

7. V_C = 12 V, V_B = 0 V, V_E = 0 V
- **a.** R_L open
- **b.** B-E shorted
- **c.** B-C shorted
- **d.** E open

8. V_C=2 V, V_B=2.4 V, V_E=2 V
- **a.** R_L open
- **b.** R_A open
- **c.** B-E shorted
- **d.** C-E shorted

9. V_C = 2.5 V, V_B = 2.5 V, V_E = 1.8 V
- **a.** C-B shorted
- **b.** R_B open
- **c.** C_E shorted
- **d.** C-E shorted

10. V_C = 12 V, V_B = 2.4 V, V_E = 0 V
- **a.** C open
- **b.** C-B shorted
- **c.** E open
- **d.** C_E shorted

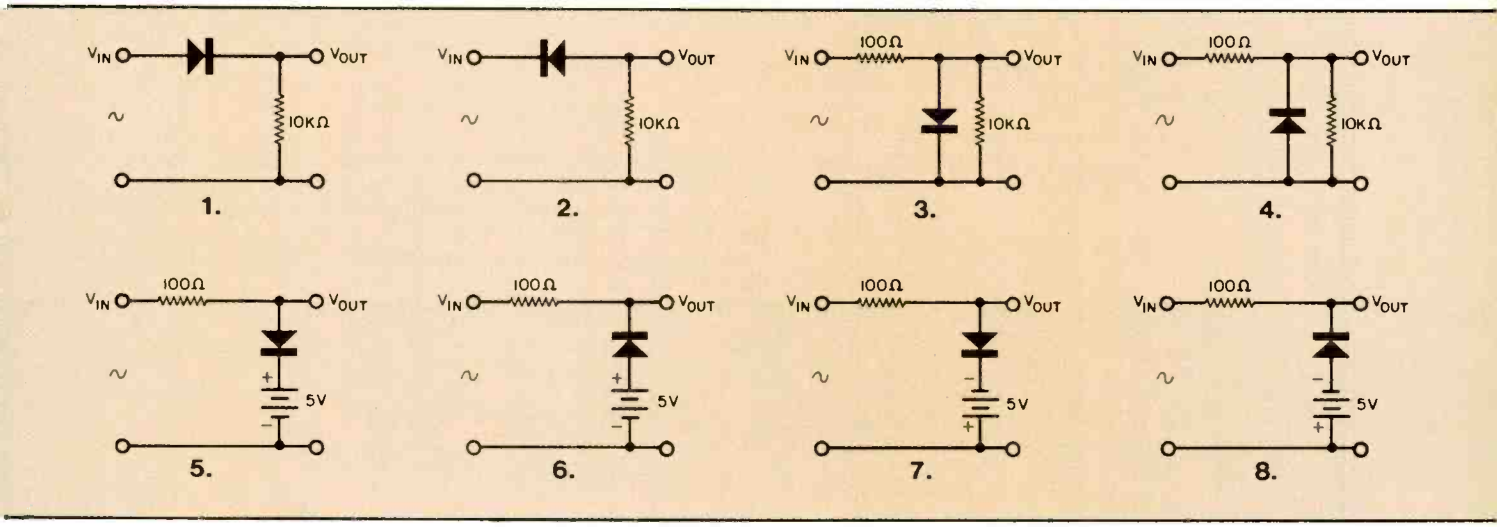
11. V_C = 12 V, V_B = 2.4 V, V_E = 0 V
- **a.** R_L open
- **b.** B open
- **c.** R_A open
- **d.** R_B open

12. V_C = 12 V, V_B = 0.7 V, V_E = 0 V
- **a.** R_L open
- **b.** R_A open
- **c.** R_B open
- **d.** C open

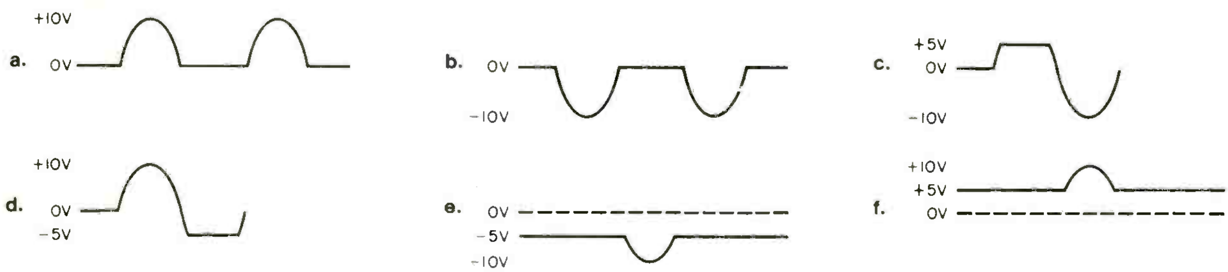
Answers: 1. a, **2.** b, **3.** b, **4.** a, **5.** d, **6.** d, **7.** b, **8.** d, **9.** a, **10.** c, **11.** b, **12.** d. (Note that the voltage measurements are similar for problems 10, 11, and 12 when there is an internal open of the transistor. An open base or emitter will result in identical readings.)

Diode Operation Quiz

A diode conducts when its anode is more positive than its cathode (about +0.2 V for germanium and +0.4 V for silicon). Diodes can be used as rectifiers to clamp ac voltages to a reference level and/or clip portions of an ac signal. If the input to each circuit is a 20 V p-p sinewave, match each of the following circuits to its proper output waveform. Consider the diodes ideal, either completely open or shorted. (Answers may be used more than once.)



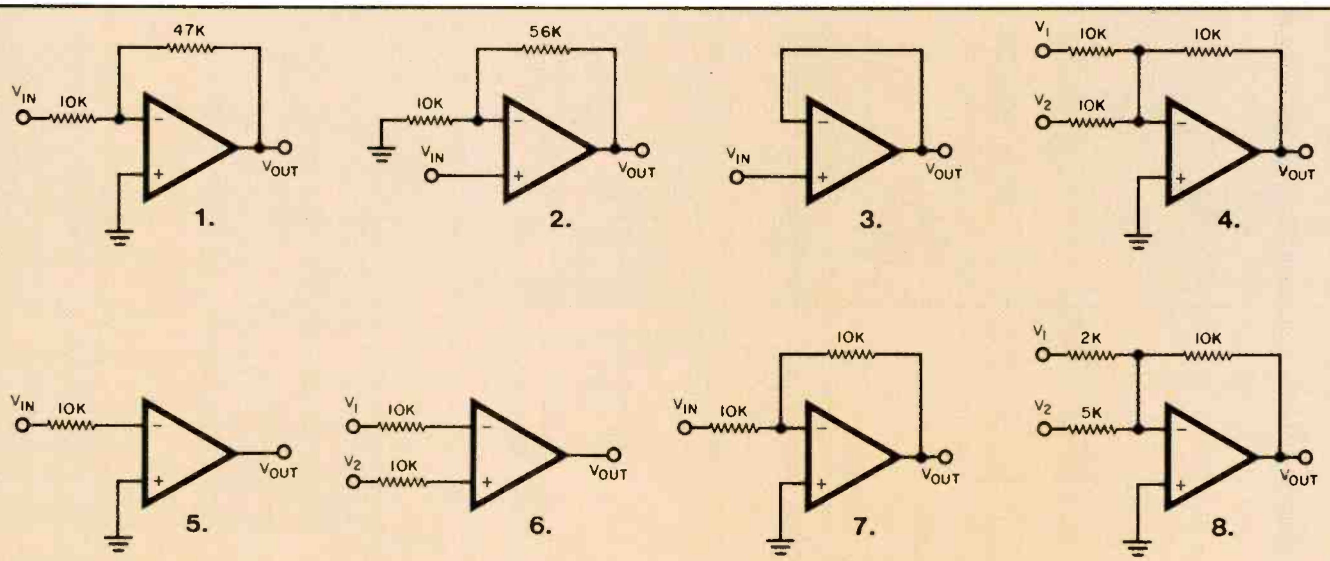
Choices:



Answers: 1. a, 2. b, 3. b, 4. a, 5. c, 6. f, 7. e, 8. d.

Op Amp Quiz

The input voltage is +1 V to all of the op amp circuits shown. Match each circuit with its proper output voltage. (Power supply voltage is ±12 V.)

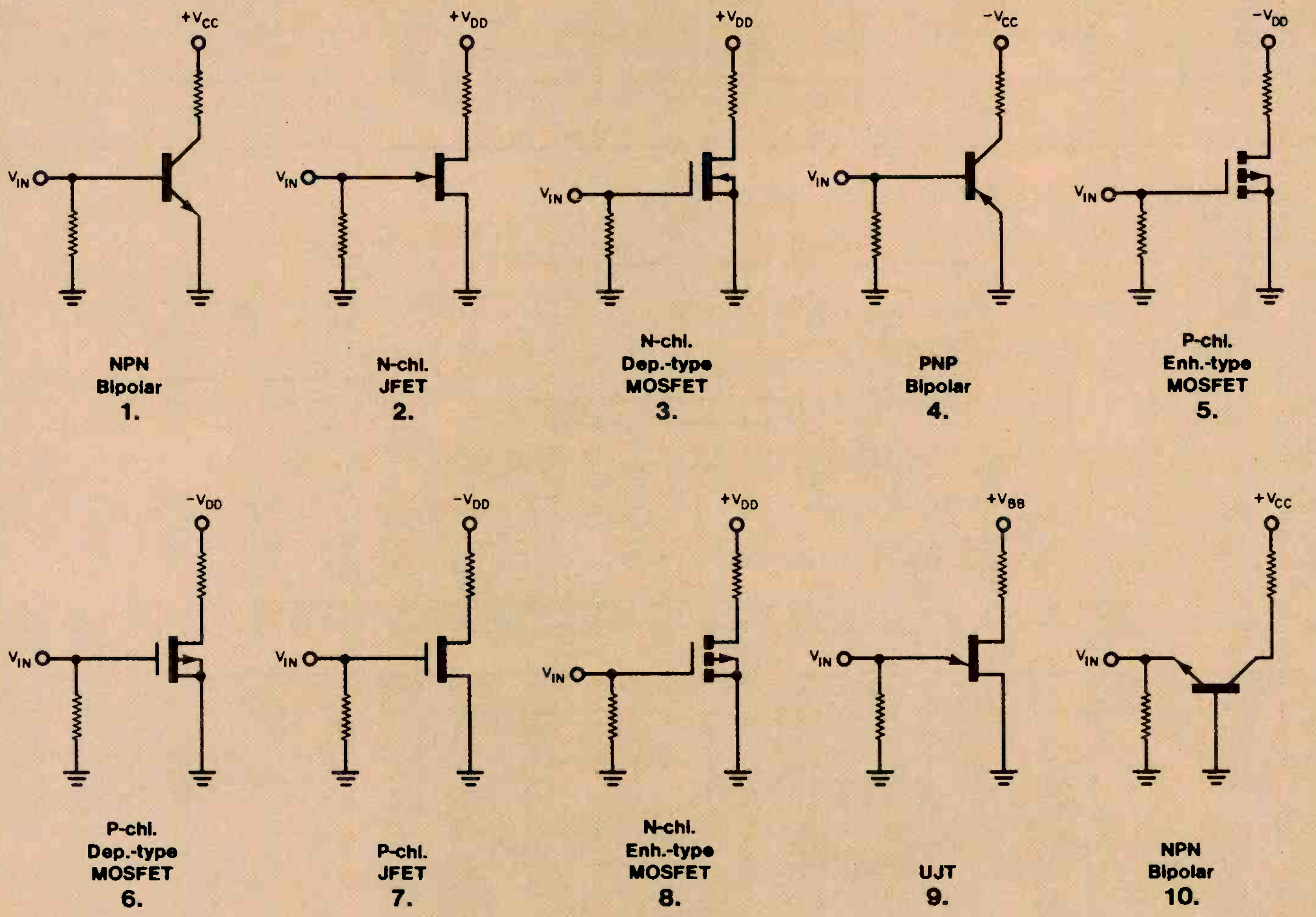


Choices: **a.** 0 V, **b.** +6.6 V, **c.** +1 V, **d.** −4.7 V, **e.** −10.8 V, **f.** −1 V, **g.** −7 V, **h.** −2 V.

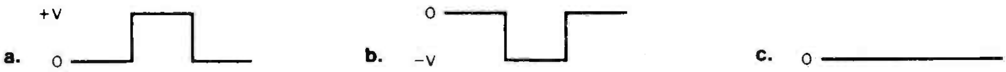
Answers: **1.** d, inverting amplifier ($V_{out} = A_V V_{in}$, where $A_V = 47K/10K$ **2.** b, non-inverting amplifier ($V_{out} = A_V V_{in}$, where $A_V = 1 + (56K/10K)$ **3.** c, non-inverting voltage follower **4.** h, arithmetic summing amplifier (when all resistors are equal, $V_{out} = -(V_1 + V_2)$ **5.** e (no feedback, amplifier saturates at about 90% of -V supply) **6.** a, voltage comparator (when inputs are equal, output is zero) **7.** f, inverting voltage follower **8.** g, summing amplifier with gain ($V_{out} = -(V_1(10K/2K) + V_2(10K/5K))$)

Transistor Operation Quiz

Some transistors are "normally on" (conducting) devices with zero bias, while others are "normally off" (not conducting) and must be turned on by a positive or negative bias or voltage. Match the voltages given to the following circuits in order to turn on the transistors. (Answers may be used more than once.)



Choices:



Answers: **1.** a, **2.** c, **3.** c, **4.** b, **5.** b, **6.** c, **7.** c, **8.** a, **9.** a, **10.** b.

BUILD A SYNCHRONOUS DETECTOR FOR AM RADIO

BY DAVE HERSHBERGER, W9GR

Improves frequency response and removes distortion

THERE IS a misconception that AM radio is inherently a low-fidelity medium. Many people assume that since the channel spacing between AM stations is limited to 10 kHz, there must be some legal restriction to 5-kHz audio response. This is not true, since FCC regulations permit full frequency response to 15 kHz (the same as FM) and the FCC frequency allocation structure takes this into account. However, geographically adjacent transmitters must be spaced at least three 10-kHz channels apart to provide sideband interference protection (FCC Part 73.40, par. A, sub. 12 and 73.182).

AM has a major advantage over FM radio in that it provides better reception in moving vehicles because of the absence of rapid-flutter multipath effects. And AM signals travel much farther than FM signals, thus expanding the listening range.

Most AM radios still use envelope (diode) detection that, when coupled with narrow i-f filtering, greatly restricts the audio bandwidth to produce "muddy" sounding audio because the higher audio frequencies are removed. Envelope detection also produces distortion, further adding to the poor sound.

An advanced method of demodulating an AM signal is to use a wideband i-f (when reception conditions permit), and replace the envelope detector with a synchronous detector. The wide i-f allows a better frequency response, while the synchronous detector will remove distortion produced by selective fading, slight receiver mistuning, modulation overshoots in the i-f filters (transient intermodulation distortion), co-channel interference, and interference or cross modulation. Impulse noise interference is also reduced.

This article will show you how to build a synchronous detector to replace the envelope detector in your AM receiver. It can be used with most any AM (or shortwave) receiver having a 455-kHz i-f. The circuit includes optional SSB detection capability to reject interference such as adjacent channel or other carriers, which occurs primarily in one sideband of a conventional DSB AM signal. When used with a wideband AM tuner, the synchronous detector will offer reception quality rivaling FM.

Theory. A synchronous detector recovers an *unmodulated* carrier from the incoming signal and uses it as a reference to discriminate against noise and distortion. Usually, a phase-locked loop (PLL) is used to regenerate the carrier, which then drives a product detector (multiplier or switch) to recover the modulation. In a more familiar application, synchronous detection is commonly used to demodulate FM stereo L-R and color-TV chrominance signals. Figure 1 shows basic synchronous and envelope detection systems.

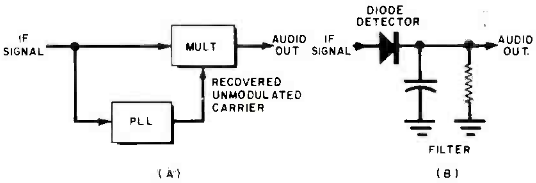
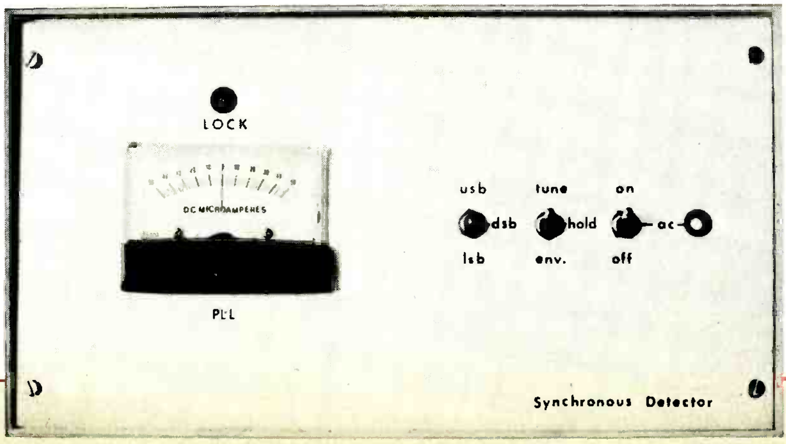


Fig. 1. Simplified diagram of the basic synchronous (A) and envelope (B) detection circuits.

Some examples of common AM phenomena are shown in Fig. 2, along with the resulting outputs of envelope and synchronous detectors. In each case, the synchronous detector gives an undistorted output, as opposed to the envelope detector. (The frequency response may not be flat, but there will be no distortion.) The envelope detector works correctly only when the carrier is large enough, and when the sidebands are perfect mirror images of each other in both amplitude and phase. The synchronous detector, not having this restriction, can demodulate a much wider range of AM signals such as DSB AM, DSB AM with reduced carrier, SSB with full or reduced carrier, vestigial sideband (VSB) AM, quadrature AM,



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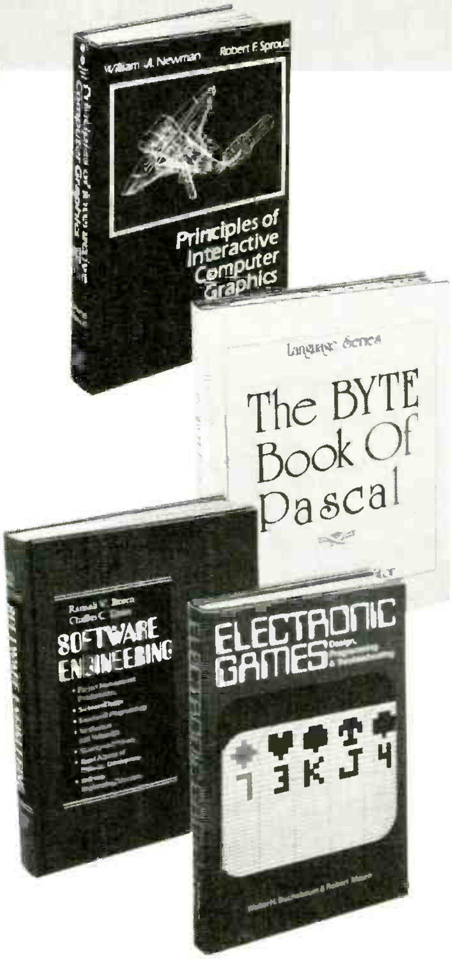

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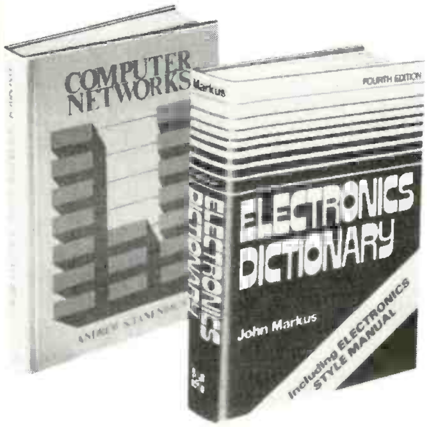

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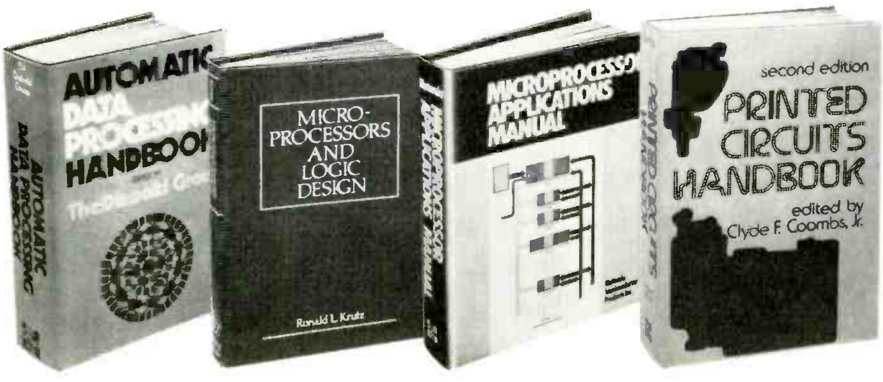

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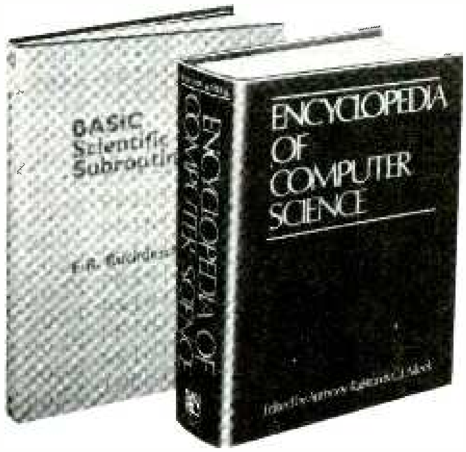

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etc. These forms of AM, which envelope detectors cannot properly demodulate, are produced under commonly occurring natural circumstances. Even though the broadcast signal starts out as conventional DSB AM, receiver mistuning, skywave reflections, etc., can change the AM signal into one or a combination of these other forms.

Circuit Description. The block diagram of a synchronous detector appears in Fig. 3. The circuit accepts a sample of the receiver's i-f (preferably taken from the last i-f stage) and a PLL is used to recover the unmodulated carrier. The circuit also provides automatic switching between envelope and synchronous detection. When the PLL is unlocked during tuning or absence of signal, the envelope detector portion provides the audio output. When the PLL locks onto the carrier, the circuit automatically switches the audio output to the synchronous detector. This action avoids audio-disturbing beat notes that would otherwise occur during tuning.

The circuit in Fig. 3 includes an optional SSB detection feature (shown within the dotted box). With the addition of audio phase-shift networks, it is possible with synchronous detection to receive SSB, or just one sideband of a DSB signal. This technique is usually used as a SSB *generation* method, but works equally well for reception. The circuit also includes a notch filter to remove any audible 10-kHz beats produced by adjacent channel transmitters. The complete schematic is shown in Fig. 4.

Emitter follower *Q1* buffers the i-f input and drives high-speed operational amplifier *IC1*. Automatic gain control (agc) of *IC1* is accomplished by LED-LDR (light-dependent resistor) combination *LDR1*, which produces far less distortion than conventional gain control techniques.

AGC/buffer amplifier *IC1* drives three analog multiplexers (*IC4A*, *IC4B*, and *IC4C*) used as balanced demodulators. The three demodulators, after RC lowpass filtering, provide in-phase ("I"), quadrature ("Q"), and envelope audio. The I channel is the synchronously detected DSB signal, while the Q channel is related to sideband asymmetry. Normally, the Q channel is zero, but if there is phase or amplitude imbalance between the upper and lower sidebands, the Q channel will contain audio. After the PLL locks, the Q channel detector detects phase.

The envelope detector uses differential pair *Q2/Q3* to hard-limit the i-f signal, and the resulting CMOS level square wave drives envelope demodulator *IC2C*. This gets around the limitations of conventional diode detectors, namely, diagonal clipping and diode-threshold distortion. The envelope detector supplies the audio output when the PLL is unlocked, and provides AGC sensing voltage to *IC5A*. The difference between synchronous detector *IC2A* and envelope detector *IC2C* is in the drive signals to the analog multiplexers. The synchronous detector always has a pure unmodulated carrier as its drive signal, while the envelope detector will have phase modulation of its drive during any of the nonideal conditions in Fig. 2.

Switch *S1* in the I circuit selects the detection mode with TUNE, the normal position of the switch. This mode provides slow locking and rapid unlocking. In this mode, the output signal is taken from envelope detector *IC4C*. After tuning in a signal, the logic will switch the output to synchronous detection. The locked bandwidth at 25 Hz is too narrow to track the carrier as the receiver tuning knob is being adjusted. Beat notes are avoided by deliberately delaying the output of lock detector *IC4D* for envelope detection while tuning, and synchronous detection after the hand is taken from the tuning knob.

The middle position of switch *S1*, HOLD, provides rapid locking and slow unlocking, and is intended for use with signals that are subject to fading. If the carrier amplitude momentarily drops below the lock threshold, unlocking is delayed several seconds. With the absence of an input error signal, integrator *IC5B* (the PLL loop filter) will hold the afc voltage during fades. This mode cannot be used for receiver tuning, as beat notes would be heard during the unlock delay period. The last position of *S1* selects the ENV detection mode.

The PLL operates in a wideband mode when unlocked, and automatically switches to a narrowband mode when locked. This allows a wide acquisition range, a fast lock time, and a narrow bandwidth—conflicting requirements in a simple PLL. When unlocked, the hard-limited i-f signal from *Q2/Q3* is compared with the vco signal in phase/frequency detector *IC8*. When the loop locks, a dc component (due to the carrier) will appear at the output of I-channel detector *IC4A*. This level will trip lock detector *IC4D*, an op amp used as a comparator. The lock detector switches the audio output, the PLL control loop, and drives indicator LEDs. When locked, the Q-channel detector is used to control the loop instead of phase/frequency detector *IC8*. The locked-loop bandwidth is about 25 Hz; therefore, when the loop is locked, it operates as a very narrow bandwidth filter, recovering the unmodulated carrier, and rejecting the modulation sidebands.

The vco uses analog multiplexer *IC3C* as the active element. At first this may seem a bit strange, but *IC3C* is connected as a CMOS logic inverter, and is used as such in a conventional CMOS L/C oscillator. Varactor diode *D6* tunes the oscillator to 455 ±15 kHz.

In PLL loop filter *IC5B*, dc feedback is entirely through the vco and Q-channel detector (or *IC8* when un-

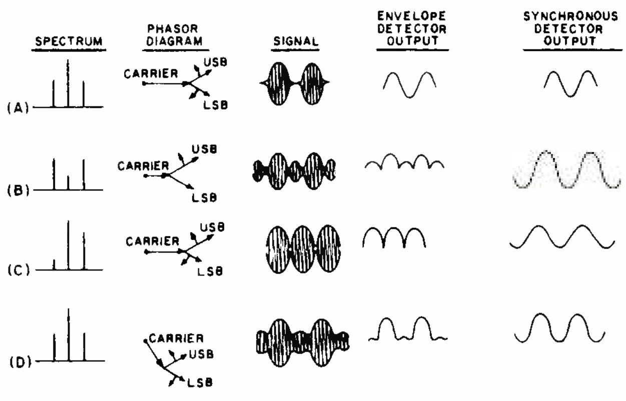


Fig. 2. Some common AM phenomena: (A) Conventional unperturbed AM signal. Both detectors give undistorted outputs. (B) Reduced carrier. Caused by selective fading or directional transmitting antenna. (C) Sideband asymmetry—selective fading or receiver mistuning. (D) Wrong carrier phase—skywave propagation or receiver i-f phase asymmetry.

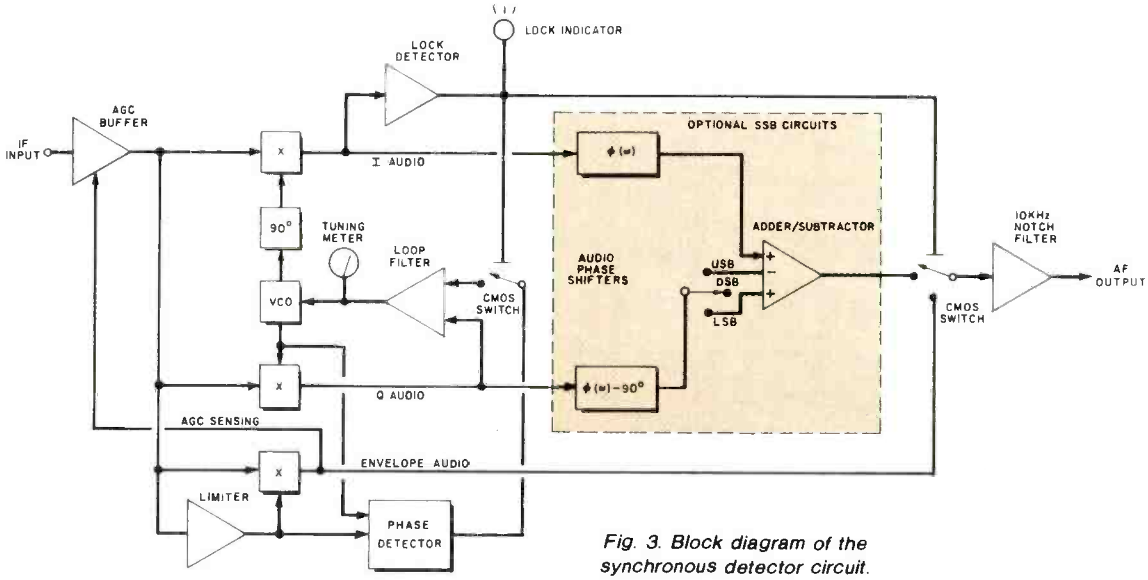
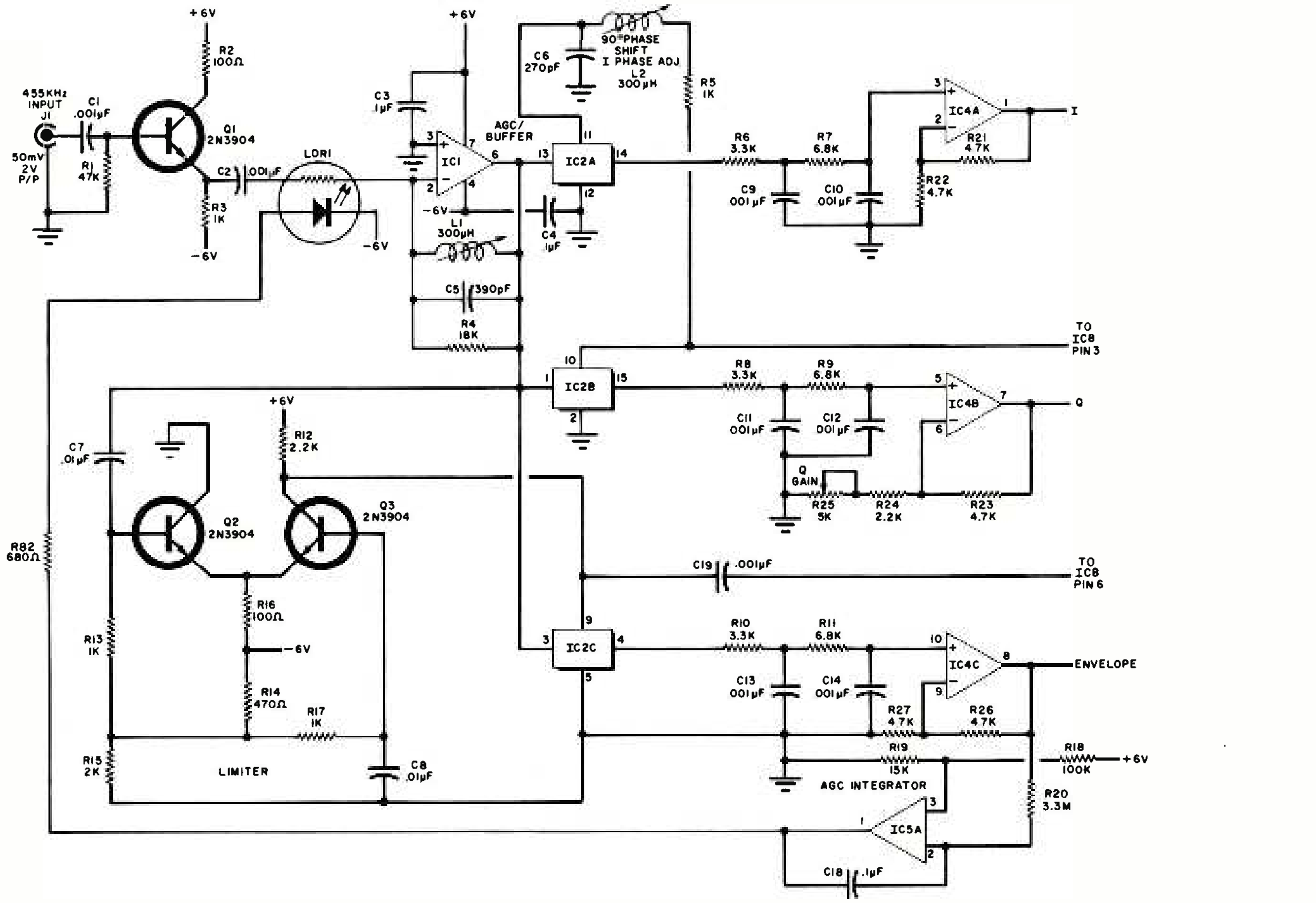


Fig. 3. Block diagram of the synchronous detector circuit.

locked). This forces the Q-channel detector to have a dc component equal to zero, which in turn forces the vco phase to be correct regardless of receiver tuning (Type II loop). Because *IC5B* "sees" varying source resistances as *IC3B* switches, a BiFet or BiMOS type of op amp must be used to minimize bias current effects.

The vco drive to *IC2A*, the I-channel demodulator, must be shifted 90 degrees from the drive to *IC2B*, the Q-channel demodulator. The network comprising *R5*, *L2*, and *C6* forms a passive L/C 90-degree phase shift network.

SSB Option. To obtain SSB reception, the I and Q signals are applied to active audio phase-shift networks having a flat frequency-response charac-



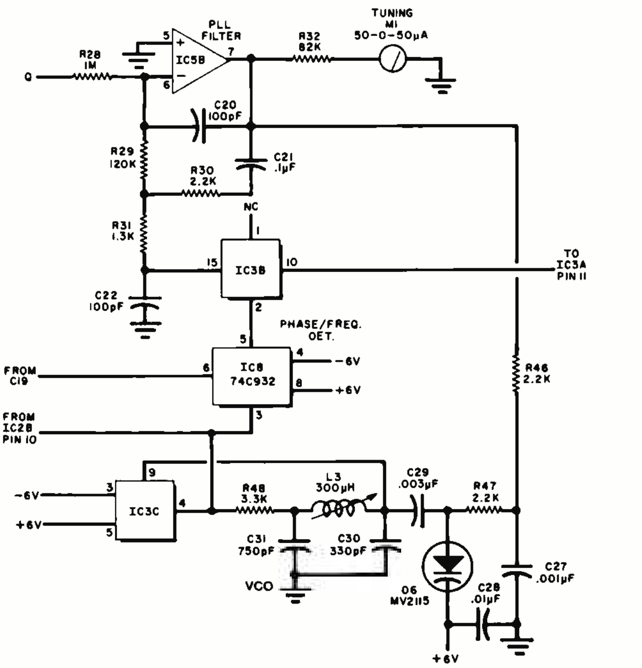
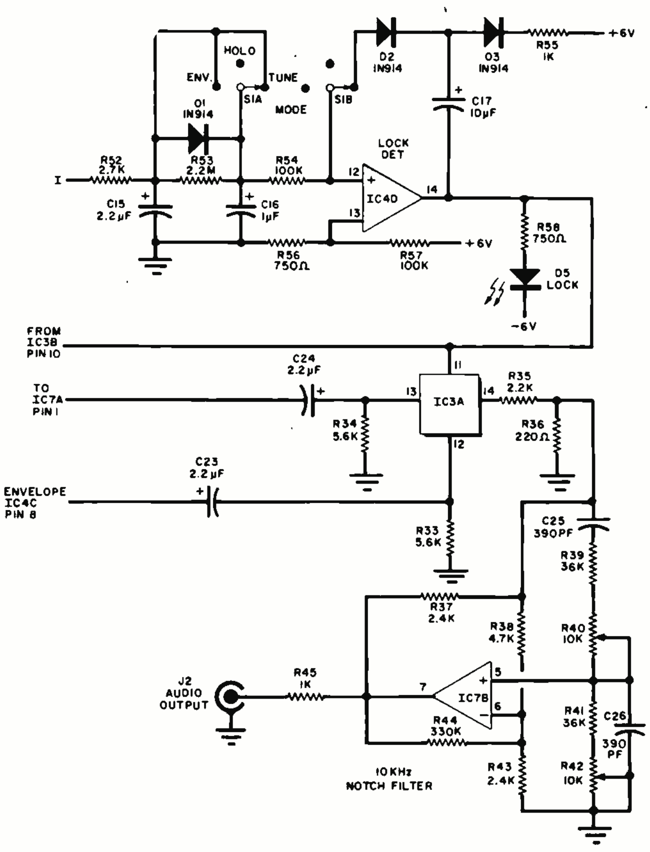
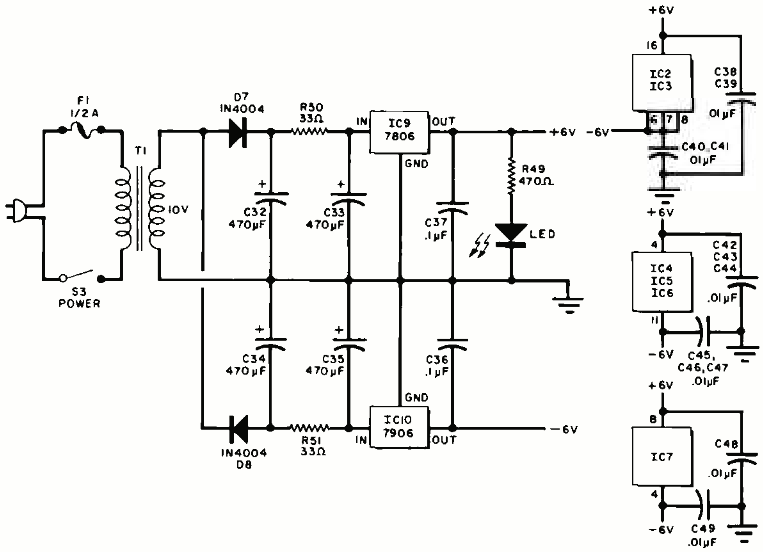
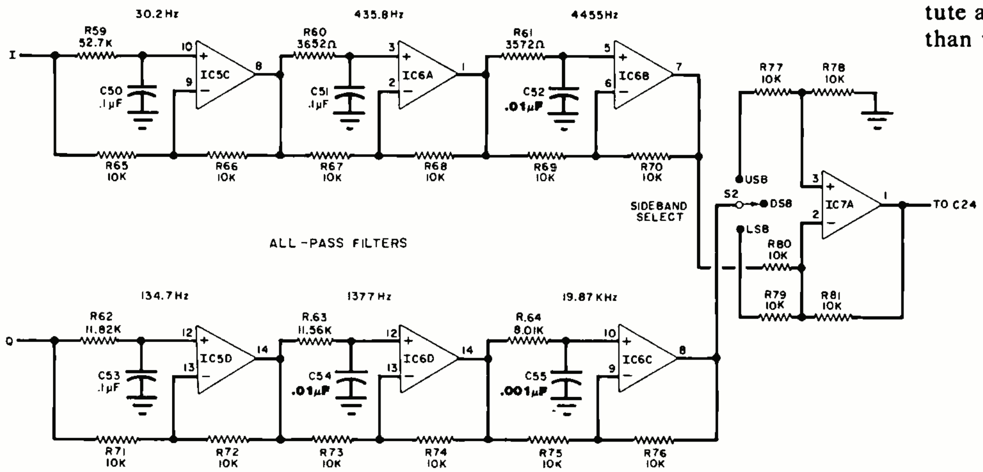


Fig. 4. Schematic diagram of the synchronous detector is shown above and opposite. The power-supply circuit is at top on opposite page.







teristic and a frequency-dependent phase shift. These networks have a nearly constant 90-degree audio phase difference (±3°) over the range of 50 to 12,000 Hz, which provides a minimum of 31-dB unwanted sideband suppression over that range.

The allpass filter outputs are applied to *IC7A*, which is used as an inverting buffer/adder/subtractor. For DSB reception, this IC forms a unity-gain inverting buffer. For lower sideband (LSB) reception, *IC7A* adds the two allpass signals, and subtracts them for upper sideband (USB). Switch *S2* selects the DSB, USB, and LSB modes.

The 10-kHz notch filter is formed by the *IC7B* circuit. This stage must have a high gain/bandwidth product for proper operation. Do not substitute an op amp of lesser performance than the TL072 suggested.

PARTS LIST

C1,C2,C9 through C14,C19,C27—0.001-μF disc capacitor
C3,C4,C36,C37—0.1-μF disc capacitor
C5,C25,C26—390-pF mica capacitor
C6—270-pF mica capacitor
C7,C8,C28,C38 through C49—0.01-μF disc capacitor
C15,C23,C24—2.2-μF, 15-V electrolytic
C16—1-μF, 15-V electrolytic
C17—10-μF, 15-V electrolytic
C18,C21—0.1-μF Mylar capacitor
C20,C22—100-pF disc capacitor
C29—0.003-μF disc capacitor
C30—330-pF mica capacitor
C31—750-pF mica capacitor
C32-C35—470-μF, 25-V electrolytic
C50,C51,C53—0.1-μF, 1% capacitor
C52,C54—0.01-μF, 1% capacitor
C55—.001-μF, 1% capacitor
D1 through D3—IN914 diode
D4,D5—Red LED
D6—MV2115 varactor diode
D7,D8—1N4004 diode
IC1—LM318N op amp
IC2,IC3—CD4053BCN triple two-input CMOS multiplexer
IC4,IC5,IC6—TL074CN quad op amp
IC7—TL072CN dual op amp
IC8—74C932N phase/frequency detector
IC9—7806 or LM340T-6 voltage requlator
IC10—7906 or LM320T-6 voltage requlator
J1,J2—RCA phono jack
L1 through L3—230-440-μH adjustable coil (Midland 25-702, 25-705, or equiv.)
LDR1—LED/LDR (Vactec VTL5C2 or similar)
M1—50-0-50 microammeter (Midland 23-207 or equiv.)
Q1 through Q3—2N3904 transistor
The following are ¼-W, 10% resistors unless otherwise noted:
R1—47-kΩ
R2,R16—100 Ω
R3,R5,R13,R17,R45,R55—1 kΩ
R4—18 kΩ
R6,R8,R10,R48—3.3 kΩ
R7,R9,R11—6.8 kΩ
R12,R30,R35,R46,R47—2.2 kΩ
R14,R49—470 Ω
R15—2.0 kΩ
R18,R54,R57—100 kΩ
R19—15 kΩ
R20—3.3 MΩ
R21 through R23,R26,R27,R38—4.7 kΩ
R25—5-kΩ potentiometer
R28—1 MΩ
R29—120 kΩ
R31—1.3 kΩ
R32—82 kΩ
R33,R34—5.6 kΩ
R36—220 Ω
R37,R43—2.4 kΩ
R39,R41—36 kΩ
R40,R42—10-kΩ potentiometer
R44—330 kΩ
R50,R51—33 Ω, ½ W
R52—2.7 kΩ
R53—2.2 MΩ
R56,R58—750 Ω
R59—52.7 kΩ, 1%
R60—3.65 kΩ, 1%
R61—3.57 kΩ, 1%
R62—11.8 kΩ, 1%
R63—11.6 kΩ, 1%
R64—8.01 kΩ, 1%
R65-R81—10 kΩ, 1%
R82—680 Ω
SI—Dpdt center-off toggle switch
S2—Spdt center-off toggle switch
S3—Spst toggle switch
T1-10 V, 250 mA
Misc.—Prototype board, suitable enclosure, sockets, mounting hardware.

Construction. The synchronous detector can be built using prototyping pc breadboards. While custom pc boards may have a "professional" appearance, users of prototype breadboards enjoy a significant luxury—the ability to modify a circuit without cutting and drilling. If the FCC finally selects an AM stereo system (see POPULAR ELECTRONICS, December, 1978), some may wish to modify this circuit for an AM stereo. The synchronous detector can be changed into an AM stereo decoder for most of the proposed AM stereo systems, with some modifications and additions.

The layout is not very critical as long as good construction practice is observed. Keep large-signal i-f circuits (*Q2, Q3, IC2, IC3,* and *IC8*) away from the i-f input (*Q1, IC1*). Try to keep vco output and limiter output signal leads short.

SSB detection capability is optional. If it is omitted, leave out SSB audio phase shifters *IC5C, IC5D, IC6,* and adder/subtractor *IC7A*. Connect *IC4A* pin 1 to *C23*, and reverse the polarity of *C23*. Replace *R24* and *R25* with a fixed 4.7-kΩ resistor.

Because component tolerances are critical in the allpass (SSB) filters, some selecting and matching of resistors and capacitors is required to obtain the exact RC value in each section. Several methods are available for selecting these components. The easiest way would be to use 1%-tolerance parts. But, since the correct 1%-tolerance parts may be hard to find, there are alternative methods. Resistors *R65* through *R76* must be matched pairs. *R65* must be matched to *R66*, *R67* matched to *R68*, etc., but each pair need not be matched to any other pair. For example, *R65* and *R66* could both be 10.2 kΩ while *R67* and *R68* could both be 9.7 kΩ. Any value between 1 kΩ and 100 kΩ is suitable for matched pairs *R65-R76*. You can use a digital ohmmeter or bridge to match these parts. Do not use carbon composition resistors because they change value with heat, as during soldering! Carbon-film ("low noise") resistors are recommended for use in the SSB audio phase shifters.

There is an RC pair associated with each noninverting input (for example *R59/C50*). The RC value (ohms, farads) of this pair must satisfy the relation $f_{90} = 1/(2\pi RC)$, where f_{90} is the frequency (in hertz) and the output of a section is shifted 90° in phase from its input. The value of f_{90} for each section is given on the schematic. You can use a digital capacitance meter to measure the capacitors, and a digital ohmmeter to match a series resistor combination to obtain the desired RC product. If you depart from the suggested values on the schematic, keep resistors in the range of 1 kΩ to 100 kΩ, and keep capacitors above 0.001 µF. Do not use ceramic capacitors as they are unstable with temperature.

If accurate resistance and capacitance measuring devices are not available, there is another method, which requires accurate frequency- and voltage-measuring devices, and a sine-wave audio source. The sine-wave generator should have a low output impedance (50 ohms or less). If the generator does not have a low output impedance or if it is unknown, temporarily connect one of the op amp sections as a voltage follower and use it to buffer the output of the signal generator. For each section, temporarily disconnect the inverting input resistor (for example, *R65*) and disconnect the ground lead of the capacitor (for example, *C50*). Apply a sine wave at f_{90} at about 1 volt rms. Make an accurate measurement of the ac signal voltage at the output of the allpass section op amp. Reconnect the capacitor ground lead and adjust the resistor (for example, *R59*) such that the ac voltage at the op amp output drops to 70.71% of its original value. If the initial voltage is 1.000 volt, it should drop to 0.707 volt when the capacitor lead is grounded. After the resistor is adjusted, reconnect the capacitor lead to ground and reconnect the inverting input resistor. Repeat the process for the other five sections.

The PLL dynamics are dependent on the vco sensitivity (output frequency change divided by input voltage change), which, in turn, is dependent on varactor *D6* characteristics. The varactor specified (MV2115) has a capacitance of 100 pF at 4 volts across the diode. If you use this varactor, the vco should tune 455 kHz plus or minus approximately 15 kHz over a −5-to-+5-volt range. The average vco sensitivity is 2.7 kHz per volt. If you use a different varactor, measure the vco frequency versus voltage characteristic and determine the vco sensitivity (kHz/volt), and call this value "X". If X is not 2.7 kHz/volt, multiply the values of the resistances of *R28* and *R31* by X/2.7.

Phase detector *IC8* (74C932) may be hard to obtain. The 74C932 is the phase detector part of the commonly available CD4046 CMOS PLL. The CD4046 may be substituted if the pin connections are rearranged according to the following:

Function	74C932 pin#	CD4046 pin#
V_{DD}	8	16
V_{SS}	4	8
VCO IN	3	3
Limiter In	6	14
Output	5	13
VCO Inhibit (connect to V_{DD})	—	5

All other CD4046 pins remain unconnected.

If the unit specified for *LDR1* cannot be obtained, use a red LED and a cadmium sulphide photocell. Use a photocell having 500 ohms or less resistance at 20 mA of LED current. Then optically seal the pair in a small piece of "heat-shrink" tubing.

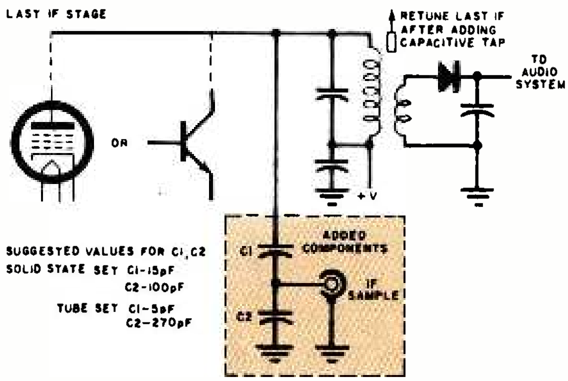


Fig. 5. The signal sample should be taken after the last i-f stage with a capacitive circuit added as shown here.

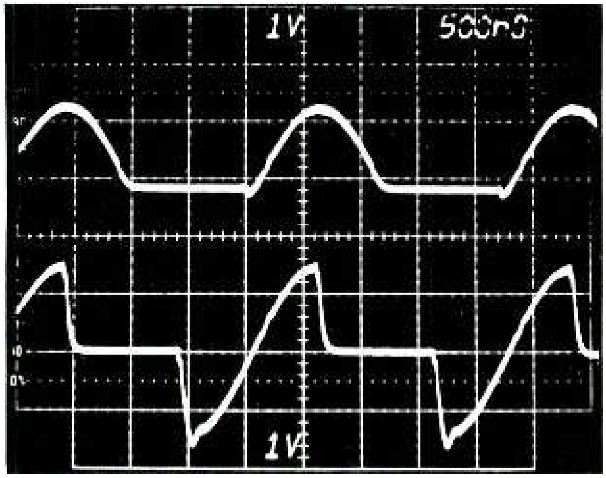


Fig. 6. The I and Q waveforms at pins 14 (top) and 15 (bottom) of IC2.

Receiver Interfacing. Most receivers will work well with the synchronous detector. The only requirement is that the local oscillator (LO) does not have spurious FM modulation. To test for this, tune in the receiver's local oscillator on a general-coverage receiver, using the bfo. If a general-coverage receiver is not available, use a second AM radio for this test, using a broadcast signal above 1 MHz as the "bfo." The audio note should be pure, without warbling sounds or pitch variations which indicate spurious FM. If you hear 60-Hz or 120-Hz FM, try improving the receiver power-supply filtering. If you are using a tube-type receiver and notice 60-Hz FM, replace the LO/converter tube. Some tubes may have some heater-to-cathode coupling that, while not affecting normal operation, will introduce a 60-Hz FM component in the LO signal.

The synchronous detector requires an input signal between 50 mV and 2 volts p-p unmodulated carrier. The agc circuit in the detector will establish the correct operating level as long as the input signal is in this range. The input impedance of the synchronous detector is high enough (about 25 kΩ) that it will not disturb most circuits.

The signal sample for the synchronous detector should be taken from the host receiver after all i-f filtering and agc, which usually means at the i-f strip output. In most receivers, a capacitive tap across the primary of the last i-f stage works well, as shown in Fig. 5. The slight additional capacitance introduced by the divider may necessitate realignment of the last i-f transformer. If signal levels are too low for capacitive dividers, try connecting the synchronous detector input directly to the collector of the last i-f stage. Again, it may be necessary to retune the last i-f stage transformer if it exists. If you intend to use your receiver's audio amplifier with the synchronous detector, disconnect the volume control from the envelope detector. Do not disable the envelope detector entirely, as it usually provides agc. Route the audio signal from the synchronous detector back into the volume control, or into an external amplifier.

If your receiver is ac-operated and has no power transformer, be sure to *use an isolation transformer to avoid shock hazard.*

Adjustment. After interfacing the receiver to the synchronous detector, place mode switch *S1* in the TUNE position and tune in a station. If the i-f signal level is above the 50 mV p-p minimum, pin 1 of *IC5* should be between −4.5 and +4.5 volts. Tune *L1* for the most negative voltage at this pin. Adjust *L3* until tuning meter *M1* indicates correct center-channel tuning. The PLL should now be locked, and the LOCK LED should illuminate. Adjust *L2* for maximum dc voltage at pin 1 of *IC4*. As there is also audio present at pin 1, use of a conventional mechanical-movement voltmeter (instead of a digital meter) will avoid confusing readings. This is a coarse adjustment of *L2*. The I and Q channel detector waveforms, at pins 14 and 15 of *IC2*, are shown in Fig. 6.

To adjust the SSB detection circuits, tune in a station which has an interfering carrier, or introduce an interfering carrier from a r-f signal generator. Place sideband selector switch (*S2*) in the position (USB or LSB) which most attenuates the interfering carrier. Alternately adjust Q-channel gain *R25* and I-Phase adjust *L2* for maximum interference attenuation.

To align the 10-kHz notch filter, tune in a station having an adjacent channel interference (10-kHz beat note). If the selectivity of your receiver is too narrow, you will not be able to detect 10 kHz and the notch filter will be unnecessary. But if your receiver does have sufficient bandwidth, alternately adjust *R40* and *R42* for maximum rejection of the 10-kHz beat note.

Operation. In normal operation, SIDEBAND SELECTOR switch *S2* should be set to DSB and MODE switch *S1* to TUNE. Tune the radio as you normally would, but with the aid of tuning meter *M1*. Keep in mind that when the receiver is being tuned, envelope detection is selected, and the LOCK LED will be dark. If the station is fading badly enough that the LOCK LED occasionally goes out, set the MODE switch to the HOLD position. The PLL will then track the received signal through deep fades. The ENV position of the MODE switch selects envelope detection, which can be used for comparison with synchronous detection.

When adjacent channel interference, TV receiver horizontal sweep harmonics, interfering carriers, etc., are present, selection of the USB or LSB mode may provide a significant reduction of the interference, since these types of interference usually affect only one sideband of the AM signal. By receiving the unaffected sideband, an otherwise unlistenable signal can be made usable. For interference which affects both sidebands equally, such as atmospheric or impulse noise, DSB reception is best. (SSB reception rejects half the power of a DSB signal.)

The SSB modes can also provide improved frequency response on narrowband receivers. By tuning off to one side of the station and selecting the appropriate sideband, the frequency response can be significantly improved. (Although detuning can improve frequency response of conventional radios, it will also introduce large amounts of distortion because of envelope detection. Synchronous detection eliminates the distortion caused by detuning.) ◇

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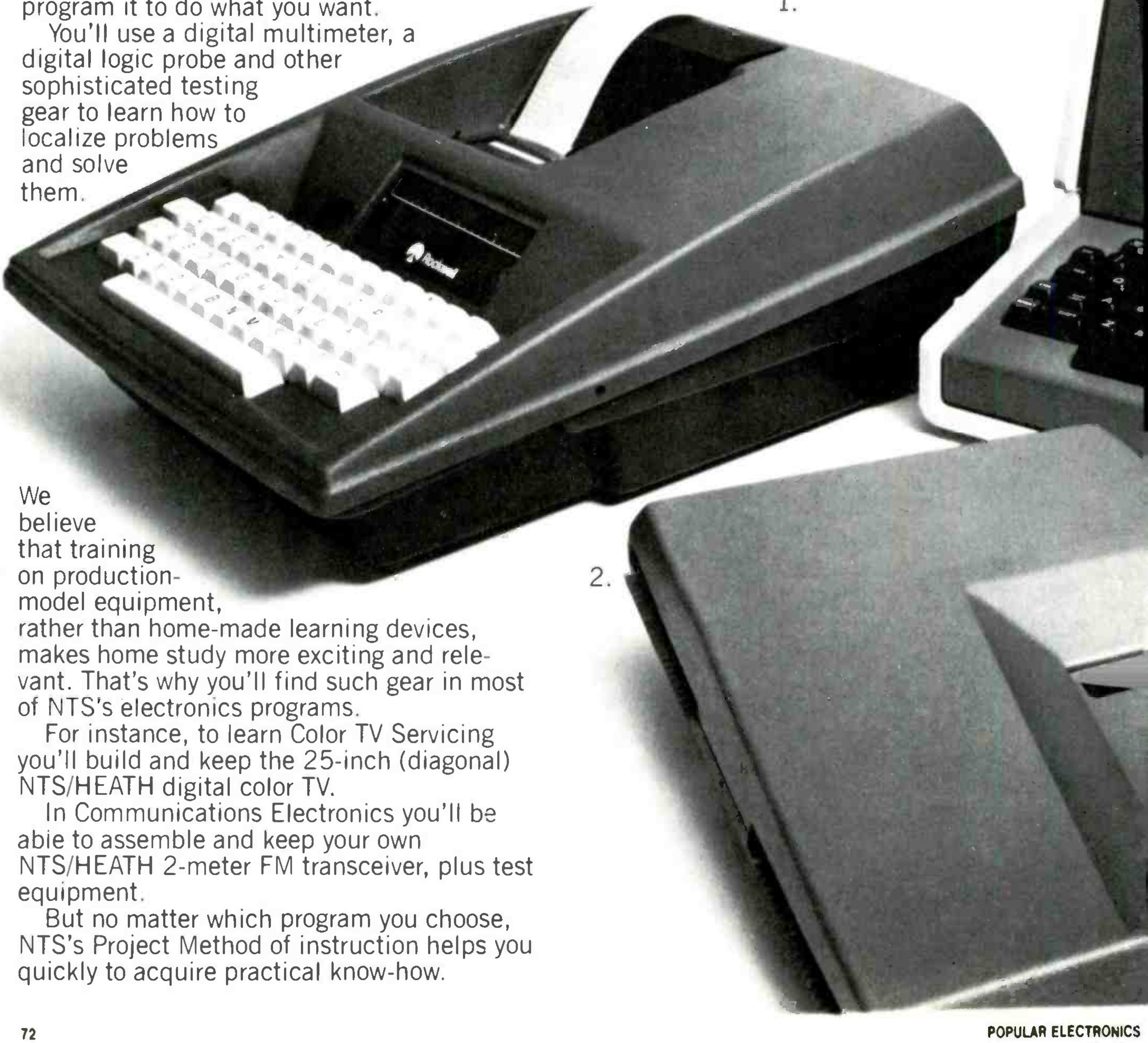

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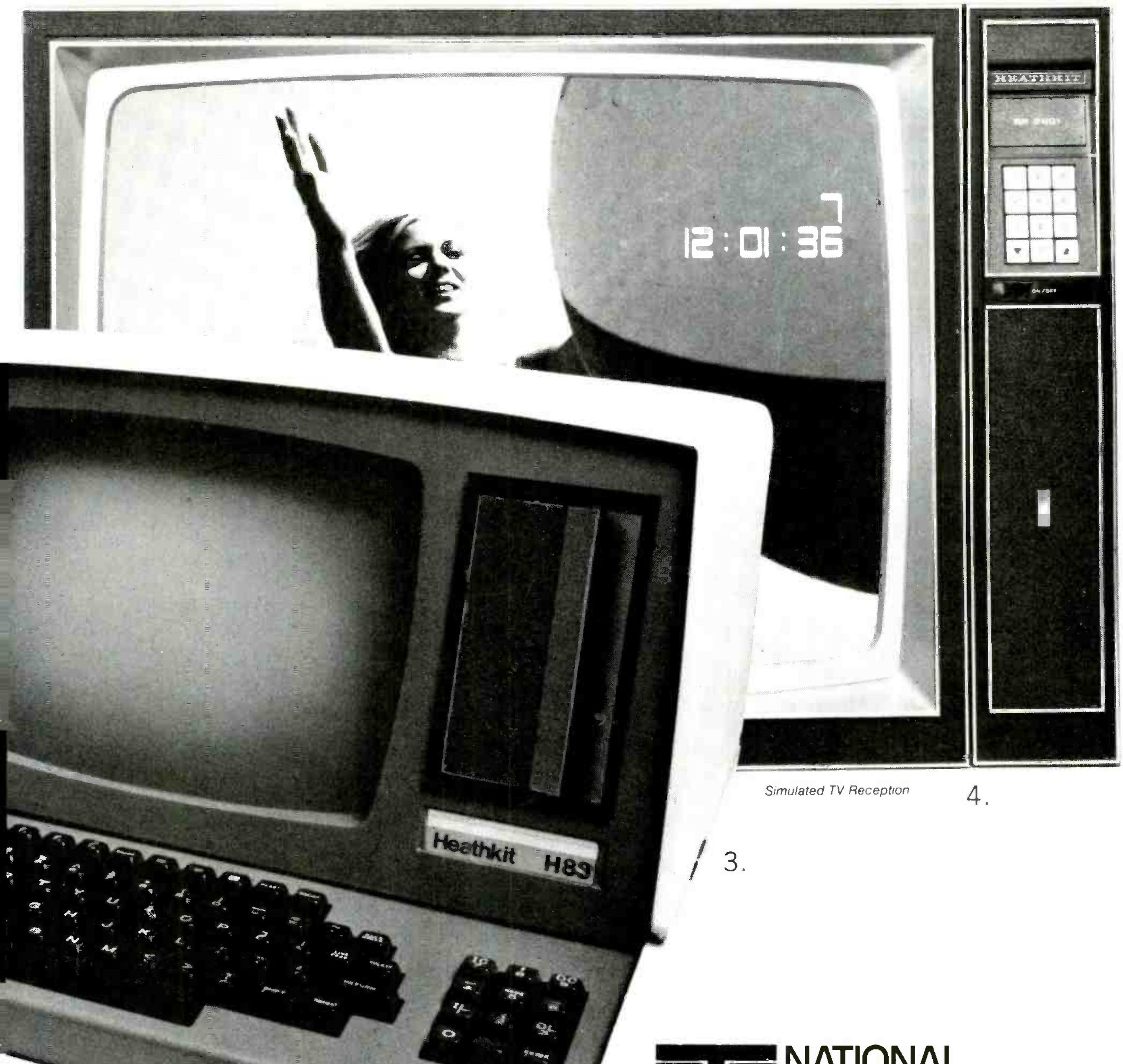


Simulated TV Reception

4.

3.

CHARGE TWO CAR BATTERIES AT ONCE

Speed charging time of batteries by doubling up on the circuit

BY CHARLES COHN

CHARGING two or more lead-acid batteries with one battery charger, while keeping them isolated from each other, can be a snap with the simple circuit modification described here. One of its uses is for recreational vehicles that have a main battery for starting and ignition and an auxiliary battery for accessories. These batteries are isolated from each other so that overuse of accessories while the engine is off will not run down the starting battery and immobilize the vehicle.

Circuit Operation. Figure 1 shows a simplified schematic of a commercially available "automatic" battery charger (the type that can be left permanently connected to a battery without danger of overcharging). A transformer and rectifier feed rectified ac to the battery through a silicon controlled rectifier (SCR). A recreational vehicle usually has a power converter that charges the auxiliary battery when line power is available. The converter works in much the same way as the battery charger. However, in some converters, the SCR anode is connected directly to one side of the power transformer.

In the battery charger, the control circuit senses the battery voltage. If that voltage is below a preset point (*e.g.* 13.4 volts), the circuit turns on the SCR. The SCR, in turn, passes current to the battery. When the battery is fully charged, its voltage rises above the preset point and the SCR is *not* gated on. Recall that the gate of an SCR can turn it on but cannot turn it off. However, SCR turnoff is guaranteed in this circuit because of the absence of a filter capacitor following the rectifier. Without filtering, the rectifier output drops to zero every half cycle, turning off the SCR. When self-discharge, electrolyte diffusion, or loading pulls the battery voltage below the preset point, the charger turns on again—just long enough to bring the voltage back up. Thus, the battery floats at full charge.

Construction. Figure 2 shows how to modify the battery charger to charge two batteries at once. Break the connections between the SCR cathode, the output, and the voltage sensing lead. Connect a diode between the SCR cathode and each battery, with the diode cathode going to the battery. You can use a lug terminal strip to make connections. Select diodes that have a current rating at least equal to the maximum output of the charger.

Connect the voltage sensing lead to one of the batteries. It's best to connect it to the battery that is most likely to need charging, for example, the auxiliary battery on a recreational vehicle. The other battery will follow. If the second battery has a higher state of charge than the controlled battery, the diodes will steer the charging current away from it. If it is lower than the controlled battery, the diodes will steer the current into it. The charger will not shut off until the controlled battery comes to full charge. That won't happen until the other battery comes up enough to allow current to be steered to the controlled battery. Self-discharge will always bring the controlled battery down enough to turn on the charger.

If your recreational vehicle has a solid-state battery isolator, you don't need the diodes. Simply connect the SCR cathode to the center terminal of the isolator, the one to which the alternator connects.

If you don't want to use individual diodes, you can use a bridge rectifier assembly with the appropriate current rating, as shown in Fig. 3. Here, two of the diodes are active, while the other two are in series opposing and do nothing. This circuit has been used with a Heathkit GP-21 10-A battery charger installed in a camper van and it works very well. ◇

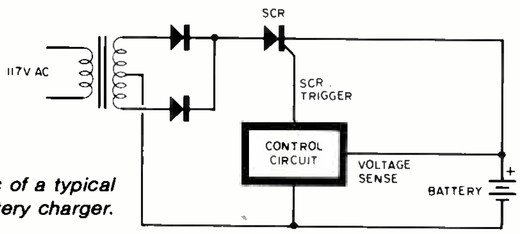


Fig. 1. Simplified schematic of a typical commercial "automatic" battery charger.

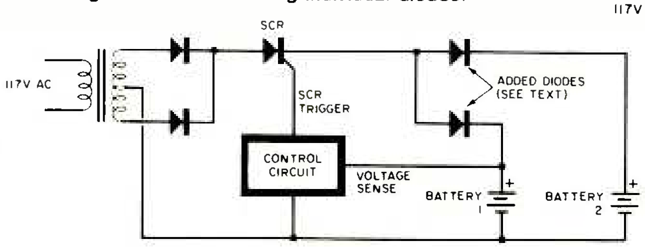


Fig. 2. Modification of the battery charger to charge two batteries using individual diodes.

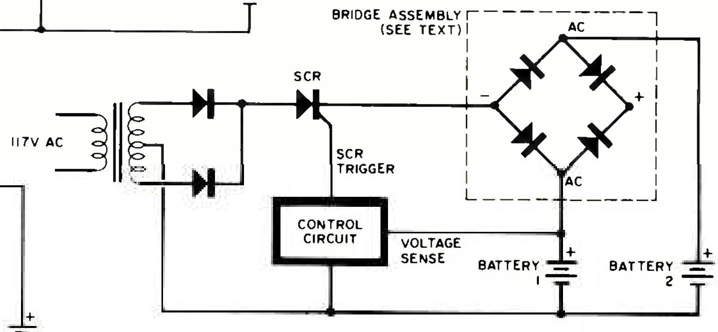


Fig. 3. The charger circuit can also be modified by adding a bridge rectifier assembly.

78-RPM RECORDS LIVE AGAIN!

Easy-to-make turntable modifications allow you to play all your old collector records

BY RAYMOND BINTLIFF

THE collector of 78-rpm records is faced with a problem when purchasing a new turntable. Only a few of them provide 78-rpm operation today: inexpensive record changers or variable-speed audiophile units priced beyond the average pocketbook.

This problem can be solved by modifying an otherwise satisfactory two-speed turntable. Belt-driven platters require a mechanical change, while direct-drive designs need electrical modification. The mechanical approach requires machine-shop facilities and precision workmanship. But an electrical conversion is relatively simple and easily implemented, as presented here.

The Technics SL-D1 direct-drive turntable is used as an example of how such a unit may easily be converted to 78-rpm operation. (The same change can be made to the Technics SL-D2, SL-D3 and SL-D5.) To keep the conversion simple, that portion of the speed control circuit used for 45-rpm operation was modified. This approach sacrifices the 45-rpm capability but avoids the addition of a switch and subsequent defacement of the turntable chassis.

A brief look at how the Technics SL-

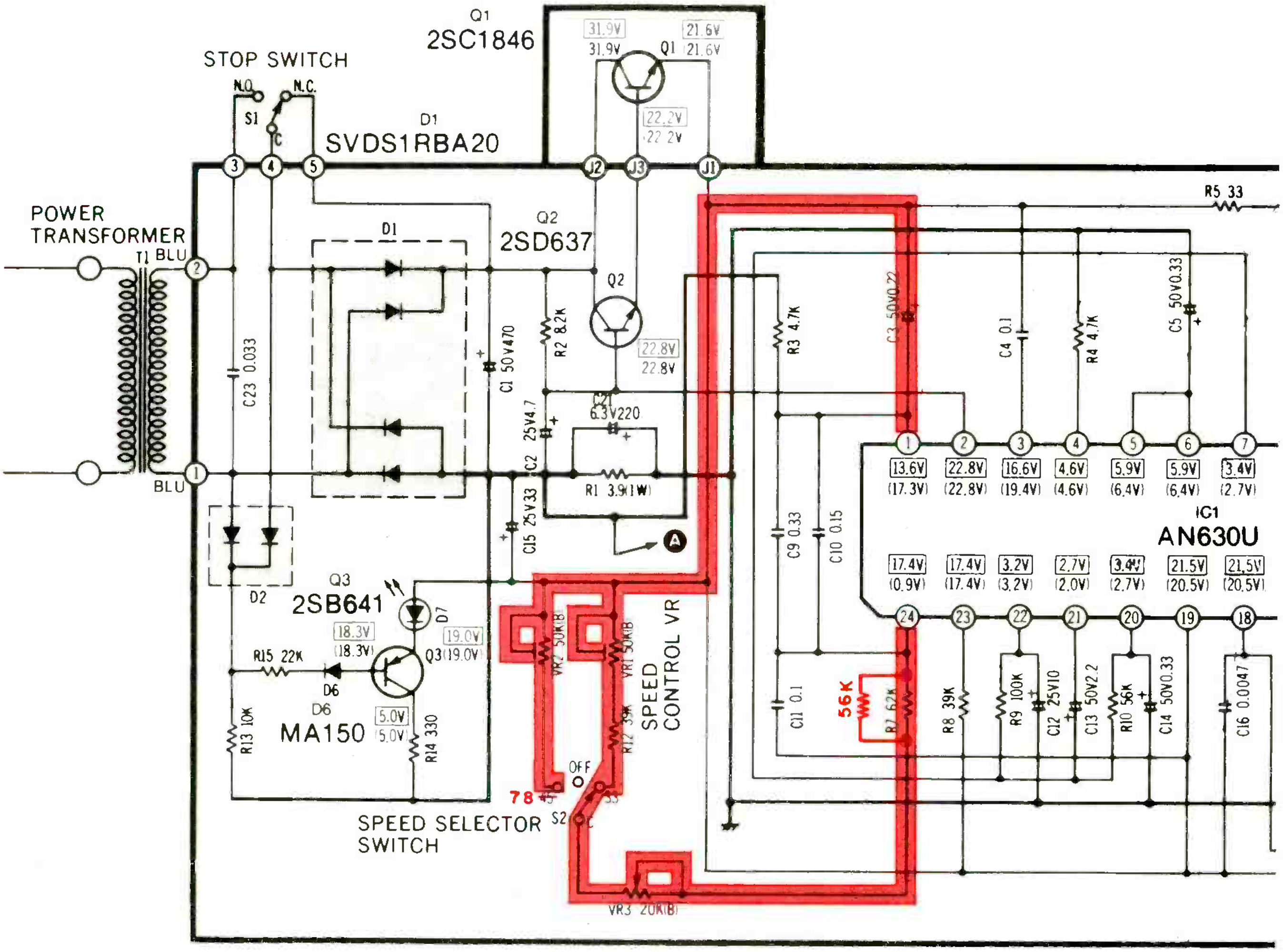


Fig. 1. Portion of speed-control circuit of the SL-D1 with new 56-kilohm resistor added for 78 rpm.

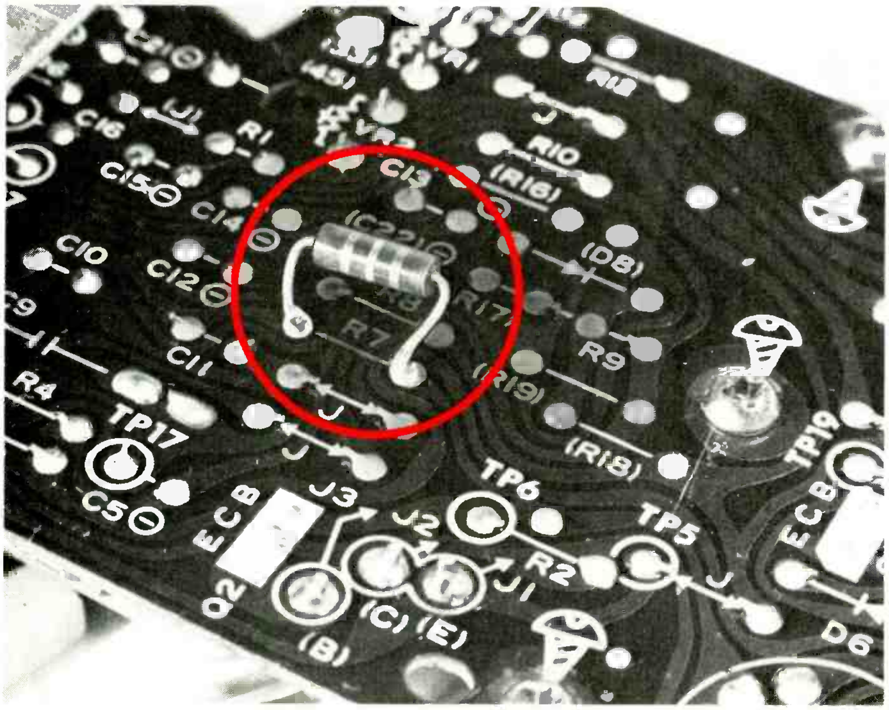


Fig. 2. Detail of pc board with addition of new resistor.

D1 direct-drive turntable operates shows why a simple modification can be effected. There are two sets of coils within the turntable platter assembly. One set applies torque to the platter, while another set generates a position signal with a frequency directly related to platter speed.

The position signal is compared to a reference frequency by a custom IC within the turntable chassis. Current to the drive coils is automatically adjusted until the reference frequency and the position signal "lock" together. A dc feedback path external to the IC is part of the circuit that determines the reference frequency. Different resistances are switched in and out of this feedback path, providing the desired two-speed turntable operation.

The schematic in Fig. 1 shows the SL-D1 speed-control circuit, including the additional 56-kilohm resistor which permits turntable operation at 78 rpm. Both *S2* and *VR3* are front-panel controls. Switch *S2* is the SPEED selector and potentiometer *VR3* is the PITCH ADJUSTMENT. Potentiometers *VR1* and *VR2* are screwdriver adjustments that trim turntable speed. They are located under the turntable platter. To obtain operation at 78 rpm, a 56-kilohm resistor is added in parallel with *R7*. The position of *R7* is clearly marked on the SL-D1's printed circuit board.

Prepare the turntable for modification by making certain that its line cord is disconnected. Then lock the tonearm in place with the arm clamp and remove the mat and turntable platter. With the dust cover in place, carefully invert the unit. Use cloth or newspapers to protect the dust cover from scratches.

(Place a small piece of masking tape on the rim of the platter as a counting aid). Turn *VR2* counterclockwise until an approximate speed of 78 rpm is obtained. (When the turntable is fully assembled, *VR2* is accessible through either of the two holes in the platter).

With the speed approximately set, place a stroboscope disc on the turntable and adjust *VR2* for exactly 78 rpm. Now place the SPEED switch at "33" and adjust *VR1* (again use platter access holes) for correct speed (marks on the turntable rim serve as a strobe). Replace the mat, and the turntable unit is ready for use. The unit will "spin-up" to 78 rpm in just under three revolutions.

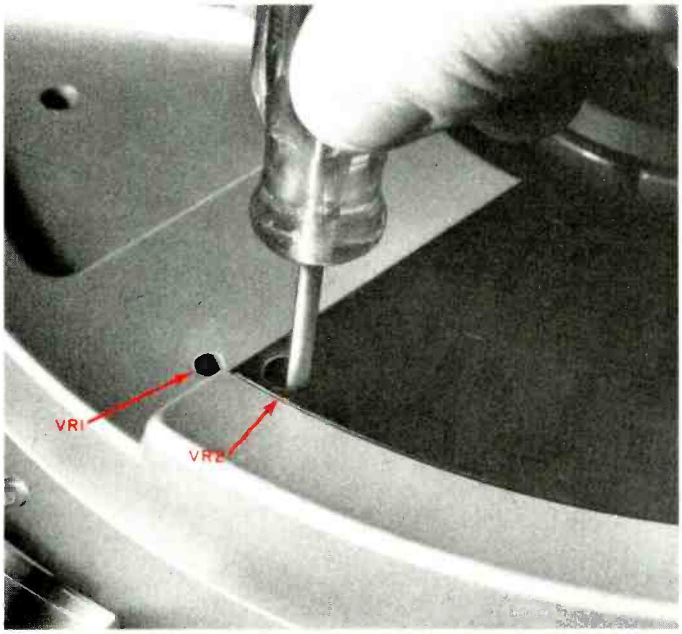


Fig. 3. Potentiometers VR1 and VR2 can be adjusted with a screwdriver through access holes underneath the turntable platter.

Now remove the seven screws which retain the isolators (bottom feet) and the bottom cover. (The front and rear isolators use different springs. During reassembly be certain to install the isolators in their correct positions.) Detach the bottom cover and four isolators.

Next, locate resistor *R7* on the printed circuit board (Fig. 2) and solder a 56-kilohm resistor in parallel with it. Do not use excessive heat.

Finally, replace the bottom cover and isolators, install the seven mounting screws, and return the unit to its upright position. Speed adjustments must now be performed before the modified turntable is ready for use.

First, turn *VR2* to the maximum clockwise position (Fig. 3) and replace the turntable platter. Then plug in the line cord and place the turntable's SPEED switch in the "45" position. Reidentify this position as "78" with Presstype numerics and set *VR3* at its midposition.

Now turn on the unit and count the number of revolutions per minute.

The turntable must be shut off when adjustment is made to *VR1* or *VR2*. Do not leave the power on and stop the platter by hand to make these speed adjustments. Correct speed adjustment is a trial-and-error process. Potentiometers *VR1* and *VR2* can also be adjusted from beneath the unit when the bottom cover is removed.

If correct speed cannot be obtained within the range of either *VR1* or *VR2*, a slight offset from midpoint may be necessary for *VR3*. Returning the turntable to 33 rpm/45 rpm operation is easily accomplished by removing the 56-kilohm resistor and readjusting *VR1* and *VR2*.

A modified SL-D1 turntable has been operated satisfactorily by the author for one year. To date, there has been no evidence of excessive heat dissipation or mechanical wear. However, it should be remembered that the manufacturer's warranty does not apply to user-modified products. ◇

BUILD A RESISTANCE-CAPACITANCE SUBSTITUTION BOX

Provides resistances from 0.5 ohm to 20 megohms and capacitances from 5000 pF to 2 μF

BY CASS LEWART

THE resistance-capacitance substitution box is a simple, yet useful, piece of test equipment. It provides a wide range of resistance and capacitance values that you can select quickly and easily.

The substitution box described here uses two multi-position rotary switches and 22 resistors and capacitors. It substitutes for a wide range of resistors, from ½ Ω to 20 MΩ, and capacitors, from 5000 pF to 2 μF. A 12-position switch selects 1 Ω, 10 Ω, 100 Ω, 1 kΩ, 10 kΩ, 100 kΩ, 1 MΩ, 10 MΩ, 0.01 μF, 0.1 μF, 1.0 μF, or an open circuit. A 3-position switch multiplies the reading on the 12-position switch by ½, 1 or 2. For finer resolution you can build two of these boxes and connect them together. Also, you can use two boxes to substitute for components in series or parallel RC networks.

Circuit Operation. Figure 1 is a schematic of the circuit. One set of eight resistors and three capacitors is connected between sections *S1A* and *S1C* of the 12-position switch, *S1*. A second identical set of components is between *S1B* and *S1D*. The 3-position switch, *S2*, is used to connect the two sets of resistors/capacitors in series or parallel, or select the first set alone. Depending on the positions of the two switches, you can select thirty-three resistor/capacitor values or an open circuit.

Construction. Multiple-section rotary switches are generally available from industrial distributors and many surplus suppliers. Set switch *S1* for 12 positions by removing the index pointer. Set the pointer on switch *S2* for 3 positions. Mount all components on a small board or directly on *S1*. To facilitate mounting of components directly on the switch, disassemble *S1* and turn sections *S1B* and *S1D* by 180 degrees. By doing this, the two sets of capacitors and resistors can be mounted on opposite sides of the switch providing for a neat layout. Both switches should be wired before being mounted in the cabinet. Select proper wattage and voltage ratings for all components depending on the intended use for the substitution box. Use only nonpolarized capacitors. Use a plastic cabinet or an insulated metal box to protect yourself against shocks from short circuits. ◇

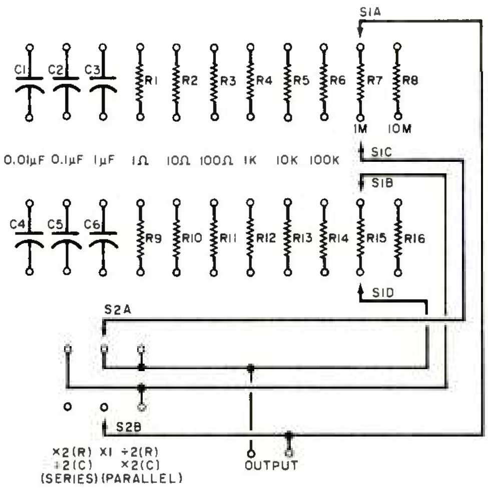
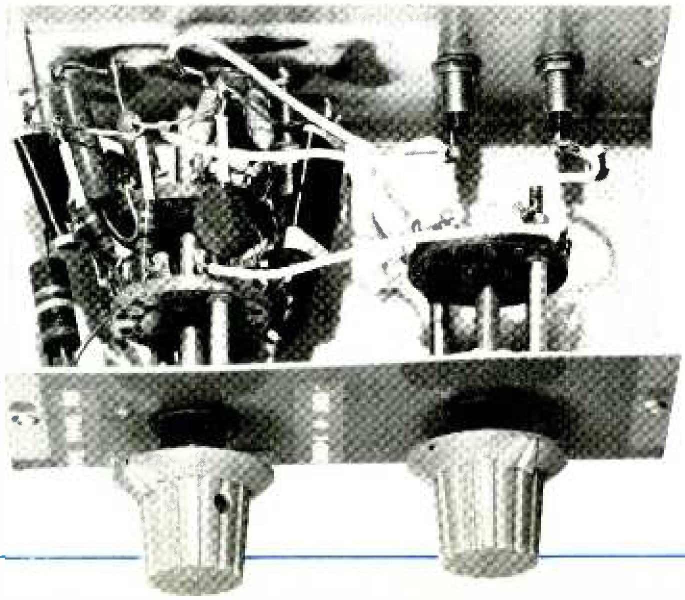


Fig. 1. Schematic of circuit shows how a set of eight resistors and three capacitors is used to provide a wide range of substitution values.



PARTS LIST

C1,C4—0.01-μF capacitor
C2,C5—0.1-μF capacitor
C3,C6—1.0-μF capacitor
R1,R9—1-Ω resistor
R2,R10—10-Ω resistor
R3,R11—100-Ω resistor
R4,R12—1-kΩ resistor
R5,R13—10-kΩ resistor
R6,R14—100-kΩ resistor
R7,R15—1-MΩ resistor
R8,R16—10-MΩ resistor
S1—1-pole per section, 4-section, 2-12-position rotary switch (OAK G-725550 or equivalent)
S2—2-pole, 1-section, 2-6-position rotary switch, (OAK G-725551-2 or equivalent).

ELIMINATE DATA LOSS IN YOUR TRS-80 COMPUTER

A simple circuit addition, usable with any microcomputer, will help prevent outages due to line disturbances

BY ROBERT E. WILSON

THE WORST computer headaches typically involve an unexpected breakdown or random bit errors with no apparent cause. An examination of the hardware may reveal one or more inoperative ICs. It may also show that everything is in good working order; but some (though not all) of the time, data does not flow properly between the system and the cassette or disk.

In most cases, damaged ICs are the result of very high voltage spikes (from air conditioner, refrigerator, or washing machine motors, for example) on the power line. And data flow can be disturbed by electrical "hash" from nearby fluorescent lamps or light dimmers—also coupled through the power line.

If you have had either of these problems or if you want to avoid them, you should add a power line filter/surge arrester to your system. Although designed for the TRS-80, the approach described here can be used with any other microcomputer system.

In the case of the TRS-80, extra outlets are added to the video monitor for the keyboard power supply and cassette player so that only one power cord (the one from the monitor) needs to be plugged into the wall outlet. Triple taps and extension cords aren't needed when this modification is made. The video monitor power switch controls the entire system; the keyboard power switch (beside the cable entrance) will no longer be needed; and there will be no idling currents in either the cassette player or keyboard power transformers.

The modification adds an r-f filter, a varistor surge arrestor, and a pair of power outlets to the video monitor for less than $8. The complete circuit, shown in Fig. 1, complements the fuse and switch already in the video monitor. Power switch *S101* is rated at 5 A (600 W), and the fuse *F101* is 1 A (120 W).

A Level II 16K-byte system requires 93 W total, including the cassette player. Replacing fuse *F101* with a 2-A type provides up to 240 W, with no change in safety. Adding the filter and varistor provides two stages of protection for the computer.

Although opening the video monitor cabinet will void the warranty, the modification does not affect monitor operation in any way. The filter surge arrestor fits into an empty space, well away from any critical signal areas, and produces no heat. The video monitor cabinet back remains completely removable for servicing.

Modification. The changes needed are straightforward and are most easily performed in three stages.

First, cut around the bottom panel of the filter with a sharp knife to break the glue line and expose the interior components. Unsolder the input power cord and plug, and set aside for later use. Solder about 12 inches of line cord to the same terminals, then solder the varistor to the terminal pins of the output (socket) connector. At this point, the filter assembly should look like Fig. 2. Fit the new line cord through the slot in the plastic (styrene) enclosure, and glue the bottom panel back in place. Any general-purpose cement will do, but the type used for building plastic models is ideal for styrene.

Next, remove the five screws securing the back panel of the video monitor (there is no seal, such as is on the keyboard unit) with a ¼-in. socket wrench, and lift off the panel. As shown in Fig. 3, the new power outlets will be located on the left-hand side (looking from the inside) of the rear panel about 4 to 6 inches up from the bottom. This is an empty area within the monitor, and the exact location is

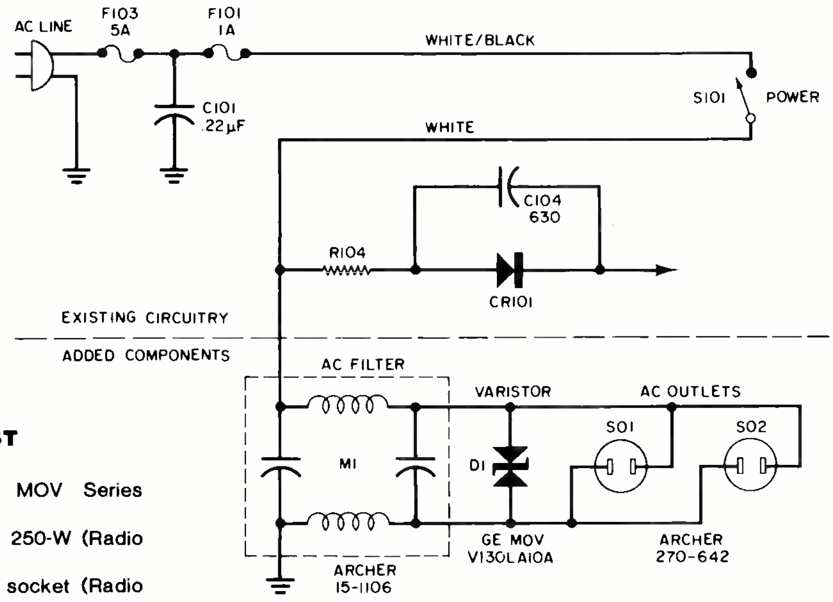


Fig. 1. Schematic of the circuit to be added to the fuse and switch already in the video monitor.

PARTS LIST

D1—Varistor diode (GE MOV Series V130LA10A)
M1—R-f interference filter, 250-W (Radio Shack 15-1106)
SO1,SO2—Chassis-mount socket (Radio Shack 270-642)
Misc.—Twin-lead lamp cord (12″), Styrene cement (modeler's glue)

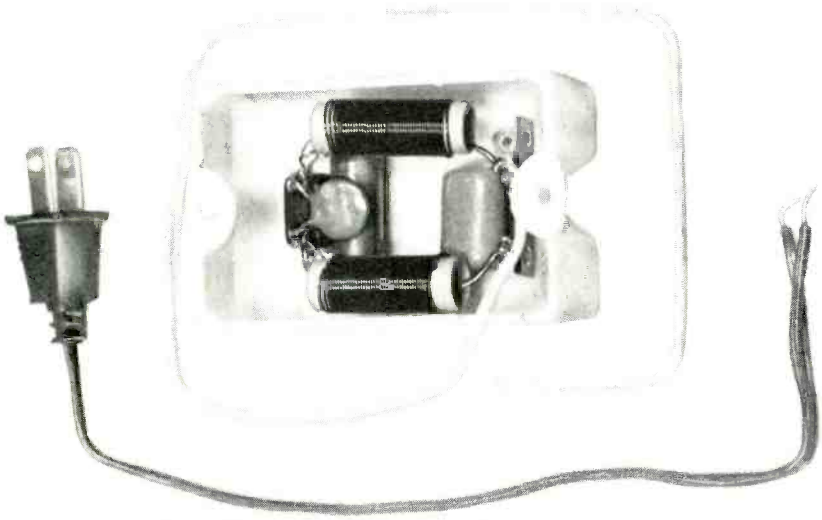


Fig. 2. The opened filter with new line cord attached.

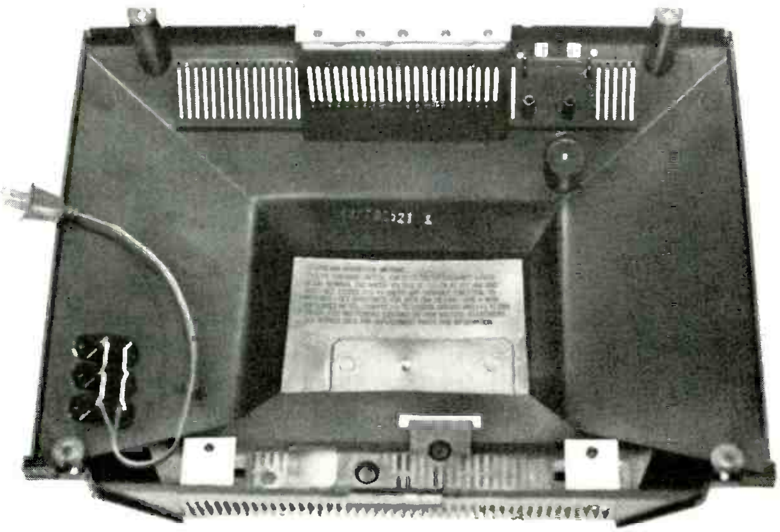


Fig. 3. Inside of the back panel with new power outlets.

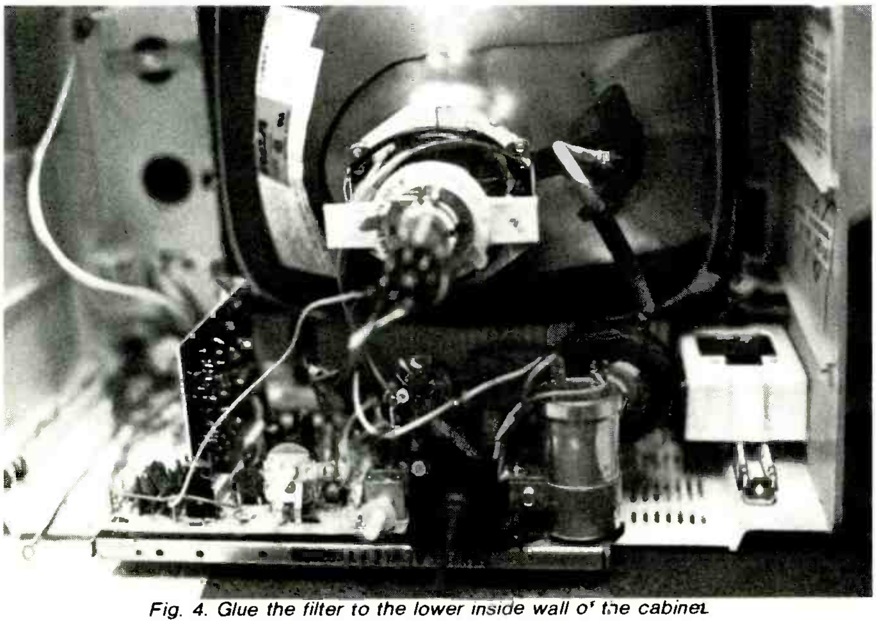


Fig. 4. Glue the filter to the lower inside wall of the cabinet.

not critical. Mark and cut the holes for the outlets. This is most easily done by first drilling a series of small holes around a marked line, then trimming the hole to proper size and shape using a sharp knife. Mount the outlets with suitable hardware, wire them together in parallel, then attach the cord and plug that was salvaged from the original filter. At this point, the back panel assembly should look like Fig. 3. The final step is to type a paper label saying:

SWITCHED POWER
80 WATTS MAX

and lacquer it onto the outside of the panel near the new outlets.

The last step is to install the modified filter in the video monitor. With the cabinet back off, the main chassis printed circuit board will slide out a few inches to make tracing of the wire easier. Follow along from the power cord through the fuse(s), to a white wire with black stripe, that goes up to the power switch, and finally to a solid white wire that returns from the power switch to a terminal strip at the front of the circuit board.

Solder one of the filter power inlet leads to this terminal, and solder the other lead to the center terminal on the same strip that extends down to the chassis plate. Slide the chassis back into the cabinet. Glue the filter assembly to the side of the monitor cabinet while sliding it down against the bottom of the cabinet for extra support, as shown in Fig. 4.

This mounting position is out of the way, yet sturdy enough to take any abuse that the cabinet as a whole can take. After the glue has set, the new outlet cord from the back panel sockets can be plugged into the filter outlet, and the back panel reinstalled on the monitor cabinet, completing the modification.

Plug the keyboard power supply and the cassette player into the new outlets on the back of the video monitor, and plug the video monitor line cord into a wall outlet. Turn on the keyboard power switch near the cable entrance at the back and forget it—you won't need it again. Now turn on the monitor. After a short warm-up delay, the beginning messages should appear on the monitor, and the system is off and running.

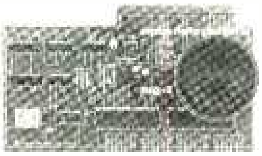
To test the new filter's effectiveness, a particularly noisy fluorescent desk lamp was plugged into the same wall outlet as the computer, and switched on and off repeatedly during a CLOAD. Although flickering appeared all over the monitor screen, the computer never dropped a bit. ◇

COMPUTER SOURCES

By Leslie Solomon
Technical Director

Hardware

Heath Sound Effects. The PSGx2 uses two GI AY3-8910 Programmable Sound Generator chips to produce a wide variety of sound effects when plugged into P504/P505 of the H89



buss. The PSGx4 uses four similar chips and plugs directly into the H8 buss. Each board comes with a speaker, a built-in audio monitor, and uses a crystal time base. PSGx2 is $125, PSGx4 is $225. The MICRO-PIANO 2.0 software can play up to 6-note polyphony over an 8-octave range, and features a graphic screen editor. $24.95. **Address**: Mako Data Products, 1441-B N. Red Gum, Anaheim, CA 92806 (Tel: 714-632-8583).

6-MHz CPU Card. The CP600 Central Processor Card uses a 6-MHz, Z80 CPU and conforms to the IEEE 696 Standard for S-100. Two on-board ports extend memory addressing to 24 bits and I/O addressing to 16 bits. This allows 16 megabytes of RAM and 65K of system I/O. RAM refresh is standard S-100 memory read cycle, and all 8 lower address bits are used for refresh to accommodate 64K RAM devices. A refresh localizer allows intensified parity checking in the area of currently executing programs. All bus cycles are three "T" times long, including refresh cycle. A crystal-controlled clock, jumper-selectable on-board memory and I/O wait states, as well as an on-board EPROM wait are provided. Ready signals are evaluated on rising edge of PHI during BS2, per IEEE 696. $550. **Address:** Echo Communications Corp., 1708 Stierlin Rd., Mountain View, CA 94043 (Tel: 415-969-6086).

Memory Management. The Memory Master 1.0 for the Apple II with Apple DOS 3.3 provides 44K-bytes of storage within the 48K on the Apple motherboard by relocating the DOS to any of the four 16K banks on the 64KC card. It will also manage Integer/Applesoft firmware, and can be used with any 16K RAM card similar in function to the Apple Language Card. An additional 8.5K of RAM is released on the Apple motherboard, each disk CATALOG displays unused sectors on diskette, machine-language programs can access the DOS RWTS routines through standard DOS page 3 vectors ($3DO through #3EC) and no additional page-3 space is used. The .FLIP command allows user to flip between DOS 3.3 and 3.2 without rebooting, the .STAT command displays DOS version in use, and the .BSTAT command displays the hex starting address and length of last binary file either Bloaded or BR,UN. **Address:** Great Lakes Digital Resources, POB 32133, Detroit, MI 48232 (Tel: 313-538-7963).

5M-Byte System. The LS525 uses a Seagate ST506 5¼-inch Winchester drive, LDOS, linear power supply, and an LSI-500 Series controller. All TRS-80 user programs currently running under TRSDOS or NEWDOS will run under LDOS. A separate off-board Host Adapter allows the LS525 to be cross-connected to almost any CPU and bus. Up to three additional Winchesters can be added with no software modifications. Size is 13.5″ deep, 12″ wide, and 5¼″ high. $3750. **Address:** Laredo Systems Inc., 2264 Calle de Luna, Santa Clara, CA 95050 (Tel: 408-980-1888).

PC-8001 Expansion. The PC-Multi Card replaces the PC-8012A Modular Expansion Unit to provide disk I/O and an additional 32K of RAM. While providing 64K of RAM for CP/M, a patch is provided for another 8K of RAM available to NBASIC in ROM. Power is supplied from the PC-8001A. $375. **Address**: Astar International Co., 5676 Francis Ave., Chino, CA 91710 (Tel: 714-627-9887).

128K For Apple. The 128KDE Soft Disk can be installed in any slot and can be accessed via DOS 3.3 as if it were an actual floppy disk. It is as much as 300% faster than an Apple Disk II. The software supports up to three 128KDE cards. By switching eight 16K banks over the existing ROM space, the Soft Disk triples the RAM capacity. $750. **Address**: Great Lakes Digital Resources, Box 32-133, Detroit, MI 48232 (Tel: 313-538-7963).

VIP Memory. The GJK 8K RAM card allows expanding the RCA VIP computer to full (32K) capacity. Each 4K block is separately addressable, and requires 600-mA from the 5-volt line. Bare board is $49, assembled is $149. **Address**: G.J. Krizek, 722 N. Morada Ave., West Covina, CA 91790.

TRS-80 Music. Orchestra-85 features music synthesis and percussion with stereo separation by instrument. The software supports five-part harmony for use with 2.66, 3.54, and 4.0-MHz

clocks. There is a full-screen editor and it will handle Orchestra-80 files. Plugs into any 16K TRS-80 Model I Level II keyboard or expansion interface without voiding warrantee. No external power supply is required. $129.95 plus $2 shipping. **Address**: Software Affair, 858 Rubis Drive, Sunnyvale, CA 94087 (Tel: 408-295-9195).

Heath Disk Systems. The high-density Z-37 disk drive uses a pair of drives to increase storage capacity to 1.3 million bytes (640,000 bytes per diskette) by doubling the number of tracks and using both sides of a diskette. Thus, 160 tracks are used versus 40 tracks in conventional drives. The drive can use CP/M or HDOS. $1995. The double-density disk controller card Z-89-37 increases the capacity of conventional 5¼" drives from 100K-bytes to 160K-bytes. It uses soft-sectored diskettes. $395. **Address**: Zenith Data Systems, 1000 Milwaukee Ave., Glenview, IL 60025 (Tel: 312-391-8181).

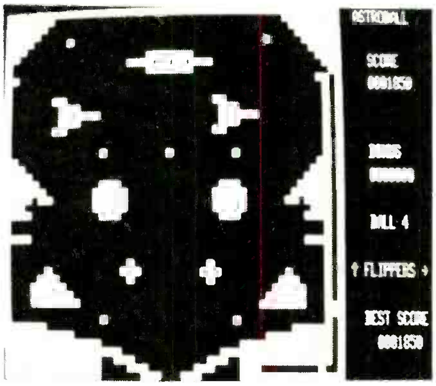
Software

FORTH Modules. This package contains hundreds of FORTH definitions not previously published. Included are data structures, software development aids, string manipulators, expanded 32-bit vocabulary, screen calculator, typing practice, and a menu-generation/selection program. The diskette provides examples of recursion (BUILDS..DOES), output number formatting, assembler definitions, and conversational programs. One hundred screens of software and one hundred screens of instructional documentation are supplied. These screens may be used with Timin

FORTH or other FIG FORTH. $75 for 8″ diskette ($15 added for other sizes). **Address:** Timin Engineering Co., 9575 Genesee Ave., Suite E-2, San Diego, CA 92121 (Tel: 714-455-9008).

Tax Planning. The Individual Tax Plan is designed for professional tax practitioners and allows isolation of tax effects attributable to changes in one or more items of income/expense. It then performs comprehensive tax planning calculations. Automatic computations include federal tax liability using appropriate tax tables and rate schedules, income averaging, and maximum tax on earned income with selection of lowest tax due; add-on minimum and alternative minimum tax; 10-year averaging for lump-sum distributions; charitable contribution, medical expense, capital loss limitations and capital gain deductions. Results are displayed on screen or printer. Requires Apple II (48K) or Western Digital Microengine. **Address:** Aardvark Software Inc., 783 North Water St., Milwaukee, WI 53202 (Tel: 414-289-9988).

TRS-80 Pinball. "Astroball" is a machine-language pinball game for the TRS-80 Model I and Model II featuring



high-resolution graphics and sound. It features space craft, flying saucers, and black holes. Cassette or diskette. $19.95 plus $2 shipping/handling. **Address:** Acorn Softward Products, Inc., 634 N. Carolina Ave., S.E., Washington, DC 20003 (Tel: 202-544-4259).

Model III CP/M. Shuffleboard III allows a TRS-80 Model III to operate with 64K CP/M. It comes with 16K of RAM and 2K of ROM (expandable to 8K). It allows the Model III to have 88K of memory. It includes Maxi-Disk CP/M 2.2 having full support for single/double density 5″ drives. The CP/M enhances the keyboard and screen as the keyboard can directly generate all 128 ASCII characters including CP/M control characters. The screen can display 255 characters including the 96 printable ASCII characters, Greek and Japanese letters, and scientific symbols. It can also handle nondestructive cursor moves and direct cursor addressing. Plugs into existing sockets. $495 includes RAM, ROM, CP/M 2.2, and seven CP/M manuals. **Address:** Parasitic Engineering Inc., 1101 Ninth Ave., Oakland, CA 94606 (Tel: 415-839-2636).

Medical Newsletter. The Micro Medical Newsletter provides advice on the use and selection of applications for microcomputers in the medical office. Free to practicing physicians and health professionals when requested on office stationery. **Address:** Charles Mann & Associates, Micro Medical Newsletter, 7594 San Remo Trail, Yucca Valley, CA 92284.

Heath Morse Code. The CW89 features a split-screen display, 4 to 99 wpm operation, receive autotrack, 1000 character pretype buffer, 10 user-definable messages, break-in mode, on-screen system status, disk I/O, hard copy and a code-practice section. It runs on a Heath H-8/H-19, H-89/Z-89 under HDOS.

One disk drive and 32K RAM are required. A hardware interface such as Commsoft Codem is required. $99.95. Complete package including Codem, cable, power supply, and complete documentation is $249.95. **Address:** Commsoft, 665 Maybell Ave., Palo Alto, CA 94306 (Tel: 415-493-2184).

TRS-80 Information. This package expands the usefulness of H.C. Pennington's "TRS-80 Disk and Other Mysteries" book. It includes procedures for disassembling system files, disassembled boot loaders with comments, and popular methods of rendering diskettes difficult to copy. It also includes a utility for viewing a file's device control block. Diskette is $17.95 plus $2 postage. **Address:** Applied Software, 4316 Vermont Ct., Virginia Beach, VA 23456.

Supercalc for CP/M. The spreadsheet software package Supercalc is available in 5¼" and 8" formats for the Apple CP/M, Xerox 820, North Star, Superbrain, Micropolis, Zenith, Osborne, and Vector Graphics machines. Features include merging several sheets into one, an extensive help command to guide the user, automatic formatting of printed reports, and ability to examine all formulas contained in the worksheet. $295 including user guide, reference card, and install program for over 25 terminals. **Address:** Sorcim Corp., 405 Aldo Ave., Santa Clara, CA 95050 (Tel: 408-727-7634).

Scope to Computer. The Nicolet/85 program transfers 4096 sampled data points from a Nicolet Digital Oscilloscope to a Hewlett-Packard HP-85 in 1.3 seconds. Once transferred, the user can PLOT the waveform on the CRT or plotter, STORE the waveform on tape or diskette, LOAD a previously stored waveform, TRANSMIT a waveform from the HP-85 to the Nicolet, FORMAT the data points for the HP-85 waveform analysis package, and store formatted data on tape or diskette. $150. **Address:** Tensegrity Inc., 2424 W. Addison St., Chicago, IL 60618 (Tel: 312-935-8192).

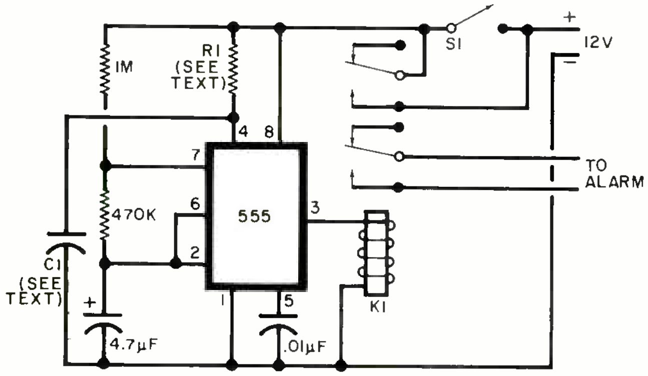
Graphics Printing. Designed for the Apple II, Apple II Plus with Apple soft ROM, 48K, DOS 3.3, and serial interface card, the Graphics Printing System allows printing of hi-res graphics on Diablo Model 1620 or 1640 and NEC Model 5510 or 5520. The program provides a wide variety of print sizes and formats, and any one or two ASCII characters can be used. Program operation is displayed on screen as printing proceeds. A MagicFrame utility provides for an on-screen selection of the area to be printed. $104.95 plus $4.95 postage/handling. **Address:** Progressive Software, Suite 323, Blue Bell West, Blue Bell, PA 19422 (Tel: 215-628-2383). ◇

TIPS & TECHNIQUES

Security System

I worked out this "universal security system" to protect a tool chest but it can be used for other applications. The basic idea is that opening the device to be protected will close switch *S1*. You then have a few seconds (determined by the time constant of *R1C1*) to turn off the alarm or it closes the relay, a dpdt type. The relay uses one set of contacts to latch *S1* shut and thereby hold the alarm on and the other set to operate whatever alarm device you choose. As long as the protected object is left violated the alarm will sound. If the intruder closes the door (or whatever), the alarm will continue to sound until the 555-timer interval (about 25 seconds) expires. The alarm then shuts off saving the battery, and rearming. The entrance delay will be completely restored when the charge leaks off *C1*. (Note: *K1* is a 1000-ohm, 8-mA sensitive dpdt type. A more sensitive relay will enable the device to work on a lower voltage.)

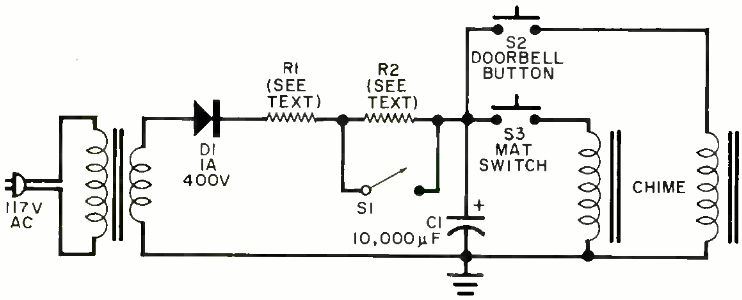
Components *R1* and *C1* will vary according to the voltage, the time delay desired from intrusion to alarm sounding and the peculiarities of your 555. The 12-V dc supply and a 3-second delay time take one megohm for *R1* and 470 μF for *C1* with my 555. Use an ordinary electrolytic because a very good cap will not leak off charge and restore the opening delay after an intrusion.—*H. Scott McCann, Annapolis, MD*



Avoid "Cooked" Solenoids

Every now and then I find someone who has a "cooked" solenoid in a door chime. Either the button stuck or the wiring malfunctioned causing excessive current and allowing things to overheat. Here is a circuit to avoid this sort of thing. I originally used it as an annunciator circuit under a mat at the entrance of my TV service shop.

The ac from the standard doorbell transformer is rectified by diode *D1*, and charges capacitor *C1* through resistor *R1*. Switch *S1* across *R2* is normally closed. Capacitor *C1* is relatively large, 10,000-μF, 25-V nominal value (whatever is available in surplus). Diode *D1* is a 1-A, 400-V diode, although the voltage rating doesn't have to be that high. Resistor *R1* is chosen by experiment to pick a time to allow the capacitor to charge between "pulses" or doorbell button operations. Pushing the button, *S2*, or stepping on the mat to close *S3* discharges the capacitor through the chime. Resistor *R2* can be made much higher in resistance than *R1* so the bell can operate only about once a minute.—*W. Waite, Wellington, OH*



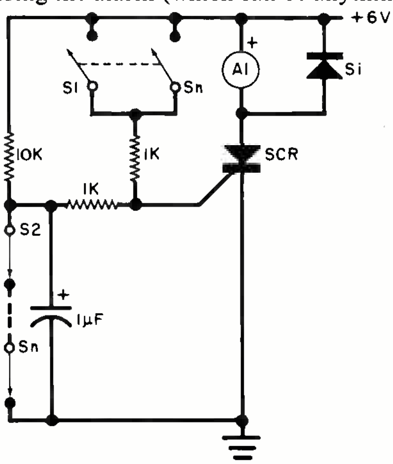
HOBBY SCENE

By Leslie Solomon
Technical Director

Simple Burglar Alarm

Q. ***All the intrusion alarms I have seen are very complicated. Isn't there a simple way to detect intruders without too much electronics?—Angelo Galante, Chicago, IL***

A. In many cases, the simpler the circuit, the more reliable the operation (William Occam, Occam's Razor). The circuit shown here is as fundamental as you can get and works every time. The trick is to get the SCR to fire thus energizing the alarm (which can be anything

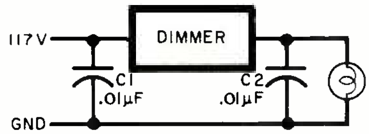


from a piezoelectric device to a Sonalert or even a light bulb). If any of the parallel-connected switches *S1* through *Sn* (any number) are closed or, if any of the series-connected switches *S2* through *Sn* (any number) are opened, the gate of the SCR is triggered and the alarm works. Reset is by opening the dc feed to the SCR.

Dimmer RFI Problems

Q. ***Please give me any information you can on how I can eliminate the hum in my AM radios caused by a dimmer control which is 100 feet away and not on the same circuit. This condition is most annoying yet I have friends who also have dimmers but do not have this problem.—Louis Halmy, Hollywood, CA***

A. Many light dimmers use a silicon controlled rectifier (SCR) in their circuits. The switching action of the SCR produces a waveform that contains high-frequency harmonics. It's this high-frequency component of the waveform that produces radio-frequency interference (RFI). The reason you hear the hum caused by the RFI on a radio that's not on the same line as the dimmer is that the RFI is *transmitted* to the receiver of the radio, thus it doesn't need the power

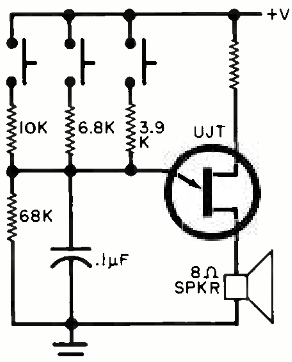


line. There are two possible reasons you're getting RFI and your friends aren't. First, you may have a faulty dimmer and second, you may have a dimmer without internal filtering. To solve the problem, either buy a better dimmer or else try connecting capacitors from external leads to ground on the dimmer you have as shown in the accompanying generalized diagram.

Three-Tone Bell.

Q. ***I need a simple electronic doorbell circuit that will produce a different tone for each of the front, side, and rear doors. Is there a simple way to do this? I do not want to spend a lot of money on a complex electronic device.—David Keelson, Dawson, CO.***

A. The most basic electronic doorbell is shown here. Although only three pushbuttons are shown, you can use more,



with each having a different series resistor. The value of the resistor determines the tone. If you want more volume, use a low-value resistor in place of the speaker and connect the upper end (and ground) to an audio amplifier.

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.

ELECTRONICS LIBRARY

Using Micro-Computers in Business

by Stanley S. Veit

Subtitled "A Guide for the Perplexed," this book addresses itself to the businessman with no specific interest in computers other than that they should help him run his operation more efficiently. The author does not discuss the practical operation of computers, i.e., program writing, which key to press, etc., but instead concentrates on elucidating, for the uninitiated, what computers do. Since the world of computing has evolved its own terminology, attention is given to rendering such expressions as "floppy disks," "menus," "word processing," "batch operation," etc. into plain English. The reader can then, presumably, understand a computer salesman and make an informed judgement about what he should or should not purchase.

Published by Hayden Book Company, 50 Essex St., Rochelle Park, NJ. 07662. Soft cover. 142 pages. $9.95.

Data Transmission

by Dogan Tugal and Osman Tugal

Addressing themselves to the issues associated with installing and upgrading data transmission systems, the authors focus on the usual range of problems in an operations center, and the limits and tolerances of various pieces of equipment. Attention is given to data security during transmission, voice-line measurements, noise-free communication, fiber optics, synchronization of digital data, multiplexing, satellite and ground-based transmission, and protocols. Also discussed are the international standards recommended by the CCITT.

Published by McGraw-Hill, 1271 Avenue of the Americas, N.Y., N.Y. 10020. Hard cover. 394 pages. $24.50.

Analog Instrumentation Fundamentals

by Vincent F. Leonard, Jr.

Analog instruments have not yet been wholly superseded by digital equipment. Many of them are still around; and there are some advantages they have over digital instruments, e.g., the observation of trends, and the measurement of voltage in a strong EM environment. This book provides an overview of analog instruments for those with a basic knowledge of electronics and some working experience with elementary algebra. Students and hobbyists should find it helpful because of its experimental approach: The familiar analog instruments (ammeters, ohmmeters, voltmeters) are explained in terms of experiments designed to give the reader, first hand, a sense of the instruments' capabilities and limitations.

Published by: Howard W. Sams, 9300 W. 62nd St., Indianapolis, IN 46268. Soft cover. 318 pages. $19.95.

Secrets of Ham Radio DXing

by Dave Ingram, K4TWJ

Written from a practical rather than a theoretical standpoint, this is a useful guide for anyone who wants to learn more about operating a ham radio. The focus of the book is on techniques for raising and maintaining distant radio contacts, i.e., methods for operating each of the amateur bands, from 160 meters through vhf; and various DX modes, from CW to TV. Techniques for setting-up antennas, amplifiers, audio filters, and the like are also discussed. You won't find much about how the hardware actually works, but the author compensates by providing lively and informative anecdotes from the world of DX talking.

Published by TAB Books, Inc., Monterey Ave., Blue Ridge Summit, PA 17214. Soft covers. 176 pages; $7.95.

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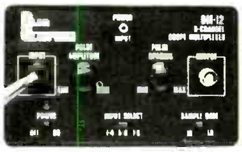

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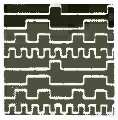

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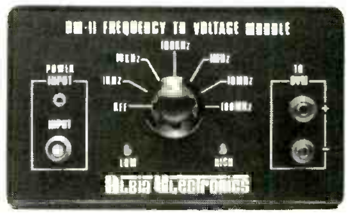

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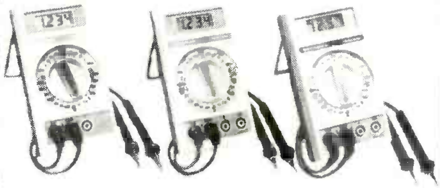

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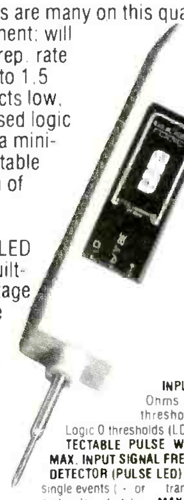

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SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

Mercury, Vacuum and Solid-State Pressure Sensors

THE legacy of Galileo extends beyond his discoveries of the laws of motion, for in 1643 one of his pupils, Evangelista Torricelli, invented the mercury barometer. Torricelli's barometer, which he invented at age thirty-five (just about the average age of readers of POPULAR ELECTRONICS), enabled him to make accurate measurements of atmospheric pressure. The barometer consisted of a glass tube that was sealed at one end, filled with mercury, and inverted with its open end immersed in a dish of mercury. The level of the mercury in the tube, typically some 30 inches at sea level, indicated the pressure of the atmosphere on the mercury in the dish.

Mercury barometers are expensive, big, and heavy, yet fragile. They have largely been replaced by *aneroid* barometers, which sense atmospheric pressure by means of an evacuated metal chamber formed like a flexible bellows or having a flexible surface. Changes in the external pressure cause the surface of the chamber to expand or contract. These changes are amplified by a mechanical linkage that, in turn, drives a pointer. The pointer moves over a scale calibrated in inches (or millimeters) of mercury.

Though aneroid barometers are much smaller, lighter, and cheaper than those that use mercury, their readings are not readily translated into electrical signals. For example, on my desk is an aneroid barometer taken from a balloon-launched radiosonde. Though the aneroid chamber is a relatively compact, disk-like bellows, 2.25 inches in diameter and less than 0.25 inch thick, the entire assembly is fairly large.

The large overall size of the unit is due to its mechanical nature. Converting the expansion of the bellows into suitable electrical signals that can be radioed to ground requires an aluminum frame that supports the bellows, a movable pointer-like stylus, and an intricate etched-circuit pattern on a rectangular board measuring 0.85 x 2 inches. The complete assembly is 2 x 3 x 4.5 inches and weighs about three ounces.

Many other mechanical pressure-sensing devices have been invented. For example, a spiral coil of hollow glass, quartz, or metal that is sealed at one end will slightly wind or unwind as the pressure of a gas or liquid in the tube is altered. This motion can be mechanically amplified and indicated by a simple pointer system attached to the innermost end of the spiral tube.

Solid-State Pressure Sensors. There will always be a role for simple, low-cost, mechanical pressure sensors. But today's move toward increasing automatic readout and control has stimulated the development of a new generation of solid-state pressure sensors. Many of these are so small that they can be incorporated into miniature packages similar to ICs, along with any necessary bridge and amplifier circuits. They provide a reasonably linear, or at least predictable, output signal.

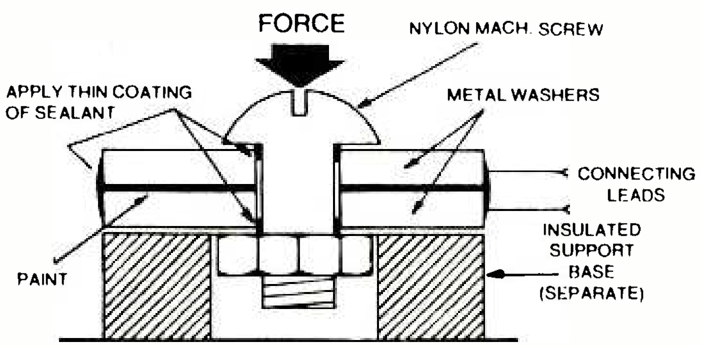


Fig. 1. A simple force transducer made with pressure sensitive paint between two metal washers.

Applications for the new generation of solid-state pressure sensors range from monitoring automobile engine parameters to detecting blood pressure. They can even be used to make miniature, solid-state barometers and altimeters.

Solid-state pressure sensors are not necessarily semiconductor devices. For example, ELAB Microducers, Inc. (3178 Pullman St., Costa Mesa, CA 92626) makes a pressure-sensitive *paint* that can be used to make very simple, reliable, and cheap pressure-sensing cells. Figure 1, for example, shows a typical low-cost pressure cell made from ordinary hardware and a drop of *Microducer Pressure Sensitive Paint.* A cell like this can detect a pressure load of a small fraction of an ounce. Figure 2 is an ELAB plot showing no-load to full-load resistance of a typical cell.

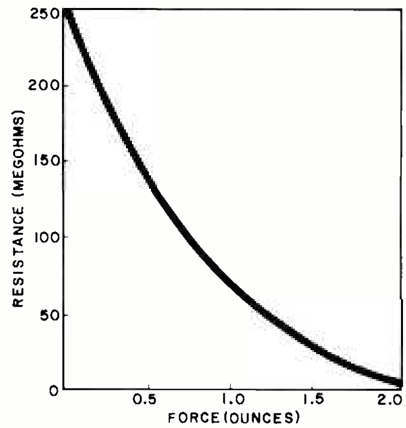


Fig. 2. Force/resistance curve of a cell such as shown in Fig. 1.

Pressure-sensitive paint can be used to make simple potentiometers, bracelet-style pulse sensors, pressure-sensitive cloth, and magnet switches. Though the cost of individual sensors is very small, a one-ounce bottle of paint (sold with thinner and applicator) costs $87.00. For details and application information, write ELAB.

You might be able to make your own pressure-sensitive paint by mixing copper filings in a suitable base. Several years ago, I made force transducers by painting flexible, insulated rods with copper paint. Similar conductive paints are used to repair etched circuit boards.

Monolithic pressure sensors made from silicon are considerably more sophisticated than those made with pressure-sensitive paint. Figure 3, for example, shows the recently announced 149PC pressure-to-current transducer made by Micro Switch, a division of Honeywell (11 West Spring St., Freeport, IL 61032).

This transducer is a hybrid integrated circuit that incorporates a 0.1-inch-square silicon chip with a sensing diaphragm etched into it. Resistors are ion-implanted into the diaphragm, and their resistances vary as the diaphragm is flexed. This gives an output current proportional to the diaphragm pressure.

A drawback of silicon pressure sensors is temperature sensitivity. The 149PC transducer overcomes this problem by means of laser-trimmed, thick-film resistors on the hybridized substrate to provide precise temperature compensation. Response time of the 149PC is 1 millisecond, and it produces an output of from 4 to 20 milliamperes in response to an input pressure range of 3 to 15 psi. Micro Switch says the cost is under $100.

Micro Switch makes an entire line of solid-state pressure sensors. National Semiconductor (2900 Semiconductor Drive, Santa Clara, CA 95051) does also. A very interesting book on my shelf

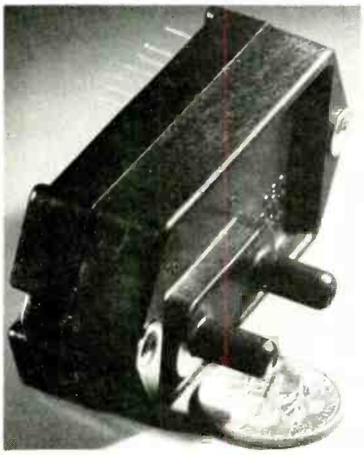


Fig. 3. A solid-state pressure-to-current transducer (149PC) made by Honeywell's Micro Switch Div.

is National's "Pressure Transducer Handbook." It describes many of National's semiconductor pressure transducers and explains how to use them to monitor fluid flow, measure altitude, sense barometric pressure, and detect both blood pressure and pulse.

Figure 4 is the block diagram of a digital, blood-pressure measuring circuit (sphygmomanometer) given in National's handbook (Fig. 1, page 9-2). In this circuit a microprocessor controls the sequencing of these events: the transducer is auto-referenced; the cuff around the patient's arm is inflated; the systolic pressure is detected, calculated, digitized, and displayed; the cuff is deflated; and, the diastolic pressure is detected, calculated, digitized, and displayed. The pulse rate is detected by means of an ac-coupled, low-pass filter.

Articles in POPULAR ELECTRONICS about medical electronics always elicit mail from readers interested in additional information. The "Pressure Transducer Handbook" discusses topics such as: the monitoring of intra-ocular pressure for the detection of glaucoma; pulmonometry for detection of emphysema and other disorders of the lung; and methods of monitoring the performance of the human ear. Rather than writing this column for more information, obtain a copy of the handbook.

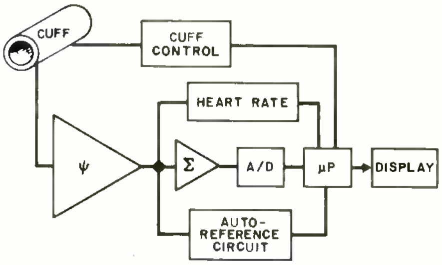


Fig. 4. Block diagram of a digital blood pressure monitor.

Incidentally, in light of the liability that may be incurred by the manufacture or use of various medical electronic devices, those of you interested in this field will certainly want to read National's disclaimer concerning the use of its products in so-called "life support applications." Their policy can best be summed up by the following quotation which appears on page 9-2: "National Semiconductor Corporation general policy does not recommend the use of its components of any type in *life support application.*" Though this statement appears in a book about pressure transducers, note that it covers "components of any type." Be sure to think about the implications should you decide to manufacture medical electronic devices.

Several other companies make semiconductor pressure sensors. Recently, for instance, Motorola (Box 20912, Phoenix, AZ 85036) entered the market with two devices. The MPX500 is a high-sensitivity device capable of sensing from 0 to 7.3 psi. The MPX200D is a version with a wider range (0 to 29 psi). A news release listed the cost of these devices as $18 in 100-unit quantities. Check with a Motorola distributor or the company for current pricing.

You can find out about other companies that make pressure sensors by consulting the various industrial directories. If you have no such directories, ask to see one at the engineering department of a university, manufacturer, or research laboratory.

An excellent article on pressure sensors has been published in *Electronic Products* magazine ("Don't Confuse Pressure Sensors and Transducers," Nov. 30, 1981). It gives the names and addresses of dozens of pressure sensor makers. You might be able to find this article in a library.

A New Telephone Receiver. In this era of increasingly complex electronic circuits, a new telephone receiver being experimented with at Bell Laboratories (600 Mountain Ave., Murray Hill, NJ 07974) is refreshingly simple. The new receiver, which is designed to fit in the earpiece of a telephone handset, directly converts digital signals into audio signals that can be understood by the listener. Conventional digital reception requires a digital-to-analog converter.

I've not yet seen a technical explanation of how the new receiver works. A Bell Labs photograph of the disassembled receiver shows an electret phone and a series of three baffles. Apparently the baffles stretch and thus integrate the audio pulses from the electret phone. Therefore, they demodulate the pulsed signal.

According to J.L. Flanagan of Bell Labs' Acoustic Research Department, work is underway to develop a microphone that directly converts speech into digital signals.

A 125-Volt Regulator. Texas Instruments (P.O. Box 202129, Dallas, TX 75220) has announced the availability of a voltage regulator having the highest output capability yet, the TL783 DMOS regulator. This new chip, which is installed in a TO-220 package, can handle an input-output differential of 125 volts! This compares with about 40 volts for previous regulators. The maximum output current of the TL783 is 0.7 amperes.

This new regulator will find widespread application in line-powered circuits. Unfortunately, the temptation to avoid the use of line-isolation transformers will be great since the new regulator can function over such a wide range. Should you choose to use this new regulator, be sure to play it safe and always use an isolation transformer.

Bubbles are Booming. National Semiconductor, Texas Instruments, and Rockwell International may have abandoned the bubble memory business, but Intel has reported that its bubble business is expanding fast. According to a recent item in *Electronic Engineering Times*, Intel is shipping some 2000 bubble memory units each month. This is about triple last year's sales figure. The steady market has led Intel to expand its bubble manufacturing facilities. ◇

Popular Electronics Tests

Sony ICF-2001 Receiver for AM-FM Broadcast and Shortwave

THE Sony ICF-2001 is a compact portable receiver with the unusually wide frequency coverage of 150 kHz to 29.999 MHz, plus the 76-to-108 MHz FM band (which includes the FM broadcast frequencies used around the world), and will also tune SSB and CW signals. It is tuned by a digitally controlled PLL synthesizer, with the frequency displayed on an LCD readout.

The ICF-2001 operates from internal batteries (three "D" cells) or from ac through an external adaptor (supplied). With an optional cable asembly, the radio can also operate from a 12-volt car battery. In addition to these power sources, the memory and computer circuits of the ICF-2001 operate from a pair of "AA" dry cells.

The ICF-2001 has a built-in 4-inch speaker, and is supplied with a single earphone that plugs into a jack on the side of the receiver, silencing the speaker. A telescoping whip antenna functions on all bands, augmented by an internal ferrite rod for AM reception between 360 and 2143 kHz. There are also terminals for attaching an external antenna.

The Sony ICF-2001 is housed in a black plastic case, approximately 12¼" x 6¾" x 2¼". It weighs about four pounds including batteries. Price: $349.95.

General Description. Unfortunately, no information is supplied by Sony concerning the circuit details, intermediate frequencies, or other internal operating characteristics of the unit. We can see that slightly more than half of the panel is devoted to controls and displays, the remainder being occupied by the speaker and three controls: the POWER switch, SLEEP timer button, and LIGHT button.

With the POWER off, pressing the SLEEP button once turns on the receiver, and a number "90" appears at the upper right corner of its LCD display panel. This indicates that the internal electronic timer will shut off the radio automatically after 90 minutes. Each additional press of the SLEEP button reduces the "on" period (and the display reading) by 10 minutes. The third button, when pressed momentarily, illuminates the LCD panel with an internal light for reading it when the ambient light is low. At the upper right corner of the panel is a three-position BAND SELECTOR switch, with settings for FM, AM, and SSB/CW. The latter turns on an internal beat frequency oscillator (bfo) for reception of CW and SSB signals.

In the center of the panel are the frequency selector keys, perhaps the most unconventional feature of the ICF-2001. Any frequency in the tuning range of the receiver can be "punched in" like making an entry on a calculator keyboard. The decimal point is automatically inserted, and the numbers appear on the display as they are entered. The actual receiver frequency remains fixed until a long red EXECUTE button is pressed, which instantly shifts it to the selected frequency.

The LCD display indicates by a "MHz" or "kHz" whether it is in the FM or AM mode. Although the "direct tuning" mode is the most convenient for setting the receiver to a known frequency, it is impractical for covering a band of frequencies. Therefore, a pair of MANUAL TUNING buttons below the frequency selectors cause the receiver to scan upward or downward while they are held down. The stepping rate for the AM bands is 100 kHz (in 1-kHz steps) in about 55 seconds. For FM, the scanning is in 0.1-MHz steps, and a band of 100 steps (10 MHz) is covered in about 55 seconds. If a center FAST button is pressed simultaneously with one of the MANUAL TUNING buttons, the scanning steps are increased to 10 kHz for AM and 0.2 MHz for FM, covering the same total range in about 13 seconds.

The ICF-2001 contains a versatile memory system, one of whose functions is to allow the receiver to scan continuously between any two frequency limits. The SCAN function is controlled by four keys to the left of the DIRECT TUNING keys. One limit frequency is selected manually (while holding in ENTER you press the L1 button). Then the other limit frequency is similarly selected with the L2 button. Below L2 is a START/STOP button; one touch on it causes the receiver to scan from L1 to L2, returning to L1 and repeating the process until you deactivate it with the START/STOP button. The scan is in steps of 3 kHz for AM, and 0.1 MHz for FM.

Normally the receiver will have tuned slightly past a signal before the scan can be halted, but a couple of taps on the opposite MANUAL TUNING button will return it to the correct frequency. If the SCAN AUTO STOP switch on the right side of the receiver is set to AUTO, the scan will cease when a sufficiently strong signal is received. After the scan stops, for any reason, another touch of the START/STOP button continues the scan from that point.

The ENTER key is also used to store station frequencies into a PRESET MEMORY. Up to six frequencies (either AM or FM) can be stored and recalled at a touch of the appropriate MEMORY PRESET button at the right of the display

panel. To store a frequency after it has been tuned in, press the desired button while holding down the ENTER button. If one wishes, the L1 and L2 buttons can be used for two more preset channels.

Along the bottom edge of the LCD display, indicators show which PRESET MEMORY positions have been assigned to the selected band and whether the scanning limits have been assigned. A row of five red LEDs to the left of the display window indicates relative signal strength on all bands. At low and medium frequencies, the antenna is a fixed internal ferrite rod, so that it may be necessary at times to rotate the entire receiver for best reception. In addition, the antenna input circuit for all bands (other than FM) is tunable by means of a thumbwheel located to the right of the DIRECT TUNING buttons.

Although the receiver tuning changes in discrete steps, its i-f bandwidth is large enough that there is no need to adjust the tuning between steps, except when receiving CW or SSB signals. The latter, in particular, require very precise tuning for an intelligible output. Therefore, an SSB/CW COMPENSATOR thumbwheel below the AM ANTENNA ADJUSTMENT varies the frequency of the receiver's bfo continuously over a ±6-kHz range. This control is calibrated at 2-kHz intervals to show how much should be added or subtracted from the digital readout to obtain the true receiver frequency (the digital display is not affected by this adjustment).

The remaining front panel controls, at the lower right of the panel, are three sliders for TONE and VOLUME adjustment. The BASS and TREBLE tone controls have "0" center calibrations and arbitrary limit calibrations of ±10.

Set into the right edge of the receiver case, in addition to the SCAN AUTO STOP switch, are screw terminals for an external antenna. It functions at all frequencies, and although the telescoping whip cannot be removed or disconnected, it folds against the receiver body when fully collapsed. Other than recommending that 75-ohm coaxial cable be used for an external antenna connection, the receiver instructions do not state the impedance of the receiver's "front end" input. There is also a three-position AM RF GAIN switch, marked DX, NORMAL, and LOCAL.

On the left edge of the case are four jacks. Three are miniature (1/8") phone jacks for driving an earphone or external speaker, feeding audio to a tape recorder, and connecting an external timer (not available from Sony) to turn the receiver on and off. There is a larger jack (DC IN 4.5 VOLT) for powering the receiver from the external power supply or the 12-volt adapter cable. The rear of the ICF-2001 contains separate compartments for the main batteries and the smaller batteries, and a hinged stand that tilts the panel upward slightly when the receiver is placed on a flat surface. A shoulder strap is furnished with the radio.

Laboratory Measurements. All measurements of the Sony ICF-2001 had to be made through the antenna r-f input by modulating an AM or FM generator. The output was measured through the headphone jack, with an 8-ohm resistive load when power and distortion readings were taken. The receiver was powered from the 120-volt 60-Hz ac line through the power-supply adapter for the tests.

The FM tuner had an IHF usable sensitivity of 23 dBf (4 microvolts across 75 ohms). The 50 dB quieting sensitivity was 24.7 dBf (4.8μV). Limiting was complete at 35 dBf (15 μV) and at 65 dBf (500μV) the noise was 62 dB below 100% modulation. Harmonic distortion at that input was 0.31%. The SIGNAL STRENGTH lights came on at inputs (75 ohm) between 1.4 and 6 μV, so that reasonably good FM reception requires that all the lights be lit.

The FM capture ratio was 4 dB at 45 dBf (50 μV) and 9 dB at 65 dBf. Both would be considered poor by the standards applied to home high-fidelity receivers, but are probably quite good for small portable units. The AM rejection was 38 dB at 45 dBf and 47 dB at 65 dBf. Alternate channel selectivity was a surprisingly good 65 dB (many low-price home receivers do not do as well) and adjacent channel selectivity was correspondingly good at 9 dB. Evidently the FM i-f is not 10.7 MHz, since we could find no trace of an image response based on that frequency.

In the AM mode, the sensitivity range of the indicator lights was also unexpectedly high (perhaps to give an impression of greater sensitivity than the radio actually has). The *highest* level light (#5) required an antenna input of only 0.85 μV at 10 MHz and 1.75 μV at 1 MHz, but at 200 kHz and 30 MHz these figures increased to 2.6 and 11 μV respectively. Aside from the LED indications, the sensitivity for a 10-dB S+N/N with 30% modulation was in the range of 1.2 to 2.2 μV at all frequencies except 200 kHz, where it was 10 microvolts.

The overall frequency response of the receiver included the tuner and amplifier characteristics, which could not be separated. With the tone controls centered, the FM tuner response was within ±3.5 dB from 80 to 20,000 Hz (the low frequencies rolled off sharply, apparently by design). The BASS tone control had a slight effect in the midrange (100 to 1000 Hz) but none at lower frequencies. It boosted the output by a maximum of 2 dB and cut it by 4.5 dB. The TREBLE control could boost the output above 1000 Hz by as much as 6 or 7 dB, and at its minimum setting it rolled it off to −17 dB at 20,000 Hz. The AM frequency response was surprisingly restricted, peaking at 400 Hz and falling to −6 dB at 190 and 930 Hz. In spite of this limited bandwidth, AM reception was perfectly intelligible.

At 1000 Hz, the audio output clipped at just under 0.6 watts into an 8-ohm load. Just below clipping, at 0.5 watts, the distortion was 3.0% and at 0.1 watts it was about 1.5%.

User Comment. These data are presented simply to provide a basis for comparing the Sony ICF-2001 to more conventional shortwave or FM receivers. Actually, it is in no way comparable to any other receiver we have seen, and should be judged on its own merits.

As a portable AM or FM receiver, the ICF- 2001 does a fine job. Its sensitivity is more than adequate on the FM and AM broadcast bands, and for general shortwave listening, even with the built-in antennas. We did not use the receiver with external antennas.

The accuracy and stability of the tuning are, of course, those of the quartz crystal oscillator that controls the synthesizer. It is impressive to set the receiver to the frequency of any receivable station within its very wide frequency coverage, and have the signal come in perfectly tuned as soon as the EXECUTE button is pressed. The tuning behavior, because of its step-wise scanning, is rather startling. The background noise (sometimes mixed with signals) is gated on at a regular rate as the receiver makes its discrete frequency jumps. The SCAN AUTO STOP only functioned on rather strong stations.

Reception of SSB signals is easy, from the standpoint of tuning them in properly. As soon as the receiver is within about 5 kHz of the correct frequency, it can be fine tuned with the COMPENSATOR. Because of its considerable i-f bandwidth (compared with communications receivers) it is easy to tune either USB or LSB signals using just the bfo (COMPENSATOR) control. The same property (poor skirt selectivity) makes reception on crowded amateur bands difficult at times, but if one learns to concentrate on the desired signal it is not too hard to pick one out of many.

The instruction manual warns of internal spurious signals from the synthesizer oscillators at 299, 350, 400, 5760, 10,700, 11,520, and 21,400 kHz. These were indeed present, at sufficient strength to obliterate almost any external signal one might find on those frequencies (except for 11,520, which was only moderately strong).

Obviously the ICF-2001 is a remarkably versatile portable receiver, ideal for taking on vacation or camping trips. It is also a fine introduction to the world of shortwave listening since its tuning ease and precision remove one of the major problems facing a neophyte SWL (how to know to which frequency a receiver is *really* set, in contrast to what its dial may read).

If the price of the ICF-2001 seems a trifle high for a small portable receiver, try comparing it to allwave or shortwave receivers covering even part of its range. It will soon be apparent that this is an excellent value as well as being a lot of fun to use.—*Julian Hirsch*

CIRCLE NO. 105 ON FREE INFORMATION CARD

EXPERIMENTER'S CORNER

By Forrest M. Mims

How to Protect Profitable Ideas
Part 2. Notebooks, Lawyers and Patent Applications

HAVE YOU a profitable idea? If so, you should know how to protect it. Otherwise, your idea may enrich others.

You should also know, however, that protecting profitable ideas can be a tricky business. Keeping accurate records of your idea and building working models are relatively straightforward procedures, but filing a patent application can be both time-consuming and expensive. Even if your idea is eventually patented, you must be prepared to protect your rights by defending it, at your expense, against any infringement.

Therefore, it's important to distinguish merely good and useful ideas from those that are profitable. Many inventors have spent thousands of hours and at least as many dollars securing patent protection for good and useful ideas from which they have received little or no return.

Let's assume your idea has money-making potential. What steps can you take to begin protecting your idea *now*? Should you seek patent protection for it? Can you sell your idea without patenting it? I'll attempt to answer these and other questions in this column. You should be forewarned, however, that I am *not* a patent attorney or an expert on patent law. For expert advice, you may wish to consult a patent attorney, about which I'll say more later.

What is a Patent? Article I, Section 8 of the United States Constitution lists the powers delegated to the Congress, one of which is "To promote the Progress of Science and useful Arts, by securing for limited Times to Authors and Inventors the exclusive Right to their respective Writings and Discoveries." Copyrights, trademarks and patents stem from this clause.

According to the Department of Commerce, which oversees the U.S. Patent and Trademark Office, "A patent is a grant issued by the United States Government giving an inventor the right to exclude all others from making, using, or selling his invention within the United States, its territories and possessions." The term of the patent is seventeen years from the date on which it is issued. Thereafter anyone may make, use or sell the invention.

What Can be Patented? Congress has enacted statutes which govern patents. The law provides that any person who "invents or discovers any new and useful process, machine, manufacture, or composition of matter, or any new and useful improvements therefore, may obtain a patent."

The definition of "new" is very important. The law provides that an invention *cannot* be patented if "(a) The invention was known or used by others in this country, or patented or described in a printed publication in this or a foreign country, before the invention thereof by the applicant for patent, or (b) The invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country more than one year prior to the application for patent in the United States." Neither can the invention be patented if what distinguishes it from previous inventions would be obvious to a skilled person.

Patent Search. Before spending time and money preparing a patent application, it is necessary to determine if your idea is novel. One way to do this is to search through the relevant literature on all closely related matters at a good technical library. You should know, however, that the subject of many patents can be found nowhere but in the patents themselves. For this reason, if your library search turns up nothing you should hire a patent attorney to perform a patent search.

In most cases, the attorney will contact an individual or firm that specializes in patent searches. The searcher will visit the Search Room of the Patent and Trademark office at Crystal Plaza, 2021 Jefferson Davis Highway, Arlington, VA. He or she will generally spend several hours or more tracking down any patents which might anticipate all or part of your invention. He will forward copies of these patents to your attorney who will then, in most cases, write you a letter recommending what you should do next. His fee, which includes the searcher's fee, should not exceed a few hundred dollars.

A search such as this is known as a *preliminary* novelty search. Should you elect to apply for a patent, it may be necessary to pay for a *complete* patent search. This search may even extend to foreign patents, but even it may not turn up important pieces of *prior art*. You may receive a patent, but years later your patent may be declared *invalid* should a rival locate an important piece of prior art.

Keeping a Notebook. Perhaps you've been advised that the best way to prove the date of your invention is to describe the idea in a letter which you then seal in an envelope and mail to yourself. The quaint reasoning behind this practice is that the postmark on the envelope verifies the date of the contents.

A far more reliable way to establish the date of invention is to enter a detailed description of your idea in a *bound* notebook. Never use spiral notebooks or three-ring binders because their pages can be removed or substituted. Instead, use a notebook with permanently bound pages.

Each of the pages in this notebook is numbered and printed with a 0.25-inch blue grid. Each page includes a yellow second copy. Carbon paper, supplied with the notebook, is inserted between each page and its yellow second to provide a carbon copy of your entries. The yellow pages are perforated and can be removed for safekeeping in a separate location.

Ideas recorded in your notebook should be dated and signed by you and at least two witnesses. The customary annotation inserted by witnesses is "Read and understood," followed by a signature and date. Since I live in a rural area, non-technical people often sign my notebooks. Therefore, I ask them to insert a sentence or two briefly describing in simple terms what they have observed, read, and understood. You should avoid amending or altering entries in your notebook after they have been signed and witnessed!

Surprisingly, being first to conceive and log in a notebook a patentable idea does *not* guarantee you will receive a patent! Unless you file your application promptly, a second inventor who independently conceives the same idea weeks, months, or even years later may be granted a patent if he exhibits what the Patent and Trademark Office terms *diligence*.

Say you invent a widdlewump on January 1, 1983. You promptly describe your invention in your notebook and have it witnessed. You then move on to other projects. A year later, Joe McSecond invents a widdlewump identical to yours. Joe also records the idea in his notebook. He then goes a step farther. He expands upon the idea over a period of several months and subsequently files a patent application.

Coincidentally, you also file a patent application about the same time. Chances are good that Joe will receive the widdlewump patent. In the view of the Patent Office, your failure to file a prompt application or exhibit continued interest in the invention constitutes *abandonment of invention*. You have failed to follow the diligence rule. Of course this example is merely hypothetical. But it does serve to indicate the complexity of patent law.

A Working Model. It's been said that an invention is incomplete until it has been *reduced to practice*. The Patent Office, however, rarely requires the submission of working models. This means you might be able to patent a way of extracting cheese from moon rocks without having to visit the moon. Naturally, you would have to convince the examiner who considers your application that your invention would really work as you claim.

Retaining a Patent Attorney. You can find patent attorneys in the telephone directories of most large cities. Another way is to obtain referrals by contacting a local bar association. A patent attorney's services will cost you from $50 to as much as $200 per hour! Initial consultations, however, should be free.

As in all professions, not all patent attorneys will live up to your expectations. They may fail to explain all the fees, expenses, and charges you will incur when applying for a patent. They may not perform their services as promptly as you would like. They may even miss a Patent Office deadline. Therefore, it is a good idea to select an attorney or firm after first getting references from those who have been previous clients. If your invention is important and if you anticipate spending several thousand dollars or more to apply for a patent, you should feel free to ask a prospective attorney for references you can contact on your own.

After you select an attorney, make sure he or she explains in detail any and all expected expenses. You should be given periodic statements listing the attorney's time and various out-of-pocket expenses.

If you cannot afford the expenses of filing a patent application, you might be able to convince an attorney to exchange his time for a share of the invention. Chances are he will expect you to absorb all filing, search, and out-of-pocket expenses.

Submitting Your Idea. The best way to submit an idea to a company is to send them a copy of your patent and ask if they are interested in acquiring any or all of the rights.

Submitting an *unpatented* idea to a company is more involved. Though many firms will consider unsolicited proposals from outsiders, for their own protection they will ask you to sign an agreement of nonconfidentiality. In brief, this means you are submitting the idea openly, not secretly. In the event they have independently arrived at your idea prior to hearing from you, the agreement will protect them from any claims you might later press.

If you read Part 1 of this two-part series on protecting ideas, you may recall some of my experiences in submitting unpatented ideas to manufacturers. Would I again consider submitting an unpatented idea to a company? Yes, but first I would make sure my notebook entries were up to date, witnessed, and as complete as possible. I would also make sure my submission included detailed drawings and a complete description of the invention. (Do not send a manufacturer copies of notebook entries or disclose dates of invention! You should supply this information only after the company has expressed strong interest and you have received expert advice, preferably from a patent attorney.)

What to do if Your Idea is Misappropriated. First, you must make sure that misappropriation has actually occurred before taking remedial action. For example, say you submit an idea to Ripoff, Inc. Ripoff requires you to sign a nonconfidential disclosure statement and, afterwards, examines your idea. Ripoff then rejects your idea. A year later, Ripoff announces a product that appears to incorporate your idea.

Do you have any recourse? Not necessarily. If you failed to patent the idea, Ripoff may have as much right to it as anyone else. Also, Ripoff may have independently conceived the idea. If, however, you are convinced that Ripoff has acted unethically and, perhaps, illegally, you should see a patent attorney. If, after studying the nonconfidentiality agreement and your notes and invention suggestion, he feels you have a valid claim, you may be able to take Ripoff to court. First, however, ask your attorney to demand a settlement from Ripoff. If they refuse to discuss the matter, then you have every right to ask the courts to arbitrate the matter.

Be forewarned, however, that fighting Ripoff in court may become a very expensive and time-consuming procedure. Be sure your emotions don't cloud your judgment, for you may spend thousands of dollars and gain nothing. Equally bad, the burden of an ongoing lawsuit will hang over you like a dark cloud. You will think about it constantly. You will have to stay in close touch with your attorneys (lest they put your case on their back burner), and you will have to prepare yourself for the mental and monetary expense of depositions. Is your idea worth all that? If it is, you should attempt to defend it the best you can. If Ripoff is a very large company, be prepared for big expenses. Smaller companies rarely have staff attorneys and are more willing to settle out of court.

You may find that a company's public relations people are much friendlier than its executives and attorneys. Prior to my adventure with Bell Laboratories, I thought they were the world's best laboratory. I still feel that way, but I now know that the inside of the bell is tarnished by the misrepresentations and rude treatment meted out to my attorneys and me by a very small minority of an otherwise very likable and highly professional staff.

During the discovery phase of your lawsuit, you may have to provide the defendant (the company you have sued) with numerous records, documents, receipts, and other items. You will need to find witnesses to testify on your behalf.

In my experience with Ma Bell, my wife and I endured a humiliating eight-hour search of my home office by three attorneys from Western Electric and Bell Labs. Though they had requested specific categories of documents which I was prepared to provide, they examined such things as my tax returns, royalty statements, and even personal papers.

So as you can see, tackling a big opponent can be a trying experience. I'm quite satisfied with the short-term results of my battle with Bell Labs, since they settled out of court. Several important matters are still unresolved, however.

Negotiating Out of Court. There's not enough space to say much about this topic, but you may be able to settle a claim against a company on your own and out of court. I came very close to settling with Bell Labs *before* filing suit.

In my experience, Bell Labs failed to take a serious interest in my claim until I formulated a detailed *action plan* that included such options as reporting their claims of having invented my suggestion to the Federal Trade Commission. I even managed to interest two congressional committee staffers in my plight, one of whom expressed strong interest.

These out-of-court actions are sometimes known as *guerrilla law*. They are certainly unconventional. But they seemed to have a major impact upon high officials at Bell Labs. You may wish to try such out-of-court tactics, should one of your ideas be misappropriated. If so, be very certain you know exactly what you are doing. False claims and accusations may do harm to a company and its officials, and may leave *you* the defendant in a lawsuit.

Additional Information. The Superintendent of Documents (Washington, DC 20402) sells various pamphlets concerning patents. One is "General Information Concerning Patents" (75¢). Another is "Patents and Inventions—An Information Aid to Inventors" ($1.30). Prices for these documents are subject to change without notice.

You can purchase copies of individual patents from the Patent and Trademark Office (Washington, DC 20231). The fee is 50¢ per patent. The patent office will *not* search out specific patents on various topics! You must supply the number of the patent you are requesting.

If you are ever in the Washington, DC area, you can visit the Public Search Room at the Patent and Trademark Office. It's located at the Arlington, VA address given above. The Search Room is a short taxi ride from National Airport. Conducting your own patent search will give you good reason to admire those who do searches for a living.

You can find out more about patents by consulting a good library. For hints about submitting an idea to a manufacturer, send 25¢ to the American Bar Association (1155 E. 60th St., Chicago, IL 60637) and request a copy of "Submitting an Idea to a Manufacturer."

Finally, while I wish I could help, please don't forward any technical questions concerning patents and ideas. Your best recourse is to visit a patent attorney. ◇

NEW LITERATURE

Portable Temperature Measuring Instruments

A 28-page catalog from Wahl offers an up-to-date listing of precision industrial thermometers for plant maintenance, quality assurance, engineering, and energy conservation. The catalog includes specs and applications for digital heat probes, thermocouple devices, infrared scanners, bimetallic thermometers, chart recorders, etc. **Address**: Wahl Instruments, Inc., 5750 Hannum Ave., Culver City, CA 90230.

Software Products

A guide from Lifeboat Associates lists more than 200 computer programs in 80 different formats for business, professional, and personal use. New product additions include: dBASE II, a relational database manager with its own language suitable for the beginning programmer; PLINK II, a two-pass linkage editor; Professional Time Accounting (PTA); MICROSTAT, which is said to bring mainframe statistical analysis power to minis; etc. **Address**: Catalog #21, Lifeboat Associates, 1651 Third Ave., N.Y., NY 10028.

Video Systems Explained

A consumer information booklet is now available from the Electronic Industries Association's Consumer Electronics Group. Called "Video—Your Window on the World," the 24-page booklet attempts to offer the consumer a full explanation of video products such as VCRs, videodiscs, satellite TV, cable, and interactive TV, e.g., Teletext, Viewdata, etc. There are also sections on antennas and care of video equipment. Single copies are free with a stamped (35¢) self-addressed envelope. Two to 99 copies are available for 15¢ each. **Address**: Electronic Industries Association, Consumer Electronics Group, 2001 Eye Street, N.W., Washington, D.C. 20006.

Calibrations from NBS

The National Bureau of Standards (NBS) has issued a new edition of the agency's complete catalog of calibration services. Among the areas covered are: mass and dimensional metrology, mechanics and acoustics, electrical and electromagnetic quantities, time and frequency, optical properties, ionizing radiation, etc. The catalog reflects changes made since the second quarter of 1980. Also included is information about the latest NBS Measurement Assurance Program, a quality control service. **Address**: Office of Measurement Services, National Bureau of Standards, Washington, D.C. 20324.

PC Board switches

EECO Incorporated has a 16-page catalog describing its complete line of printed-circuit board switches. The line features one- and two-pole, 10- and 16-position 2300 Series MICRO-DIP switches, and the 2400 Series MINI-DIP switches which offer standard bottom seal or optional total environmental seal. The new catalog also contains outline dimensions, terminal identifications, mounting hold patterns, circuit diagrams, cutaway drawings, switch orientations, specs, code truth tables, etc. **Address**: EECO Incorporated, Switch Products Marketing, 1601 E. Chestnut Ave., Santa Ana, CA 92701.

Speaker Kit Catalog

Gold Sound announces a line of 15 Home Loudspeaker Kits, each of which is described in a catalog available for $2. Using name-brand drivers, e.g., JVC, JBL, Audax, etc., each speaker can be built for one third to one fifth the cost of a comparable store-bought model, according to the manufacturer. If you want to build a professional speaker, a catalog of 21 speaker kits is available for $3. **Address**: Gold Sound Loudspeaker Kits, P.O. Box 141, Englewood, CO 80110.

Power Line Carrier

A brochure from Honeywell describes the PLC 720 Power Line Carrier system, which is said to eliminate the need for extensive wiring in the installation of energy management systems in commercial buildings. By using a building's existing ac power lines to carry digital commands to control points, the system is claimed to lower wiring costs by as much as 75%. The microprocessor-based PLC 720 system also incorporates a two-function receiver relay that controls two points independently, thereby reducing the number of relays needed for a job. **Address**: Honeywell Inquiries Dept., MN12-4118, Honeywell Plaza, Minneapolis, MN 55408.

8088 User's Manual

Written for hobbyists and OEMs, this 300-page book is a design aid for microcomputer systems based on the Intel iAPX 88/10 8-bit processor. The chip's architecture is described from a programmer's point of view. Included are discussions of the 8/16-bit registers, megabyte memory addressing modes, and the instruction set. A separate hardware discussion covers bus timing, direct memory access, and interface considerations. Also discussed are basic microcomputer concepts, terminology, and applications. The book costs $7.50. **Address**: Intel Corp., Literature Dept., 3065 Bowers Ave., Santa Clara, CA 95051.

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.)

Dumont type 767H oscilloscope. Need operating manual and schematic. Dawes N. Hiu, 3276 Ala Laulani, Honolulu, HI 96818.

Electronic Measurements Corp., Model 300 vacuum tube meter. Need schematic and technical information. John VanWinkle, Rt., 1, Box 69BC, Ft. Gibson, OK 74434.

Gonset Communicator II. Need service manual, parts list and schematic. **Surplus Collins** ARR-15 receiver. Need service manual and schematic. Ed Wilkie, 2828 W. Charleston, Phoenix, AZ 85023.

Hallicrafters SX-43 receiver. Need instruction manual and schematic. Also need tube 7F8 or 7F8W. Tim Regan, 15926 Liggett St., Sepulveda, CA 91343.

Symphonic Model TPS30 television. Need 3 inch picture tube. Gene Vajgrt, QTRS 6305D, USAF Academy, CO 80840.

Video Brain computer Model 101A. Need expanders and cartridges. Dan Taipala, 3970 Parker Rd., Gladwin, MI 48624.

Telequipment Model S32A oscilloscope. Need schematic, parts list, and any information available. Ray Woods, 130 Waterford, Florrisant, MO 63033.

B&K Model 400 cathode rejuvenator tester. Need operation manual and wiring diagram. Bill's Bargains, W. 1524 Broadway, Spokane, WA 99201.

Hallicrafters Model HT-41 amplifier. Need tube #7094. T.E. Isaacson, Box 307, Wentzville, MO 63385.

Wega Radio Model 809-1 (1960). Need schematic. John Okolowicz, 836 Sunnyside Ave., Audubon, PA 19407.

Supreme Model 504-B set tester. Need any information available. Richard O. Davidson, 306 Russell St., Carlsbad, NM 88220.

Eversonic Model 100R AM/FM radio. Need operation manual and schematic. Sammie L. Crawford, Rte. 1, Box A-112, Appling, GA 30802.

Sears & Roebuck Co., Model 1232 tape recorder. Need owner's manual or any information available. Mike Melton, 3504 Pageant Dr., Sacto, CA 95826.

Precision Apparatus Co., Inc., series 920 electronamic tube and set tester. Need schematic, manual and tube adapters #G-140, A-15, B16. Gus Kroll, 9 Raymo St., Albany, NY 12209.

Digital Time Device Mark IV clock. Need schematic. Dave Hoffmann, RR #2, Centerville, IN 47330.

Knight Model R-100A receiver. Need operating manual, schematic and parts list. Mike Carson, Box 611, Brookings, OR 97415.

Spectronics Model DD frequency counter. Need schematic or service data. H. Morgan, Box 10993, Knoxville, TN 37919.

Cossor Model 1035 MKIII oscilloscope. Need schematic and manual. Bill Street, 525 E. 9th St., North Vancouver, B.C. Canada V7L 2B6.

EMC Model 213 tube tester. Need list of settings for tube testing. James Hegedus, 109 Longwood Dr., Groveville, NJ 08620.

Military Test Set AN/URM 113 (TS 997/u). Need schematic and manual. Hal MacArgle, W8MCH, PO Box 201, Grantsville, WV 26147.

Knight Electronics Model KG 686 r-f generator. Need operator manual, schematic, and parts. J. Depiere, 222 Lange Leemstraat, 2000 Antwerp, Belgium.

Litton Business Systems Model 1230 console/printer. Need schematics and any available information. Bob Reed, 12112 Melody Dr., #301, Denver, CO 80234.

General Radio Model 1001A signal generator. Need service manual and schematic. A. Reges, 16W761 White Pines, Bensenville, IL 60106.

Fairchild-Dumont Type 304-A oscilloscope. Need schematic and owner's manuals. Peter Bloch, 791 W. 28th, Eugene, OR 97405.

National Model NC173 receiver. Need manual and schematic. Bindu M. Rao, 160 I Block East, Jayanagar, Bangalore 560011, India.

Scott Console (Andover pra 1970 model). Need detailed schematic copy. Ed Kraine, 719 Salem Dr., Huron, OH 44839.

Knight Model KG-2100 dc oscilloscope. Need schematic and service manual. Christian G. Davis, Electricity Electronics, East Central Multi-District, 700 Elm Avenue, Brookings, SD 57006.

Heathkit Model IO-12 oscilloscope. Need schematic and service manual. Same for **Commercial Controls Corp.** Model FPC-5 recorder-producer. William Sinoff, Box 1251, Alhambra, CA 91802.

Bristol Model KD-3534 car AM/FM digital radio and cassette player. Need service manual. Ralph R. Neuman, 4592 Okemos Rd., Okemos, MI 48864.

Hammarlund HQ-125X receiver. Need operating manual and/or circuit diagram. James H. Schwartz, Harmarville Rehabilitation Center, Inc., Box 11460, Guys Run Road, Pittsburgh, PA 15238.

Mallory Model 12RS140 regulated and filtered power supply. Need service manual and writing diagram. John W. Shull, Sr., 1410 Wolverine, Anchorage, AK 99504.

Navy CRV-59 AAE of ATJ or ATK video camera. Need operator's manual and schematics. Daniel Koller, 19 Bernard Rd., E. Brunswick, NJ 08816.

RCA Model MI-12188 power amp. Need schematic and operating manual. Also need parts for **Gately** Prokit Model SM-6 mixer. C.F. McCabe, 519 Lombardy Blvd., Brightwaters, NY 11718.

Hallicrafters Model SX-110 shortwave radio. Need schematic, service manual and owner's manual. Also same for **RCA** Model CRM-P4A-5 CB transceiver. Steve Parkin, 11 Orwell Close, Red Deer, Alberta, Canada T4N5J2.

Heathkit Model TT1 tube tester. Internal calibration procedure needed. Also the setup steps. Sal Trentino, 1790 Sir Francis Drake, Fairfax, CA 94930.

Hallicrafters Model SX28A Super Skyrider receiver. Need schematic and alignment procedures or any other information. Mark Higgins, 52 Gilby Rd., Estcourt, 3310, South Africa.

Elco Model HFT-90A FM tuner. Need front end. Nick Meale, 3316 Richmond, Cincinnati, OH 45236.

B&K Model 1075 television analyst. Need schematics. Same for **Shiba** Model HV14 CCTV camera. William J. Graft, 2431 Julian, Ft. Wayne, IN 46803.

Webster Model 80-1 wire recorder. Need any available information. Sam Hearn, Box 202, DeWitt, AR 72042.

Hallicrafters Model S-38C receiver. Need schematic diagram or any information available. Carmelo Ortiz, 785 Courtlandt Ave., New York, NY 10451.

RCA CTC24 and KCS180 TV chassis. Need horizontal flyback and section schematics for KRK120, KRK132 and uhf KRK127 tuner. Also need CRT pinouts. K. Willas, 5 Grandville Ave., St. Albert, Alberta, Canada T8NOT5.

Poly Model PC-6 Com 6-meter transceiver. Need schematic and owner's manual. Dave Cregar, 825 Eastmont Dr., Gas City, IN 46933.

Heathkit Model SB-200 linear amplifier. Need operation, alignment, and service information. Mike Adams, Rt. 4, Box 764, Panama City, FL 32405.

LFE Model 411 oscilloscope with Model 1402 plug-in. Need schematics, manual, and calibration data. Larry Shannon, 5615 Truscott Terrace, Lakeview, NY 14085.

Miracle Hill Model 800 automatic transistor checker. Need schematic or operation manual. E.J. Markusic, 14761 Leon Pl., Tustin, CA 92680.

Military type ARM-26 radio test set. Need plug in modules. Arthur Kocsi, Route 138, West Kingston, RI 02892.

Accurate Instrument Co., Model 151 tube tester. Need operating manual. Angel L. Borras, JE-22 Carmelo D. Soler St., Levittown Lakes, PR 00632.

Webster-Chicago Model 80-1 or 180-1 wire recorder. **Stromberg-Carlson** PA amplifier No. 20 and **Operadic** Model 1025A PA amplifier. Need schematics. Vernon Blaine, Box 50, Gary SD 57237.

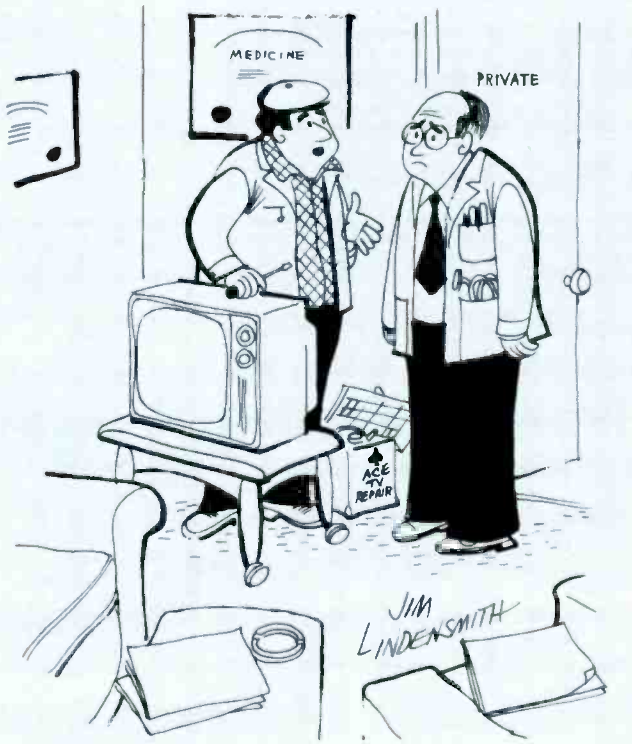
Down The Tube

BY JIM LINDENSMITH

"Either you finish your vegetables, young man, or you're going to have to watch 'The Wonderful World of Disney' on the black-and-white set!"

"How come TV stations never experience difficulties during commercials?"

"Don't tell them we'll come until you make sure their TV set is working. Last time it wasn't."



"I was afraid of this, doc—your old TV set has rejected the new picture tube I installed last week."

PROJECT OF THE MONTH

By Forrest M. Mims

Event-Failure Alarm

AN alarm that sounds a warning a predetermined time after an event has taken place (if there has been no corrective action) has many applications. Automobile seat-belt alarms are a common example. Others include: an alarm to indicate that a refrigerator or freezer door has not been closed 30 seconds or so after it was opened; an alarm that works on a checklist basis to indicate that one or more actions have not been taken within a predetermined time period; a delayed-action alarm that ignores momentary faults (even those lasting up to a minute or two) but which otherwise functions normally; and a timer or quick-reaction tester for children's games or toys.

A Practical Event-Failure Alarm. Figure 1 is the circuit for a straightforward two-chip, event-failure alarm. The 7555 timer is connected as a missing pulse detector, and the 4011 quad NAND gate serves as a tone generator.

In operation, the 7555 enters a timing cycle when power is applied to the circuit. The duration of the cycle is determined by *R2* and *C1*. The circuit may be reset at any time by closing *S1*. This turns on *Q1* which, in turn, discharges *C1*. If *S1* is *not* closed prior to the completion of the timing cycle, the 7555 output goes low, thus enabling the tone generator.

Only two of the gates in the 4011 are required for the tone generator. One of the spare gates is used to invert the enable signal from the 7555 output (pin 3). Pullup resistor *R3* allows this gate to be interfaced directly with the 7555. The final spare gate in the 4011 provides a buffer between the tone generator oscillator and an external transducer or amplifier.

Though the circuit I prototyped incorporates a 7555, you can use a standard 555 timer if you prefer. The chief advantage of the 7555 is its very low power consumption. You may also substitute a fixed resistor for *R2* when you arrive at a suitable delay time. Remember that *C2* also influences the delay time. Increasing the capacity of *C2* increases the delay time of the circuit.

Adding an Amplifier. Though the circuit in Fig. 1 will drive a small 8-ohm speaker at low volume, much better results are obtained by first amplifying the tone signal. Figure 2 shows a very simple power amplifier designed around a low-cost LM386 and little else. Potentiometer *R1* controls the input signal level and therefore functions as a volume control for the amplifier.

Adding a Logic Input. Many new applications for the basic circuit in Fig. 1 become available if the alarm is reset under digital control. A simple way to do this is to replace *S1* with one of the analog switches in a 4066 as shown in Fig. 3. When the input is low, the analog switch is *open*. When the input is high, the switch's resistance falls from about 10^9 ohms to a few hundred ohms or less. This is low enough to simulate a mechanical switch for this circuit.

Adding a Visual Indicator. Figure 3 also shows how to add an LED to the circuit. In operation, the LED is normally off. When the delay time is up, the LED glows and the alarm sounds. ◇

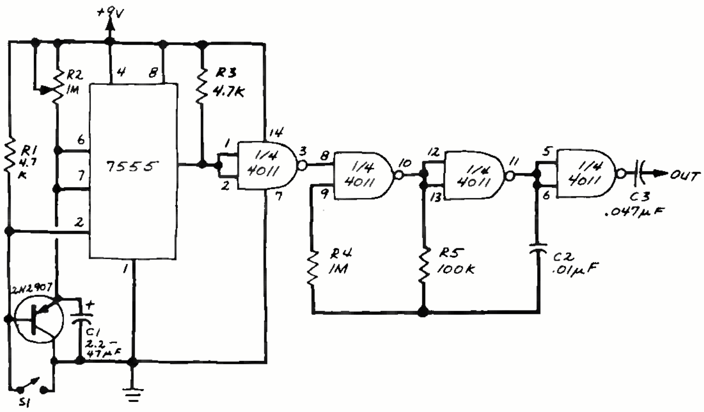


Fig. 1. Schematic diagram of an event-failure alarm.

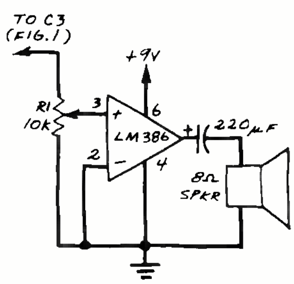


Fig. 2. A simple amplifier to be used with the event-failure alarm.

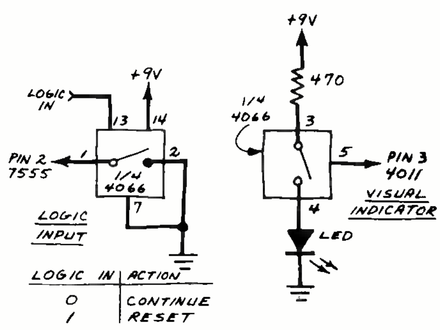


Fig. 3. Adding a logic input to the event-failure alarm.

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74LS14	1.09	74LS157	1.19
74LS30	.55	74LS161	1.29
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74LS38	.69	74LS175	1.19
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74LS73	.75	74LS244	1.89
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74LS75	.75	74LS367	.89
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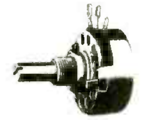
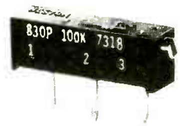
74LS90	.89	81LS97	2.29

POTENTIOMETERS



2 Watt @ 70°C
7/8" Slotted Shaft
Linear Taper
1K, 5K, 10K, 25K, 50K, 100K, 1 Meg

CMU $2.95



3/4 Watt @ 70°C
15 Turn Pot.
Linear Taper
100 Ohm, 500 Ohm, 1K, 5K, 10K, 50K, 100K, 500K, 1Meg

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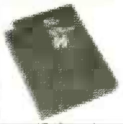

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4.7mfd@25V	2/1.39	100mfd@50V	.59
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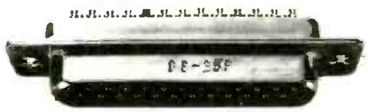
.047mfd	4/.99	.1mfd	4/.79
.1mfd	4/1.19		
.22mfd	4/1.29		

CONNECTORS



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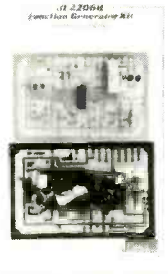
Function Generator Kit



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2N3903	0.87	7.20	60.00
2N3904	0.87	7.20	60.00
2N3905	0.87	7.20	60.00
2N3906	0.87	7.20	60.00
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2N4124	0.87	7.20	60.00
2N4400	0.87	7.20	60.00
2N4401	0.87	7.20	60.00
2N4402	0.87	7.20	60.00
2N4403	0.87	7.20	60.00
MPS2222	0.87	7.20	60.00
MPS2222A	0.94	7.80	65.00
MPS2369	0.87	7.20	60.00
MPS2907	0.87	7.20	60.00
MPS2907A	0.94	7.80	65.00
MPSA42	2.67	22.20	185.00
MPSA43	2.60	21.60	180.00
MPSA92	2.67	22.20	185.00
MPSA93	2.60	21.60	180.00

VOLTAGE REGULATORS

DEVICE TYPE	VREG VOLT	IMAX AMP	PKG. STYLE	PRICE PER 1	10	100	1000
LM317KC	ADJ.	1.5	TO-3	$1.84	$16.64	$151.25	$1,375.00
LM317UC	ADJ.	1.5	TO-220	1.34	12.10	110.00	1,000.00
UA7805KC	5	1	TO-3	1.17	10.59	96.25	875.00
UA7805UC	5	1	TO-220	0.60	5.45	49.50	450.00
UA7806UC	6	1	TO-220	0.60	5.45	49.50	450.00
UA7808KC	8	1	TO-3	1.17	10.59	96.25	875.00
UA7808UC	8	1	TO-220	0.60	5.45	49.50	450.00
UA7812KC	12	1	TO-3	1.17	10.59	96.25	875.00
UA7812UC	12	1	TO-220	0.60	5.45	49.50	450.00
UA7815KC	15	1	TO-3	1.17	10.59	96.25	875.00
UA7815UC	15	1	TO-220	0.60	5.45	49.50	450.00
UA7818KC	18	1	TO-3	1.17	10.59	96.25	875.00
UA7818UC	18	1	TO-220	0.60	5.45	49.50	450.00
UA7824KC	24	1	TO-3	1.17	10.59	96.25	875.00
UA7824UC	24	1	TO-220	0.60	5.45	49.50	450.00
UA78GKC	ADJ.	1	TO-3	1.25	11.35	103.13	937.50
UA78GU1C	ADJ.	1	TO-220	0.84	7.57	68.75	625.00
UA78H05KC	5	5	TO-3	5.00	45.38	412.50	3,750.00
UA78H12KC	12	5	TO-3	5.83	52.94	481.25	4,375.00
UA78HGKC	ADJ.	5	TO-3	5.66	51.43	467.50	4,250.00
UA78P05KC	5	10	TO-3	9.99	90.75	825.00	7,500.00
UA78S40PC*	ADJ.	1.5	16-DIP	1.92	17.40	158.13	1,437.50
UA7905KC	-5	1	TO-3	1.17	10.59	96.25	875.00
UA7905UC	-5	1	TO-220	0.60	5.45	49.50	450.00
UA7908KC	-8	1	TO-3	1.17	10.59	96.25	875.00
UA7908UC	-8	1	TO-220	0.60	5.45	49.50	450.00
UA7912KC	-12	1	TO-3	1.17	10.59	96.25	875.00
UA7912UC	-12	1	TO-220	0.60	5.45	49.50	450.00
UA7915KC	-15	1	TO-3	1.17	10.59	96.25	875.00
UA7915UC	-15	1	TO-220	0.60	5.45	49.50	450.00
UA79GKC	-ADJ.	1	TO-3	1.25	11.35	103.13	937.50
UA79GU1C	-ADJ.	1	TO-220	0.84	7.57	68.75	625.00
UA79HGKC	-ADJ.	5	TO-3	5.66	51.43	467.50	4,250.00

*SWITCHING REGULATOR

MICRO-PROCESSOR & SUPPORT DEVICES

DEVICE TYPE	CLOCK/ SPEED	PRICE PER 1	10	100	1000
Z80A-CPU	4 MHZ	$ 3.20	$ 29.04	$ 264.00	$ 2,400.00
Z80B-CPU	6 MHZ	8.79	79.86	726.00	----
Z80A-DMA	4 MHZ	10.39	94.38	858.00	----
Z80A-PIO	4 MHZ	4.24	38.48	349.80	3,180.00
Z80A-CTC	4 MHZ	4.24	38.48	349.80	3,180.00
Z80A-SIO/1	4 MHZ	17.25	156.82	1,425.60	----
Z80A-SIO/2	4 MHZ	17.25	156.82	1,425.60	----
Z80A-SIO/9	4 MHZ	15.02	136.49	1,240.80	----
Z80A-DART	4 MHZ	7.99	72.60	660.00	----
Z8001-CPU	4 MHZ	94.80	---	---	----
6800	1.0 MHZ	4.80	43.56	396.00	3,600.00
68A00	1.5 MHZ	4.86	44.17	401.50	3,650.00
68B00	2.0 MHZ	5.04	45.74	415.80	3,780.00
6802	1.0 MHZ	4.80	43.56	396.00	3,600.00
6809	1.0 MHZ	14.38	130.68	1,188.00	----
6810	450 NS	1.52	13.80	125.40	1,140.00
68A10	350 NS	1.59	14.40	130.90	1,190.00
68B10	250 NS	1.60	14.52	132.00	1,200.00
6820	1.0 MHZ	2.00	18.15	165.00	1,500.00
6821	1.0 MHZ	2.00	18.15	165.00	1,500.00
68A21	1.5 MHZ	2.24	20.33	184.80	1,680.00
68B21	2.0 MHZ	2.56	23.24	211.20	1,920.00
6840	1.0 MHZ	3.60	32.67	297.00	2,700.00
68A40	1.5 MHZ	3.67	33.28	302.50	2,750.00
68B40	2.0 MHZ	4.00	36.30	330.00	3,000.00
6844	1.0 MHZ	8.79	79.86	726.00	----
6845	1.0 MHZ	8.79	79.86	726.00	----
6847	1.0 MHZ	6.39	58.08	528.00	----
6850	1.0 MHZ	1.92	17.43	158.40	1,440.00
68A50	1.5 MHZ	1.99	18.03	163.90	1,490.00
68B50	2.0 MHZ	2.24	20.33	184.80	1,680.00
6852	1.0 MHZ	2.24	20.33	184.80	1,680.00
68A52	1.5 MHZ	2.56	23.24	211.20	1,920.00
68B52	2.0 MHZ	3.20	29.04	264.00	2,400.00
6854	1.0 MHZ	5.99	54.45	495.00	----
68A54	1.5 MHZ	6.71	60.99	554.40	----
68B54	2.0 MHZ	7.43	67.52	613.80	----
6856	1.0 MHZ	31.95	290.40	---	----
68488	1.0 MHZ	6.39	58.08	528.00	----
2114L	450 NS	1.60	14.52	132.00	1,200.00
2114L-2	200 NS	2.00	18.15	165.00	1,500.00
2114L-1	150 NS	2.50	22.60	205.95	1,872.00
6116-3	150 NS	9.19	83.49	759.00	----
4116-3	200 NS	1.76	15.98	145.20	1,320.00
4116-2	150 NS	1.84	16.70	151.80	1,380.00
2708	450 NS	3.28	29.77	270.60	2,460.00
2716	450 NS	5.20	47.19	429.00	3,900.00
2732	450 NS	14.45	131.34	1,194.00	----

SOLDER-TAB SOCKETS

NO. OF PINS	PRICE PER 1	10	100	1000
8-PIN	$0.09	$0.79	$ 7.15	$ 65.00
14-PIN	0.10	0.91	8.25	75.00
16-PIN	0.11	1.00	9.08	82.50
18-PIN	0.13	1.17	10.59	96.25
20-PIN	0.15	1.29	11.69	106.25
22-PIN	0.16	1.38	12.48	113.45
24-PIN	0.17	1.52	13.75	125.00
28-PIN	0.20	1.82	16.50	150.00
40-PIN	0.29	2.58	23.38	212.50

Hitachi Denshi, Ltd.

OSCILLOSCOPES

MODEL	DESCRIPTION	PRICE
V-151B	15MHZ, SINGLE TRACE	$ 427.50
V-152B	15MHZ, DUAL TRACE	551.25
V-202	20MHZ, DUAL TRACE	637.50
V-301	30MHZ, SINGLE TRACE	558.75
V-302B	30MHZ, DUAL TRACE	746.25
V-352	35MHZ, DUAL TRACE	862.50
V-550B	50MHZ, DUAL TRACE	1,308.75
V-1050	100MHZ, QUAD TRACE	1,792.50

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7400

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

74LS

74LS00	.29	74LS92	.75	74LS192	1.15
74LS01	.29	74LS93	.75	74LS193	1.15
74LS02	.29	74LS95	.99	74LS194	1.15
74LS03	.29	74LS96	1.15	74LS195	1.15
74LS04	.35	74LS107	.45	74LS197	1.19
74LS05	.35	74LS109	.45	74LS221	1.19
74LS08	.35	74LS112	.45	74LS240	1.49
74LS09	.35	74LS113	.49	74LS241	1.49
74LS10	.35	74LS114	.49	74LS242	1.49
74LS11	.39	74LS122	.89	74LS243	1.49
74LS12	.35	74LS123	1.25	74LS244	1.49
74LS13	.59	74LS125	.59	74LS245	2.95
74LS14	.99	74LS126	.59	74LS247	1.19
74LS15	.35	74LS132	.99	74LS248	1.19
74LS20	.35	74LS133	.89	74LS249	1.19
74LS21	.35	74LS136	.49	74LS251	.99
74LS22	.35	74LS138	.89	74LS253	.99
74LS26	.35	74LS139	.89	74LS257	.89
74LS27	.35	74LS151	.89	74LS258	.69
74LS28	.35	74LS153	.89	74LS260	.69
74LS30	.35	74LS154	1.75	74LS266	.69
74LS32	.35	74LS155	.89	74LS273	1.95
74LS33	.59	74LS156	.89	74LS279	.89
74LS37	.45	74LS157	.89	74LS283	.89
74LS38	.39	74LS158	.89	74LS290	.99
74LS40	.35	74LS160	1.15	74LS293	.99
74LS42	.89	74LS161	1.15	74LS298	1.25
74LS47	.89	74LS162	1.15	74LS352	1.29
74LS48	1.15	74LS163	1.15	74LS353	1.29
74LS49	1.15	74LS164	1.15	74LS365	.69
74LS51	.35	74LS165	1.15	74LS366	.69
74LS54	.35	74LS166	1.15	74LS367	.69
74LS55	.35	74LS168	1.19	74LS368	.69
74LS73	.45	74LS169	1.19	74LS373	1.95
74LS74	.45	74LS170	1.95	74LS374	1.95
74LS75	.59	74LS173	.99	74LS375	.89
74LS76	.45	74LS174	.99	74LS386	.69
74LS78	.49	74LS175	.99	74LS393	2.49
74LS83	.89	74LS181	2.95	74LS399	2.49
74LS85	1.25	74LS190	1.25	74LS670	2.49
74LS86	.49	74LS191	1.25	81LS95	1.95
74LS90	.69			81LS97	1.95

74S

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

CA—LINEAR

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

CD—CMOS

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

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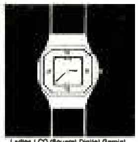
80396-5W Sugg. Retail $150.00

Ladies LCD (Round) Digital Gemini
Gold with Gold Link Metal Strap
82398-3Y Sugg. Retail $165.00



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LITRONIX Stick Display Sale

WHILE THEY LAST! — SALE!

MULTI DIGIT REFLECTOR ARRAYS FOR CLOCKS

PART NUMBER/COLOR	CHAR HT (IN.)	POLARITY	DESCRIPTION SEGMENT/DIGIT	OVERALL SIZE Length x Height x Depth	LIGHT OUTPUT (MCD) TYP	MIN	@mA	FORWARD VOLTAGE SEGMENT (V) TYP	MAX	CONTINUOUS FORWARD CURRENT PER SEGMENT (mA) MAX	PRICE	2 FOR SALE
DL-4501 (Red)	.50	C C MPX	With Colon and Auxiliary Indicators	[illegible]	1	.5	10	1.7	2.0	30	1.95	2/2.95
DL-4507 (Red)				[illegible]		1.0					1.75	2/2.95
DL-G-4501 (Grn)		C C		[illegible]							4.95	2/7.95
DL-4505A (Red)		non-MPX		[illegible]							2.48	2/2.95

MULTI DIGIT REFLECTOR ARRAYS

PART NUMBER/COLOR	CHAR HT (IN.)	POLARITY	DESCRIPTION SEGMENT/DIGIT	OVERALL SIZE	LIGHT OUTPUT (MCD) TYP	MIN	@mA	FORWARD VOLTAGE TYP	MAX	CURRENT MAX	PRICE	2 FOR SALE
DL-2M (Red)	.30	C C MPX	[illegible]	[illegible]				1.7			.79	2/1.90
DL-G-3LB (Grn)	.30	C A MPX	[illegible]	[illegible]								2/1.19
DL-4M (Red)	.30	C C MPX	[illegible]	[illegible]							1.49	2/1.95
DL-5LB (Red)	.50	C A MPX	[illegible]	[illegible]							2.25	2/3.49

NATIONAL Stick Display Sale

LIMITED QUANTITY — SALE!

LED NUMERIC ARRAYS

PART NO	DIGIT SIZE (RED)	FORMAT	DRIVE Comm Cathode/Comm Anode	OVERALL SIZE	PRICE	SALE
NSA188	100 (9 Bubble Stick)	888888	CC 6 Digit Multiplexed	2" L x .72" H x .27" D	[illegible]	2/1.99
NSA198	100 (9 Bubble Stick)	888888888	CC 9 Digit Multiplexed	2" L x .72" H x .27" D	[illegible]	2/1.99
NSA298	100 (9 Bubble Stick)	888888888	CC 9 Digit Multiplexed	[illegible]	[illegible]	2/1.99
NSA1140	100 (8 Bubble Stick)	88 88	CC 4 Digit Multiplexed	2" L x .72" H x .27" D	[illegible]	2/1.79
NSA1150	100 (9 Bubble Stick)	8 88 88	CC 5 Digit Multiplexed	2" L x .72" H x .27" D	[illegible]	2/1.59
NSA1188	140 (9 Bubble Stick)	88888888	CC 8 Digit Multiplexed	[illegible]	[illegible]	2/1.19

MULTI-DIGIT LED NUMERIC DISPLAYS

PART NO	DIGIT SIZE (RED)	FORMAT	DRIVE	OVERALL SIZE	PRICE	SALE
NSN373	3 No Decimal	88	CC 2 Digit Direct	[illegible]	[illegible]	2/1.79
NSN374	3 No Decimal	88	CA 2 Digit Direct	[illegible]	[illegible]	2/1.99
NSN501	5 No Decimal	88	CA 2 Digit Direct	[illegible]	[illegible]	2/1.49
NSN581	5	88	CC 2 Digit Multiplexed	[illegible]	[illegible]	2/1.79
NSN583	5	88	CC 2 Digit Direct	[illegible]	[illegible]	2/1.79
NSN781	7	88	CC 2 Digit Multiplexed	[illegible]	[illegible]	2/1.86
NSB2100	3	[illegible]	CC 8 Digit (10 Spaces)	[illegible]	[illegible]	2/1.89
NSB3001	3	8888	CC 4 Digit Multiplexed	[illegible]	[illegible]	2/1.89
NSB3382	3	1888	CA 3½ Digit Multiplexed	[illegible]	[illegible]	2/1.49
NSB3411	3	[illegible]	CC 4 Digit Colon/PM Indicator	[illegible]	[illegible]	2/1.19
NSB3852	3	8 88 88	CC 6 Digit AM/PM, Failure Ind	[illegible]	[illegible]	2/3.96
NSB3884	3	88888888	CA 8 Digit Multiplexed	[illegible]	[illegible]	2/3.95
NSB3881	3	8888	CC 4 Digit Multiplexed	[illegible]	[illegible]	2/4.95
NSB3882*	3	8888	CA 4 Digit Multiplexed	[illegible]	[illegible]	2/4.95
NSB5382*	5	1888	CA 3½ Digit Multiplexed	[illegible]	[illegible]	2/5.96
NSB6441	5	88 88	CC 4 Digit AM/PM Colon Ind	[illegible]	[illegible]	2/3.96
NSB5881	5	8888	CC 4 Digit Multiplexed	[illegible]	[illegible]	2/5.96
NSB6882*	5	8888	CA 4 Digit Multiplexed	[illegible]	[illegible]	2/5.96
NSB5918	5	1888	CA 3½ Digit Multiplexed	[illegible]	[illegible]	2/3.49
NSB5922	5	88888	CA 5 Digit Multiplexed	[illegible]	[illegible]	2/3.49
NSB7623	7	888888	CC 6 Digit Multiplexed	[illegible]	[illegible]	2/4.95

*Standard Stocked Items — only pin out specifications available on non stocked items

COMPUTER GRADE CAPACITORS

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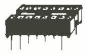
MFD	WVDC	PRICE	MFD	WVDC	PRICE	MFD	WVDC	PRICE
250	150	1.95	10,000	15	2.95	24,000	20	2.95
500	200	2.49	10,000	16	3.95	27,000	10	2.95
1,250	3	.99	11,000	[illegible]	4.95	32,500	25	4.95
1,500	25	1.95	11,000	[illegible]	[illegible]	[illegible]	25	5.95
1,500	50	2.95	11,000	[illegible]	[illegible]	[illegible]	[illegible]	7.95
2,000	10	2.95	13,000	16	2.95	50,000	20	7.95
2,250	100	3.95	14,000	13	2.95	52,000	20	5.95
2,300	33	2.95	14,000	35	3.95	55,000	15	5.95
2,500	15	2.95	18,000	10	3.95	58,000	20	5.95
3,000	25	1.95	20,000	20	2.95	65,000	10	7.95
3,600	40	3.95	20,000	55	3.95	73,800	5	7.95
4,500	50	3.95	21,000	15	3.95	80,000	15	9.95
5,500	25	4.49	23,000	7	1.95	90,000	10	6.95
6,100	40	2.49	23,000	10	2.95	160,000	10	8.95
6,600	50	4.95	73,000	20	1.95	200,000	3	12.95

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

LOW PROFILE (TIN) SOCKETS

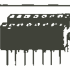


	1-24	25-49	50-100
8 pin LP	.17	.16	.15
14 pin LP	.20	.19	.18
16 pin LP	.22	.21	.20
18 pin LP	.29	.28	.27
20 pin LP	.34	.32	.30
22 pin LP	.37	.36	.35
24 pin LP	.38	.37	.36
28 pin LP	.45	.44	.43
36 pin LP	.60	.59	.58
40 pin LP	.63	.62	.61

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL (GOLD) STANDARD



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

WIRE WRAP SOCKETS (GOLD) LEVEL #3

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

1/4 WATT RESISTOR ASSORTMENTS — 5%

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

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4/82

INTERSIL

Part No.	Function		Price
7045IPI	CMOS Precision Timer		14.95
7045EV/Kit*	Stopwatch Chip, XTL		24.95
7106CPL	3½ Digit A/D (LCD Drive)		16.95
7106EV/Kit*	IC, Circuit Board, Display		34.95
7107CPL	3½ Digit A/D (LED Drive)		15.95
7107EV/Kit*	IC, Circuit Board, Display		29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.		18.95
7117CPL	3½ Digit A/D LED Dis. HLD.		17.95
7201IDR	Low Battery Volt Indicator		2.25
7205IPG	CMOS LED Stopwatch/Timer		12.95
7205EV/Kit*	Stopwatch Chip, XTL		19.95
7206CJPE	Tone Generator		5.15
7206CEV/Kit*	Tone Generator Chip, XTL		12.95
7207AIPD	Oscillator Controller		6.50
7207AEV/Kit*	Freq. Counter Chip, XTL		13.95
7208IPI	Seven Decade Counter		17.95
7209IPA	Clock Generator		3.95
7215IPG	4 Func. CMOS Stopwatch CKT		13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL		19.95
7216AIJI	8-Digit Univ. Counter C.A.		32.00
7216CIJI	8-Digit Freq. Counter C.A.		26.95
7216DIPI	8-Digit Freq. Counter C.C.		21.95
7217IJI	4-Digit LED Up/Down Counter		12.95
7218CIJI	8-Digit Univ. LED Drive		10.95
7224IPL	LCD 4½ Digit Up Counter DRI		11.25
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	CMDS 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 Oual Op Amp Comp.	5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp.	10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp.	10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp.	10MV	7.50
7660CPA	Voltage Converter		2.95
8038CCPD	Waveform Generator		4.95
8048CCPE	Monolithic Logarithmic Amp		21.60
8069CCQ	50ppm Band—GAP Volt Ref. Diode		2.50
8211CPA	Volt Ref/Indicator		2.95
8212CPA	Volt Ref/Indicator		2.95

74C

74C00	.39	74C95	1.59	74C221	1.95
74C02	.39	74C107	1.89	74C240	2.25
74C04	.39	74C151	2.95	74C244	2.25
74C08	.39	74C154	3.95	74C373	2.49
74C10	.39	74C157	2.25	74C374	2.59
74C14	.75	74C160	1.69	74C901	.69
74C20	.39	74C161	1.60	74C903	.69
74C30	.39	74C162	1.49	74C911	10.95
74C42	1.39	74C163	1.69	74C912	10.96
74C48	1.95	74C164	1.59	74C915	1.69
74C73	.79	74C173	1.39	74C917	10.95
74C74	.79	74C174	1.39	74C922	5.49
74C85	1.95	74C175	1.19	74C923	5.75
74C86	.99	74C192	1.69	74C925	7.50
74C89	6.95	74C193	1.69	74C926	7.50
74C90	1.29	74C195	1.59	80C95	.79
74C93	1.29			80C97	.79

LINEAR

LH0002CN	6.85	LM340T-5	1.25	LM702H	.79
LM10CLH	4.50	LM340T-12	1.25	LM703CN	.89
LM11CLH	4.75	LM340T-15	1.25	LM709N	.29
LH0070-OH	4.95	LM341P-5	.75	LM710N	.79
TL071CP	.79	LM341P-12	.75	LM711N	.79
TL072CP	1.39	LM341P-15	.75	LM723N	.69
TL074CN	2.49	LM342P-5	.69	LM733N	1.00
LH0082CD	35.80	LM342P-12	.69	LM739N	1.19
TL082CP	1.19	LM342P-15	.69	LM741CN	.35
TL084CN	2.19	LM348N	1.25	MC1741SCG	3.00
LH0094CD	36.80	LM350K	5.75	LM747N	.79
LM300H	.99	LF351N	.60	LM748N	.59
LM301CN	.35	LF353N	1.00	LM1014N	2.75
LM302H	1.95	LF355N	1.10	LM1310N	1.95
LM304H	1.95	LF356N	1.10	LM1458CN	.59
LM305H	.99	LM358N	1.00	LM1488N	1.25
LM307CN	.45	LM359N	1.79	LM1489N	1.25
LM308CN	1.00	LM370N	4.49	LM1496N	1.95
LM309H	1.95	LM373N	3.25	LM1556V	1.75
LM309K	1.25	LM377N	2.95	LM1800N	2.95
LM310CN	1.75	LM380N	1.25	LM1871N	5.49
LM311/CN	.90	LM381N	1.95	LM1872N	5.49
LM312H	2.49	LM382N	1.79	LM1877N-9	3.25
LM317MP	1.15	LM384N	1.95	LM1889N	3.20
LM317T	1.75	LM386N-3	1.29	LM1896N	1.75
LM317K	3.95	LM387N	1.45	LM2002T	1.49
LM318CN	1.95	LM389N	1.35	LM2877P	2.05
LM319N	1.95	LM392N	.69	LM2878P	2.25
LM320K-5	1.35	LF398N	4.00	LM2896P-1	2.25
LM320K-12	1.35	LM399H	5.00	LM3189N	2.95
LM320K-15	1.35	TL494CN	4.49	LM3900N	.69
LM320T-5	1.25	TL496CP	1.75	LM3905CN	1.25
LM320T-12	1.25	NE510A	6.00	LM3909N	1.15
LM320T-15	1.25	NE529A	4.95	LM3914N	3.95
LM323K	5.95	NE531H	3.95	LM3915N	3.95
LM324N	.99	NE536H	6.00	LM3916N	3.95
LM329DZ	.65	NE540H	6.00	RC4136N	1.25
LM331N	3.95	NE544N	4.95	RC4151NB	3.95
LM334Z	1.30	NE550A	1.30	RC4194TK	6.95
LM335Z	1.40	NE555V	.39	RC4195TK	5.49
LM336Z	1.75	LM556N	.99	LM4500A	3.25
LM337T	1.95	NE564N	3.95	ICL8038B	4.95
LM337MP	1.15	LM565N	1.25	LM13080N	1.29
LM338K	6.95	LM566CN	1.95	LM13600N	1.49
LM339N	.99	LM567V	1.25	75138N	1.95
LM340K-5	1.35	NE570N	4.95	75450N	.89
LM340K-12	1.35			75451CN	.39
LM340K-15	1.35			75492	.89

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

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

100 VOLT MYLAR FILM CAPACITORS

Value	1-9	10-99	100+	Value	1-9	10-99	100+
.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

Value	1-9	10-99	100+	Value	1-9	10-99	100+
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.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

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.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

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2716	2048 x 8	(5V) (450ns)	5.50	4.95
2716-1	2048 x 8	(5V) (350ns)	9.00	8.50
TMS2716	2048 x 8	(450ns)	9.95	8.95
TMS2532	4096 x 8	(5V) (450ns)	12.95	11.95
2732	4096 x 8	(5V) (450ns) (200ns)		CALL
2764	8192 x 8	(5V) (450ns)		CALL

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4027	4096 x 1	(250ns)	2.50	2.00
4116-120	16,384 x 1	(120ns)	8/29.95	CALL
4116-150	16,384 x 1	(150ns)	8/18.95	1.95
4116-200	16,384 x 1	(200ns)	8/15.95	1.80
4116-300	16,384 x 1	(300ns)	8/14.95	1.75
4164	64,536 x 1	(200ns)		CALL

STATIC RAMS

				100 pcs
2101	256 x 4	(450ns)	1.95	1.85
2102-1	1024 x 1	(450ns)	.89	.85
21L02-4	1024 x 1	(LP) (450ns)	1.29	1.15
21L02-2	1024 x 1	(LP) (250ns)	1.69	1.55
2111	256 x 4	(450ns)	2.99	2.49
2112	256 x 4	(450ns)	2.99	2.79
2114	1024 x 4	(450ns)	8/16.95	1.95
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2114L-3	1024 x 4	(LP) (300ns)	8/18.95	2.25
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TMS4044-4	4096 x 1	(450ns)	3.49	3.25
TMS4044-3	4096 x 1	(300ns)	3.99	3.75
TMS40L44-2	4096 x 1	(LP) (200ns)	4.49	4.25
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6.5536	3.95
8.0	3.95
10.0	3.95
14.31818	3.95
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18.432	3.95
20.0	3.95
22.1184	3.95
32.0	3.95

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8T96	.99
8T97	.99
8T98	.99
DM8131	2.95
DS8836	1.29

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MM5375	3.95
MSM5832	7.45
7207	7.50
7208	15.95

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MC1408 L8	4.95
DAC-0800	4.95
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Z80B	CPU 6MHZ	17.95
Z80A	CPU 4MHZ	6.00
Z80A	PIO 4MHZ	6.00
68000	CPU 4-10MHZ	call
6802	MPU, CLK, RAM	9.95
6845	CRT CONTROLLER	15.95
6502A	CPU 2MHZ	8.95
6502B	CPU 3MHZ	15.95
8086	16 BIT CPU	59.95
8088	8 BIT CPU	34.95
8089	8/16 BIT PROC	89.95

14 Pin Gold Wirewrap Sockets .49ea
16 Pin Gold Wirewrap Sockets .59ea

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74LS02	.25	74LS90	.65	74LS170	1.75	74LS324	1.75
74LS03	.25	74LS91	.89	74LS173	.80	74LS352	1.55
74LS04	.25	74LS92	.70	74LS174	.95	74LS353	1.55
74LS05	.25	74LS93	.65	74LS175	.95	74LS363	1.35
74LS08	.35	74LS95	.85	74LS181	2.15	74LS364	1.95
74LS10	.25	74LS96	.95	74LS189	9.95	74LS365	.95
74LS11	.35	74LS107	.40	74LS190	1.00	74LS366	.95
74LS12	.35	74LS109	.40	74LS191	1.00	74LS367	.70
74LS13	.45	74LS112	.45	74LS192	.85	74LS368	.70
74LS14	1.00	74LS113	.45	74LS193	.95	74LS373	.99
74LS15	.35	74LS114	.50	74LS194	1.00	74LS374	1.75
74LS20	.25	74LS122	.45	74LS195	.95	74LS377	1.45
74LS21	.35	74LS123	.95	74LS196	.85	74LS378	1.18
74LS22	.25	74LS124	2.99	74LS197	.85	74LS379	1.35
74LS26	.35	74LS125	.95	74LS221	1.20	74LS385	1.90
74LS27	.35	74LS126	.85	74LS240	.99	74LS386	.65
74LS28	.35	74LS132	.75	74LS241	.99	74LS390	1.90
74LS30	.25	74LS136	.55	74LS242	1.85	74LS393	1.90
74LS32	.35	74LS137	.99	74LS243	1.85	74LS395	1.65
74LS33	.55	74LS138	.75	74LS244	.99	74LS399	1.70
74LS37	.55	74LS139	.75	74LS245	1.90	74LS424	2.95
74LS38	.35	74LS145	1.20	74LS247	.76	74LS447	.37
74LS40	.35	74LS147	2.49	74LS248	1.25	74LS490	1.95
74LS42	.55	74LS148	1.35	74LS249	.99	74LS668	1.69
74LS47	.75	74LS151	.75	74LS251	1.30	74LS669	1.89
74LS48	.75	74LS153	.75	74LS253	.85	74LS670	2.20
74LS49	.75	74LS154	2.35	74LS257	.85	74LS674	9.65
74LS51	.25	74LS155	1.15	74LS258	.85	74LS682	3.20
74LS54	.35	74LS156	.95	74LS259	2.85	74LS683	2.30
74LS55	.35	74LS157	.75	74LS260	.65	74LS684	2.40
74LS63	1.25	74LS158	.75	74LS266	.55	74LS685	2.40
74LS73	.40	74LS160	.90	74LS273	1.65	74LS688	2.40
74LS74	.45	74LS161	.95	74LS275	3.35	74LS689	2.40
74LS75	.50	74LS162	.95	74LS279	.55	81LS95	1.69
74LS76	.40	74LS163	.95	74LS280	1.98	81LS96	1.69
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74C04	.35	74C902	.85	4021	.95	14409	12.95
74C08	.35	74C903	.85	4022	1.15	14410	12.95
74C10	.35	74C905	10.95	4023	.35	14411	11.95
74C14	1.50	74C906	.95	4024	.75	14412	12.95
74C20	.35	74C907	1.00	4025	.35	14419	4.95
74C30	.35	74C908	2.00	4026	1.65	4502	.95
74C32	.50	74C909	2.75	4027	.65	4503	.65
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74C74	.85	74C914	1.95	4034	2.95	4512	.95
74C76	.80	74C915	2.00	4035	.85	4514	1.25
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74C93	1.75	74C925	6.75	4046	.95	4522	1.25
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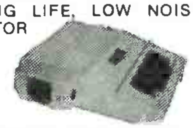

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18 pin ST	.20	.18
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22 pin ST	.30	.27
24 pin ST	.30	.27
28 pin ST	.40	.32
40 pin ST	.49	.39

ST = SOLDERTAIL

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78L05	.69	79L12	.79
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78L15	.69		
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75451V	.39
75452V	.39
75453V	.39

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7401	.19	7453	.23	74141	.65	74190	1.15
7402	.19	7454	.23	74142	2.95	74191	1.15
7403	.19	7460	.23	74143	2.95	74192	.79
7404	.19	7470	.35	74144	2.95	74193	.79
7405	.22	7472	.29	74145	.60	74194	.85
7406	.22	7473	.34	74147	1.75	74195	.85
7407	.22	7474	.35	74148	1.20	74196	.79
7408	.24	7475	.49	74150	1.35	74197	.75
7409	.19	7476	.35	74151	.65	74198	1.35
7410	.19	7480	.59	74152	.65	74199	1.35
7411	.25	7481	1.10	74153	.55	74221	1.35
7412	.30	7482	.95	74154	1.40	74246	1.35
7413	.35	7483	.50	74155	.75	74247	1.25
7414	.55	7485	.65	74156	.65	74248	1.85
7416	.25	7486	.35	74157	.55	74249	1.95
7417	.25	7489	4.95	74159	1.65	74251	.75
7420	.19	7490	.35	74160	.85	74259	2.25
7421	.35	7491	.40	74161	.70	74265	1.35
7422	.29	7492	.50	74162	.85	74273	1.95
7423	.29	7493	.49	74163	.85	74276	1.25
7425	.29	7494	.65	74164	.85	74279	.75
7426	.29	7495	.55	74165	.85	74283	2.00
7427	.29	7496	.70	74166	1.00	74284	3.75
7428	.45	7497	2.75	74167	2.95	74285	3.75
7430	.19	74100	1.00	74170	1.65	74290	.95
7432	.29	74107	.30	74172	5.95	74293	.75
7433	.45	74109	.45	74173	.75	74298	.85
7437	.29	74110	.45	74174	.89	74351	2.25
7438	.29	74111	.55	74175	.89	74365	.65
7440	.19	74116	1.55	74176	.89	74366	.65
7442	.49	74120	1.20	74177	.75	74367	.65
7443	.65	74121	.29	74178	1.15	74368	.65
7444	.69	74122	.45	74179	1.75	74376	2.20
7445	.69	74123	.55	74180	.75	74390	1.75
7446	.59	74125	.45	74181	2.25	74393	1.35
7447	.69	74126	.45	74182	.75	74425	3.15
7448	.69	74128	.55	74184	2.00	74426	.85
7450	.19	74132	.45	74185	2.00	74490	2.55

74S00 SERIES

74S00	.44	74S74	.69	74S163	3.75	74S257	1.39
74S02	.48	74S85	2.39	74S168	4.65	74S258	1.49
74S03	.48	74S86	1.44	74S169	5.44	74S260	1.83
74S04	.79	74S112	1.59	74S174	1.09	74S274	19.95
74S05	.79	74S113	1.98	74S175	1.09	74S275	19.95
74S08	.48	74S114	1.50	74S181	4.47	74S280	2.90
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74S30	.48	74S139	1.25	74S197	4.25	74S381	7.95
74S32	.98	74S140	1.45	74S201	14.95	74S387	5.75
74S37	1.87	74S151	1.19	74S225	8.95	74S412	2.98
74S38	1.68	74S153	1.19	74S240	3.98	74S471	9.95
74S40	.44	74S157	1.19	74S241	3.75	74S472	16.85
74S51	.78	74S158	1.45	74S244	3.98	74S474	17.85
74S64	.79	74S161	2.85	74S251	1.90	74S482	15.60
74S65	1.25	74S162	3.70	74S253	7.45	74S570	7.80
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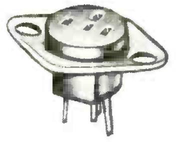

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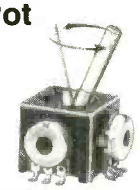

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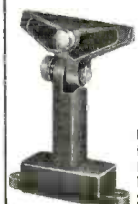

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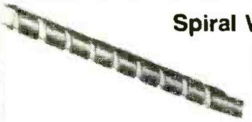

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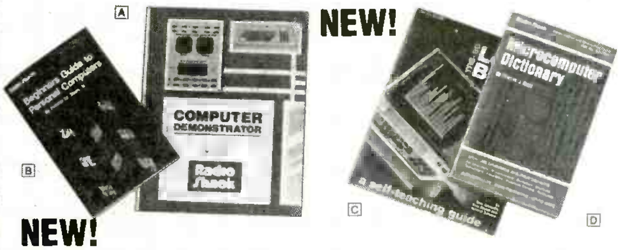

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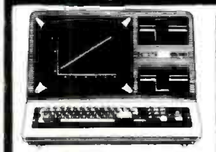

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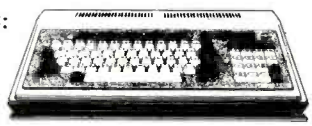

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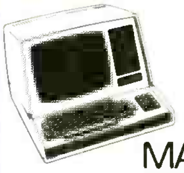

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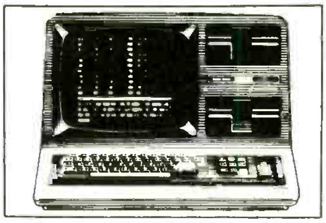

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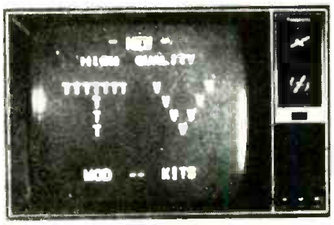

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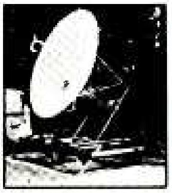

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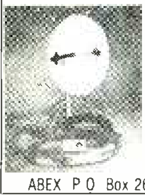

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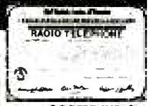

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A 3" FLOPPY DISK STANDARD has been agreed upon by three companies: Matsushita, Hitachi, and Hitachi Maxell. The standardization will apply to the new 3" Compact Floppy Disk, scheduled for U. S. distribution sometime this year. Though the 3" represents a smaller format than the 5" Mini Floppy Disk currently in widespread use, it is compatible with the existing drive system for the Mini Floppy and, by increasing the data density per track, offers the same recording capacity, rotation speed, and data transfer rate. Chief advantage of the new format is said to be its smaller size (8 cm W x 10 cm L x 0.5 cm D), permitting it to be carried in a shirt pocket. Protective features associated with the standard 5" disks—write-protect, easy identification on the case, window shutters, etc.—are retained in the new format.

PIEZOELECTRIC TECHNOLOGY has found a new application in dot-matrix printers: quartz piezo-crystals, sheathed between metal plates, could be substituted for the solenoids that actuate wires in conventional dot-matrix printers, according to Piezoelectric Products, Inc., New Jersey. Because only a few milliamperes are necessary to cause rapid bending in a piezo-crystal, the problem of ohmic heating does not arise. Thus, print speeds of up to 1000 characters per second are said to be possible without excess heat damaging the machine.

PINBALL GAME WIZARDS will soon be able to hone their skills on a miniaturized, electronically controlled pinball machine at their favorite pub. Called "Micropin," from Micropin Corp., Pasadena, CA, the pinball machine is designed to fit on a bar top—right next to your Jack Daniels. It uses contactless Micro Switch 8SS Hall-effect switches to activate the flippers, ensuring especially long switch life. Up to four people can participate in real-metal-ball action. Furthermore, a rubber shock mounting allows players to "gunch" (nudge the machine from side to side to steer the ball with less chance for a tilt penalty). Scoring and sequencing are microprocessor-controlled, with electronic digital LED display. High score is kept in memory and displayed. A bartender controls start of each game from the compact (30" L x 13" W x 16" H) machine's rear, including handling the money (four balls for a quarter).

TALKING CHIPS will be supplied by Texas Instruments for Chrysler's 1983 model production. Along with the TMS-P control processor, the chip set includes the TMS-6125 32-bit ROM and the TMS-5110-A speech processor, which uses TI's LPC (Linear Predictive Coding). The "talking car" will provide up to eleven messages that are digitally stored by a microcomputer located in the glove compartment. The system will voice alerts such as "Your engine is overheating—prompt service is required." The message is delivered over the car radio—interrupting the program if the radio is on.

FIXED-DISC HOME AUDIO has been successfully tested by the Digital Recording Corp. (Salt Lake City, Utah). According to the company, a laboratory prototype of its patented in-home digital audio player is now capable of reproducing high-fidelity music. The unit uses a low-power laser beam to scan the digital code on a fixed, film-like record. The code is then converted into an audio signal that is said to be virtually free of noise. One advantage reported over the spinning disc is its potential for use with a device to change records.

AN ELECTRIC GUITAR that uses optical fibers instead of metal strings has been unveiled by Dynamic Systems, Inc. of McLean, VA. Musical notes are created by tiny beams of light contained within the fibers. According to inventor, George D. Bowley, many of the problems associated with conventional electric guitars (such as noise and hum, limited frequency response, cable length restrictions, and electric shock hazards) are virtually eliminated by fiber optics. The question is: will rock and rollers still be able to smash their equipment onstage with the same short-circuit fireworks?

How to turn your HP-41 into a handheld computer.

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