Popular Electronics®

WORLD'S LARGEST SELLING ELECTRONICS MAGAZINE JUNE 1982/$1.25

How to Get Stereo Sound from TV & VCRs

Wireless System Stops Burglars Before They Enter

Add a Status Monitor to Extension Telephones

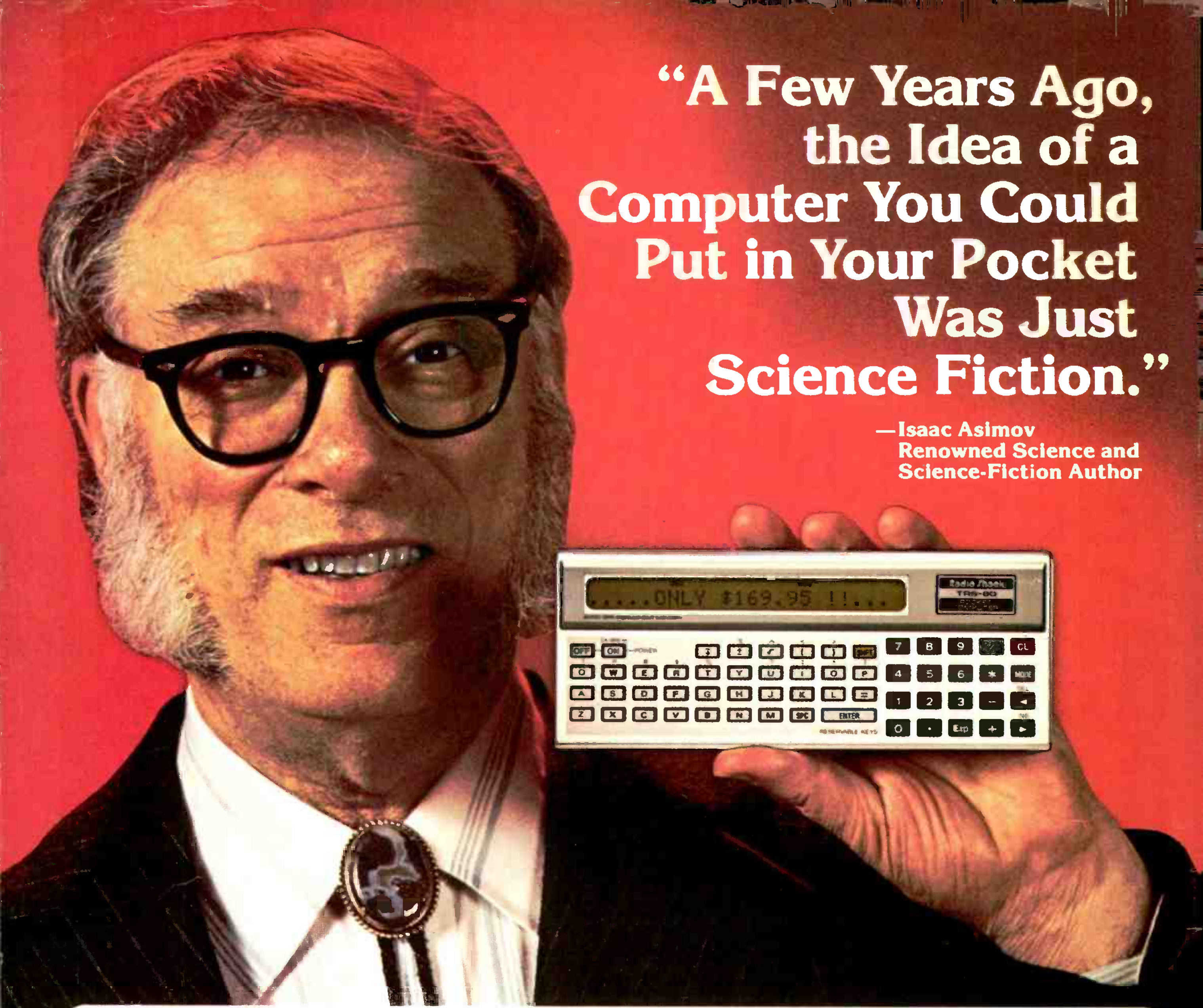
Big-Computer Performance from a Pocket Computer

Tested in this Issue:

...mputer System

...Audio/Video Control Amplifier

Sony NR ... -C Noise Reduction Processor



Today, Just $149.95 Buys a Radio Shack TRS-80® Pocket Computer—And That's a Fact!

Back when computers filled entire rooms, Isaac Asimov was writing about computers you could hold in your hand. "Radio Shack's TRS-80 Pocket Computer turned my dreams into reality. Now I can take the power of a true computer with me wherever I go," says Asimov.

The TRS-80 Pocket Computer is programmable in BASIC. Isaac, however, would rather write novels than programs. "If you're like me, you'll want to get a low cost interface that lets you use Radio Shack's ready-to-run programs." There are programs for engineering, finances, statistics—even real estate and aviation.

Programs and data stay in memory even when the Pocket Computer is turned off. And it can also function just like a calculator—something a desktop computer *can't* do.

"With a TRS-80 Pocket Computer, you can hold the future in the palm of your hand." Add our $79.95 Minisette®-9 cassette recorder and a Cassette Interface for $29.95, or a Cassette Interface with built-in printer for $127.95. They're all as close as your nearby Radio Shack store, dealer or Computer Center.

I want a glimpse of the future— send me a TRS-80 computer catalog.

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Radio Shack®

The biggest name in little computers™

Retail prices may vary at individual stores and dealers.

Digital Watch Radio

When people see you plug stereo headphones into your digital watch, they may wonder. Walkman, move over.

The samarium headphones and the Digital Watch Radio produce a strong sound you'll find hard to believe.

It all makes sense. If you wear your digital watch most of the time just adding an alarm, a chronograph, and even an hourly chime might make it more appealing. But adding a radio, that tops it all.

The Advance Digital Watch Radio is exactly that—a full-featured digital watch with a built-in AM radio that lets you listen to music, news and sports anytime, anywhere—all with a sound so powerful that you'll shake your head in disbelief.

Remember your surprise the first time you listened to a Sony Walkman or to one of the new headphone radios? Remember the sound quality, the deep bass response and the crystal clear highs? That's what you'll discover from that little sound package on your wrist. But wait, there's more.

NO EASY TASK

Keeping the radio small and powerful was no easy task. It involved new technology and some pretty clever thinking. For example, the volume control is located on the headphones and there is no on/off switch. Just plugging in the headphone jack turns on the radio.

The 2 milliamp circuit gives you over 100 hours of play from your radio—all from just one commonly available silver oxide battery. A separate battery runs your watch for over a year. But the features don't stop there.

The AM radio tuner is attached to a thin flat disc that you turn with your thumb. Stations come in clear and crisp and despite the tuner's small size, the stations are easy to fine tune thanks to a highly directional Hitachi radio antenna which has a low signal-to-noise ratio. But what about the watch?

FULL-FUNCTION WATCH

The Watch Radio is a full-function LCD digital alarm, chronograph timepiece with hourly componentry. The watch is an impressive product that could alone be worth $49.95.

Now, when you add the powerful AM radio and a set of samarium cobolt high fidelity headphones, only then can you appreciate the real value of the Watch Radio. Samarium cobalt, a space-age material, reduces the weight of the headphones, provides outstanding frequency response and replaces the need for the bulkier iron magnet traditionally used in today's smaller headphones. The combination of both the samarium cobalt headphones and the unique circuitry is one of the breakthroughs that has made this product possible.

With the lightweight headphones, you also get a small ear plug headphone which lets you monitor your radio without drawing too much attention to it. It's really a cheap listening device that makes a perfect accessory because you can easily carry it with you in your pocket or purse.

Now you can jog or play most sports without having to lug a cassette recorder or AM radio around. Just plug the long headphone wire into your watch and select your entertainment. At sporting events, while walking your dog, riding your bicycle or even waiting in line at the checkout counter, you've always got your entertainment with you. Think of it. Now to check the weather you can use your watch.

You can easily change the battery after 100 hours of use. The small opening to the right of the dial (shown in the photo at the bottom) is a sound port for the watch chime and alarm.

We suggest you order an Advance Digital Watch Radio on our 30-day, no obligation trial. We realize that it is impossible for you to imagine the incredible sound and the watch quality until you personally wear and use it. So, when you receive it, give it a real work out. Use it while you shop, work or play. Take it with you on a trip. See how handy it is when you want to check the weather or sports results.

But the most fun is watching the reactions of people who see you listening to your digital watch or seeing their expressions after they hear its powerful sound on your headphones. It's a product that people will find hard to believe—even in today's electronic revolution.

If after your testing you're not convinced that the Advance Digital Watch Radio is even more than we've described, no problem. Return your watch and headphones for a full refund including your $3.00 for postage and handling.

GREAT VALUE PACKAGE

But with all its advanced technology and sophisticated electronics, the Advance Digital Watch Radio is probably one of the greatest values we've ever offered in one complete package. A digital watch, a built-in radio, a handsome set of samarium cobalt headphones, a cheap ear plug headphone plus the batteries—all for $49.95. Each watch comes complete with a one-year limited warranty and all batteries. Just open up your package, plug in the headphones and you're ready to go.,

The Watch Radio offers us the opportunity to add some fun and everyday practicality to our life—all at a very reasonable price.

Technology keeps marching on. So, we wouldn't be surprised if the Advance engineers are working on the TV version of their new watch. And you won't be too surprised either—once you personally hear the phenomenal sound from their radio. Order your Digital Watch Radio at no obligation, today.

To order send a check or money order to the address below or credit card holders call toll-free **800 228-5000** (In Nebraska call **800 323-6400**). When ordering, please use order number (shown in parenthesis) for faster service. Please add 3.00 for postage and handling and Illinois residents add 6% sales tax.

Digital Watch Radio **$49.95** (2040PE01)

Send $1 for the new JS&A catalog

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JUNE 1982 VOLUME 20, NUMBER 6

Popular Electronics

WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

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COVER PHOTO DESIGN BY STEVEN HUNT

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A video cassette mechanism needs to be more than a package for your tape.

Your video cassette mechanism needs to do more than store and transport your video tape. Because a lot can go wrong with your picture that has nothing to do with your tape.

Our specially engineered cassette mechanism maintains proper tape tension, preventing jamming and snapped leaders so that your tape can have a longer life.

We also designed our mechanism for optimal tape-to-head contact to prevent skewing and jitters. And we use stainless steel pins to support the guide rollers which provide better alignment and tape-edge protection than the plastic pins used by some manufacturers.

TDK maintains tolerances up to 2½ times tighter than industry standards. We even build our video cassette shell halves to micron tolerances for an exact top and bottom match.

We do everything we can to make sure that TDK Super Avilyn video tape and the TDK super precision mechanism will combine to give you the best possible picture. That's why our video cassette mechanism is every bit as impressive as our video tape.

TDK®
The vision of the future.

CIRCLE NO. 46 ON FREE INFORMATION CARD

THE $149.95 PERSONAL COMPUTER.

Introducing the Sinclair ZX81.

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

The 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 first personal computer to break the price barrier at $200.

In fact, the ZX81's 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
- 164-page programming guide and operating manual

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. It comes with a comprehensive 164-page programming guide and operating manual designed for both beginners and experienced computer users. And you can use a regular cassette recorder to store and recall programs by name.

Order at no risk.**

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

And if you have a problem with your ZX81, send it to Sinclair Research within 90 days and we'll repair or replace it at no charge.

Introducing the ZX81 kit.

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

A leader in microelectronics.

The ZX81 represents the latest technology in microelectronics. More than 10,000 are sold every week. In fact, the ZX81 is the fastest selling personal computer in the world.

We urge you to place your order for the ZX81 today.

To order.

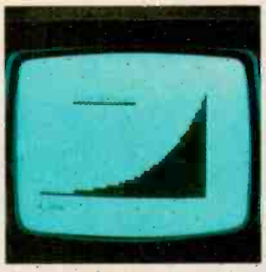
To order, simply call toll free. Or use the coupon below. Remember, you can try it for 10 days at no risk.** The sooner you order, the sooner you can start enjoying your own computer.

Call toll free 800-543-3000.

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

These numbers are for orders only. If you just want information, please write: Sinclair Research Ltd., 2 Sinclair Plaza, Nashua, NH 03061.

*Plus shipping and handling. Price includes connectors for TV and cassette, AC adaptor, and FREE manual.
**Does not apply to ZX81 kits.



NEW SOFTWARE: Sinclair has published pre-recorded programs on cassettes for your ZX81. 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. 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. Cost is $99.95, plus shipping and handling.

sinclair

To order call toll free: 800-543-3000

Ad Code 06PE	Price*	Qty.	Amount
ZX81	$149.95		
ZX81 Kit	99.95		
16K Memory Module	99.95		
Shipping and Handling	4.95		$4.95
		TOTAL	

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

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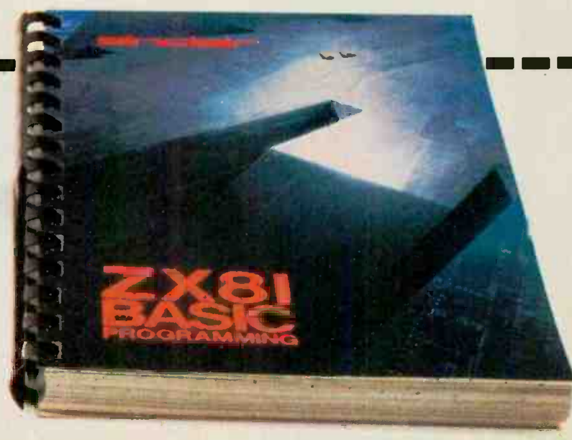
Address____________________

City__________ State________ Zip______

*U.S. dollars



EDITORIAL

Copping Out

copout: to back out (as of an unwanted responsibility).

The Federal Communications Commission (FCC) recently declined to endorse any of the five AM stereo transmission methods submitted to it. The Commision decided to allow the "marketplace" to determine which system(s) it wishes to use.

What a copout! To give you some background: the FCC chose one stereo AM system (Magnavox's) in 1980, then succumbed to a cacophony of screeches and screams from a variety of disappointed contenders and others who favored one system or another. So it did not finalize its endorsement, intending to study the proposals again. Now the FCC contends, in a 6-1 vote, that choosing a single system would cause further delays in introducing stereo AM owing to fears of a lengthy court fight.

What a copout!

The one dissenter, Abbot Washburn, notes that having competing systems out there would result in higher receiver prices for consumers, who would have to buy a receiver capable of tuning in the various AM stereo systems that could be used in their reception area. He also observed that this decision could delay AM stereo service (which has been on the FCC agenda since 1977).

A Commissioner who decided not to decide said that the action was "terribly unfortunate." Another apologized by calling the refusal " . . . a practical and political solution to a technical problem."

I believe that the FCC has sullied itself by not choosing a single, nationwide system. This is carrying a free-market philosophy too far. Will the AM stereo broadcast maker who is best financed overwhelm poorer competitors? Will the confusion of choosing from among multiple systems cause broadcasters to delay buying a transmitting system? Will radio receiver makers move more cautiously in producing units to receive the mix of transmissions that is likely to be chosen by various broadcasters?

According to the National Semiconductor Corporation, it has developed a low-cost AM stereo decoder chip that is universal to all AM stereo systems proposed. The pilot-tone section for each system has to be added, though, as do switching provisions. Since system compatibility extends beyond different pilot tones, I question whether performance of each system would be optimized, penalizing the consumer with less-than-the-best performance as well as higher price.

The ultimate loser in this comedy is the consumer, who will be forced to blithely switch his car stereo (estimated to be the largest radio market for AM stereo) from one stereo AM system to another as he rides merrily along a highway. This would be a dangerous distraction for any driver.

I hope that copping out won't become the order of the day for FCC decisions in the future.

Art Salsberg

Popular Electronics

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Can you improve excellence?

We can. By adding our Memotech Memopak to the excellence of the ZX81 we have achieved perfection.

The growth of interest in computer use caused by the introduction of the Sinclair ZX81 has made new and exciting demands on the ingenuity of electronic engineers. At Memotech we have focused our attention on the design of inexpensive, reliable memory extensions.

The Memopak is a 64K RAM pack which extends the memory of the ZX81 by a further 56K. The new memory extensions are designed to be within the price range expected by Sinclair users. It plugs directly into the back of the ZX81 and does not inhibit the use of the printer or other add-on boards. There is no need for an additional power supply or leads.

Increase your memory.

The Memopak together with the ZX81 gives a full 64K, which is neither switched nor paged, and is directly addressable. The unit is user transparent and accepts such basic commands as 10 DIM A(9000).

0-8K . . . Sinclair ZX81 ROM
8-16K . . . This section of memory switches in or out in 4K blocks to leave space for memory mapping, holds its contents during cassette loads, allows communication between programs, and can be used to run assembly language routines.
16-32K . . . This area can be used for basic programs and assembly language routines.
32-64K . . . 32K of RAM memory for basic variables and large arrays.

With the Memopak extension the ZX81 is transformed into a powerful computer, suitable for business, leisure and educational use, at a fraction of the cost of comparable systems.

Free service on your Memopak.

Within the first 90 days, should anything go wrong with your Memopak return it to us and we will fix or replace it free of charge.

Try Memopak with no obligation.

You can use our Memopak in your home without obligation. After 10 days, if you are not completely satisfied, simply return it for a full refund.

MEMOTECH

Memotech Corp.
7550 W. Yale Ave.
Suite 220
Denver Co. 80227
Ph. (303) 986-0016

Mail to: Memotech Corp. 7550 W. Yale Ave. Suite 220 Denver, Colo. 80227

I understand that if I'm not completely satisfied, I can return my Memopak in 10 days for a full refund.

	Price †	Qty.	Amount
Memopak 64k RAM	$ 179.95		
Memopak 16k RAM	$ 79.95		
Shipping and Handling	$ 4.95	———	$ 4.95
		Total	

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† U.S. Dollars

CIRCLE NO. 44 ON FREE INFORMATION CARD

LETTERS

SW Receiver Power Supply

I own a Sony ICF-2001 Receiver (April 1982) and I must say that, if there were a fire in my house, that receiver would be the first thing I would grab to carry out! However, you should have pointed out that, when operated on battery power, only a few hours of operation can be expected since the current drain is relatively high.—*Andrew Zum, San Francisco, CA.*

Needles for 78-RPM Records

With regard to the article "78-RPM Records Live Again!" by Raymond Bintliff (April 1982). I believe the author missed an important point. Isn't a 3-mil needle needed to play most 78-rpm records? A good stereo needle will be damaged quickly by using it with 78's. Also, the incorrect needle may damage valuable records.—*M. E. Marks, San Jose, CA.*

The article you mention had strictly to do with altering the player to run at 78 rpm. The subject of needles and tracking weight was not intended to be covered and would indeed make another entire article.—Ed.

Good Advice on Patents

Congratulations on Forrest Mims's two excellent columns on protecting ideas and obtaining patents (April and May 1982). He did a fine job of providing a concise and refreshingly accurate statement of the patenting process and post-issuance enforcement of patents.—*A. H. Gordon, Houston, TX.*

Toxic Gas Alarm

The "Alarm for Toxic Gases" described in your September 1981 issue is an excellent device for detecting products of combustion. This alarm is essential where fireplaces, wood-burning stoves and kerosene heaters are used. The popular smoke alarms sold in most stores detect particles of smoke only—not carbon monoxide and methane gas.—*J. Castelli, Romar Alarm Systems, Brooklyn, NY.*

Testing ILP's Amp

I thought you might be interested in the results of tests performed by the Swedish hobbyist publication *Radio och Television*, on the ILP Audio Amplifier Module in which they found, as you did, a problem with high-frequency oscillations. (See PE, February 1982.) They experimented with the hookup and found that the oscillations would disappear if the supply was decoupled with 1-μF at the module and the input ground connected directly to the ground terminal on the module rather than to the power-supply ground. They found some unit-to-unit variability though, so this remedy may not help in all cases. Sometimes the manufacturer's instructions work as well.—*Johan Karlsson, Umea, Sweden.*

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.

TRS-80 Graphics Board

The Grafyx Solution from Micro-Labs, Inc. is reported to give any configuration of a TRS-80 Model III computer a resolution of up to 512 x 192 pixels, for a total of 98,304 individually accessible points. The included graphics software package permits the setting of points, lines, and rectangles, by using simple BASIC commands. Other software includes an 80-character display for word processing, and a save-program for producing a hard copy of a display (if you have a printer with graphics capability). The Grafyx Solution is an add-on circuit board that contains 12,288 bytes of additional read/write memory that does not conflict with the TRS-80 address space. Installation requires no soldering. $300.

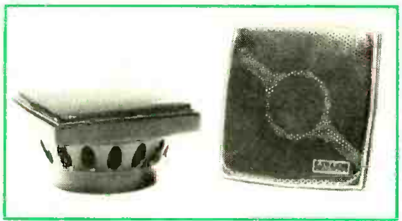
CIRCLE NO. 86 ON FREE INFORMATION CARD

Video Switcher

The "Touch Sensor Four" from the Cable Works is designed to maintain the integrity of the different video signals that can be used with a TV receiver. When a receiver is connected to a VCR, video disc, video game, cable TV, home computer, or standard or earth-station antenna system, the video switcher can take any four inputs, isolate their respective signals up to 90 dB, and send the selected signal to the receiver. The circuitry is solid-state rather than mechanical, which, according to the manufacturer, ensures accurate handling of the complex signal patterns of modern VCRs and discs. A sloping front panel with rear-lit touch controls is said to facilitate ease of operation.

CIRCLE NO. 87 ON FREE INFORMATION CARD

Compact Auto Speaker



The SK2 Duplex from Altec Lansing is a 5¼" two-way speaker claimed to be capable of 107-dB long-term acoustic output. The speaker, an addition to Altec's "Voice of the Highway" line, requires 2⅛" mounting depth, allowing rear-shelf or in-the-door installation. The grille frame and basket form a single, solid framework around the low- and high-frequency components—stabilizing, according to Altec, the accoustic elements and improving durability $100.

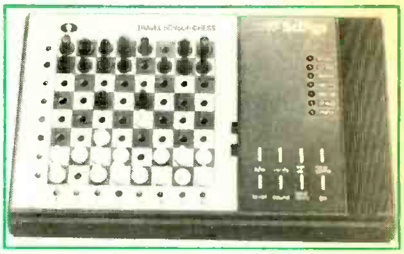
CIRCLE NO. 88 ON FREE INFORMATION CARD

Electronic Soldering System

The new System 9000 temperature-controlled soldering array from the Ungar Division of Eldon Industries permits a tip temperature to be varied from 420°F to 800°F with a resolution of ±10°. ICs sample the tip temperature 120 times per second; LEDs on the temperature controller display each 20 degree increment, creating an illuminated bar chart. The System 9000 iron uses a small heating element, which is said to make possible a thin, cool handle. For extremely precise applications, any temperature within a given range is reported to be adjustable to a precision of ±5° F. $150.

CIRCLE NO. 85 ON FREE INFORMATION CARD

Computer Chess



"Travel Sensor Chess" from SciSys Computer is a portable computer that measures only 7.25 x 4.5 x 1.5 inches and has eight levels of play. The game features an integral sensorboard with red LEDs running parallel to the outer squares of the playing surface. The sensorboard automatically enters all moves in the computer as the chess pieces are advanced. In response, the LEDs illuminate coordinates of the computer's next move. Other features include both recognition and performance of castling, en passant, pawn promotion, a position setup mode, and automatic verification of pieces taken. Also, it can store board position, permitting continuation of a match after the game is turned off. Travel Sensor comes complete with molded chess pieces and dust cover. $50.

CIRCLE NO. 89 ON FREE INFORMATION CARD

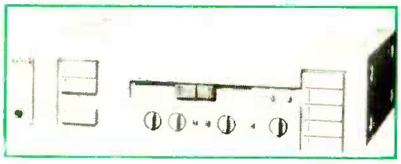
Apple-Compatible Personal Computer

The Franklin ACE 100 is a personal computer that is said to be hardware- and software-compatible with the Apple II, though color provisions are not included. All programs written for the Apple II are reported to run on the ACE 100 without modification, including those using high- and low-resolution black-and-white graphics. The ACE 100 uses the 6502 microprocessor operating at a clock rate of 1.022 MHz. It has 64K RAM memory and 12 sockets for 12K of ROM. The keyboard has 72 keys (upper and lower case) and a 12-key numeric pad that includes special keys used frequently with VisiCalc software. Text is formatted at 24 lines/40 characters per line, with full cursor control. Graphics can be resolved at 40 pixels per line horizontal x 48 vertical, high resolution graphics at 280 pixels horizontal x

192 vertical. The unit includes a joystick/game paddle connector, a speaker, and eight peripheral connectors. A built-in fan and a 50-W power supply permit all peripherals to be used at once. $1,595.

CIRCLE NO. 91 ON FREE INFORMATION CARD

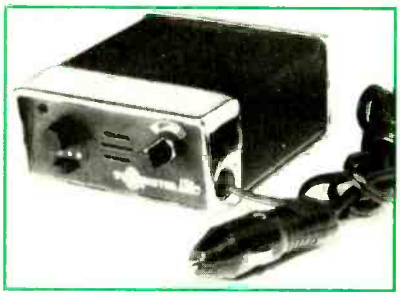
Integrated Amplifier



The AM-U41 from Akai is claimed to drastically reduce transient intermodulation distortion (TIM), and to totally eliminate switching and crossover distortion. This is accomplished through what the manufacturer calls a "Zero Drive" circuit, which employs a servo principal to correct nonlinearity in the power output stage. The AM-U41 offers 55 W/ch at 8 ohms from 20 to 20,000 Hz—with a THD given at no more than 0.005%. In addition, the unit employs high-speed and electronic protection circuits and subsonic filters. Other features include slide volume controls, tape-dubbing capability, audio-muting switches, and a selector switch for two separate speaker systems. $300.

CIRCLE NO. 92 ON FREE INFORMATION CARD

Radar Detector



Electrolert has added a "pilot light" power indicator to the Fuzzbuster Elite, while retaining the self-test mechanism found in its comparable older model, the Fuzzbuster III. The Elite also has an automatic sensitivity control with manual override, and a three-position warning selector. One switch position, for daytime use, gives audio cueing and a bright warning light. The second position, for night use, gives normal audio cueing but a dimmed light. The third position deactivates the light, allowing activation of the audio section only. The Fuzzbuster Elite is claimed to detect every radar unit now on the road, including the 9.4-GHz European MESTA. $200.

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Electronics Furniture

The Model CE-1280 "Classic Elegance"

cabinet from Bush Industries is designed to accommodate a combination of audio and video equipment—to form a home-entertainment center. The audio portion has four shelves that can house a turntable, cassette deck, receiver and/or tuner/amplifier, etc. Framed safety-tempered glass doors enclose the audio equipment. The video section has a retractable roll-out shelf for both front and top-loading VCR or Videodisc machines, and an area that accommodates most 19" receivers. Enclosed storage areas provide room for records, tapes, discs, and accessories. Styling is "traditional." Dimensions: 50"H x 53"W x 20"D. $420.

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High-Quality PC Board

PC-08 is the latest in OK Machine and Tool Corp.'s new line of pc boards. Material is glass-reinforced epoxy, and all holes are drilled (rather than stamped) to ensure accurate location and diameter. The PC-08 is a "Double-Eurocard"-sized board, measuring 6.3" x 9.2". The board consists of 52 columns of 85 holes each, all on a 0.1" grid, thereby accommodating any size IC or DIP socket in either horizontal or vertical orientation. The board also contains a row of 26 discrete holes on 0.2" spacing at each end, as well as two patterns to accommodate 96-pin "DIN"-type two-part I/O connectors plus a row of access holes on either side of each pattern. Hole diameter is 0.040", allowing either direct soldering of components or insertion of wire wrapping sockets. The PC-08 can hold as many as 120 14-pin sockets or 100 16-pin sockets, with discrete devices utilized as necessary. $18.

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Three-Way Linear Phase Speaker

The SB-L201 from Technics is a three-way linear system, featuring a 10" woofer, 4" cone-type midrange, and a radial horn tweeter. The unit is said to be capable of handling 105 W music, 65 W DIN.

The output level is 90 dB/W/m; impedance is eight ohms. The SB-L201 is equipped with a thermal relay protector, LED overload indicator, tweeter level control, and a detachable net. $200.

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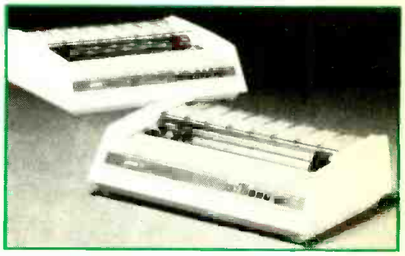
Compact Printer



Printek's Model 920 printer is a 9 x 9 dot matrix printer that uses 96 ASCII characters with seven foreign character sets, and operates bi-directionally from serial, RS-232, and full or half-duplex interfaces. Baud rate is switch-selectable from 300 to 9600; print speed is 340 cps (80 cps for correspondence-quality print); graphics can be printed at 4000 dots per second at a density of 144 x 144 dots per sq. inch; and paper slew rate is 10"/s. The unit features an 1800-character buffer to maximize throughput; the number of characters per inch is variable from 10 to 16.7. Other operator controls include a test/set-up mode for self-diagnosis; horizontal and vertical tabbing; and fine-adjustment settings for variable paper formats. Dimensions: 6.75"H x 23.25"W x 16.75"D; weight is 44 lb. $2,595.

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Radio Shack's 20-channel scanning receiver, Realistic PRO-2020, is an FM/AM direct entry programmable unit for home or mobile use. It covers six vhf and

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uhf bands, including the AM aircraft band. It features direct keyboard entry of up to 20 channels in six bands; two scan speeds; scan delay to avoid missing callbacks; automatic and manual scanning; an all-band search mode that scans all channels between the upper and lower frequency limits entered into the keyboard; and electronic individual lockouts. It also has a priority-tuning circuit that permits constant monitoring of one frequency while scanning the others. Both the assigned channel number and the actual frequency being monitored are displayed on a fluorescent digital readout. Channel information is maintained in the scanner's memory by a 9-V battery when the unit is turned off. The unit may be operated from a 12-V dc source, as well as the usual ac outlet. $300.

CIRCLE NO. 98 ON FREE INFORMATION CARD

Lightweight Headphones

BP electronics, Inc. has introduced the Model SH-92A lightweight stereo headphones as part of its "Light & Lively" series. The phones use high-compliance Mylar diaphragm speakers and anoxic copper wire that is claimed to reduce signal attenuation. The cable end has a 3.5-mm plug (for portable stereo players), with an adapter for standard 1/4" plugs. Specs: impedance, 4-32 ohms; frequency response, 20-25,000 Hz; weight (without 7' cord), 2 oz. $21.50.

CIRCLE NO. 99 ON FREE INFORMATION CARD

Design Evaluation Kit

Advanced Analog Systems has announced a new design evaluation kit to investigate the functions and capabilities of the Signetics NE572 Dual Programmable Compander. The kit, designated AAS572, contains a printed circuit card, ICs, and other necessary components for constructing a complete audio signal compander. Inputs to both the compressor and expander sections consist of a high-performance (110 dB dynamic range), low-noise (6 μV) voltage follower. The input has a 9V/μs slew rate, input noise figure of 5nV/$\sqrt{Hz}$, and a gain bandwidth of 10 MHz. Each compressor utilizes 1/2 of a NE572 configured for 2:1 compression—switch-selectable for a compression ratio of 4:1. The attack time constant can be set for either 10 ms or 20 ms; recovery time is either 200 or 400 ms. THD is given as 0.05%; power requirement is +15V. $65.

CIRCLE NO. 100 ON FREE INFORMATION CARD

ENTERTAINMENT ELECTRONICS

By Len Feldman

Finally—A Test Record for Everyone

IN THE course of testing and evaluating phonograph cartridges you will encounter numerous test records, each designed to provide one form of data or another regarding a cartridge's performance. These test records fall into two large categories: those containing specific test signals (tones, combinations of tones, frequency-response sweeps, etc.), and those offering musical selections designed to point up a specific flaw in system performance.

Test-signal recordings usually require elaborate measurement equipment (meters, filters, distortion analyzers, spectrum analyzers, etc.) and are therefore best suited for use in a well-equipped laboratory. Musical samples, in contrast, can be evaluated by nontechnical listeners who do not own laboratory test equipment. However, such tests seldom yield anything more than vague, subjective opinions. Music samples would probably provide a better gauge of cartridge performance if "instant comparisons" were made between "Cartridge A" and "Cartridge B"—the way most of us judge loudspeakers. Unfortunately, the time required to make such "A-B" tests—dismounting and mounting pickups—is so great, and "hearing memory" is so short, that such attempts at comparison lose their validity.

To address this problem, Shure Brothers, Inc., the well-known manufacturer of phono cartridges, microphones, and professional audio products, has developed a new test record designed to permit non-technical music lovers to evaluate the performance of a phono cartridge (or several cartridges) in a quantitative manner. This new record, known as TTR-117, contains many "standard" tests. However, the last test on side "A," and all of the tests on side "B," are unique and worth describing here in detail.

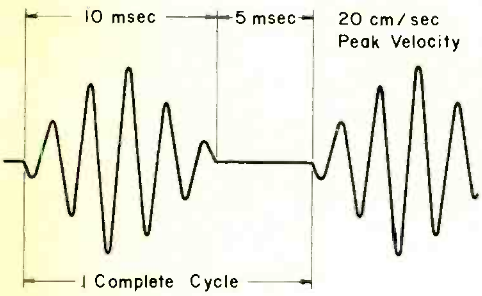

Fig. 1. This signal, enscribed on Shure's TTR-117 test record, is used to adjust the tonearm antiskating force.

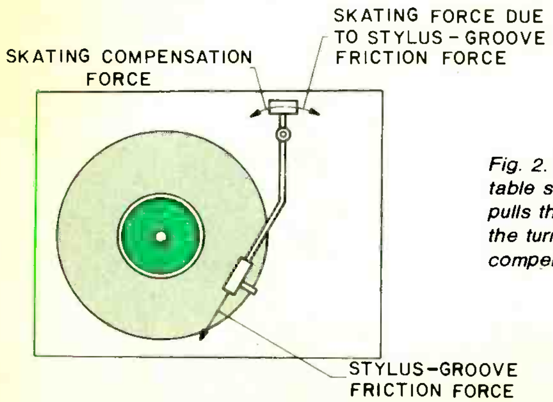

Fig. 2. The usual stylus/tonearm/turntable setup creates an inward force that pulls the tonearm toward the center of the turning platter. Antiskating compensation counteracts this effect.

All illustrations courtesy Shure Brothers.

The last band of side "A" contains a complex signal (Fig. 1), a 500-Hz, 20-cm/s peak-velocity burst, repeated at a 61-Hz rate. With this signal the listener can properly set the anti-skating adjustment provided on most better-quality turntables currently available.

All pivoted tonearms are pulled toward the center of a spinning record. To keep stylus pressure equal on both walls of a record groove, it is necessary to compensate for this "skating" force. Figure 2 illustrates skating and anti-skating forces as they pertain to pivoted tonearms. (Owners of linear-tracking tonearms need not worry—skating forces do not exist in such systems.)

The on/off duty cycle of the 500-Hz burst signal used for the anti-skating adjustment test sounds like a buzz. If the skating compensation is too great, an easily distinguishable form of distortion will be heard in the left channel. If insufficient anti-skating force has been applied, this same distortion will be heard in the right channel. Only when the correct amount of anti-skating force has been applied will the sounds coming from both speakers be identical.

Total Trackability Index. Shure has long promoted the concept of "trackability"—the ability of a phono pickup stylus to follow high-velocity groove undulations over the entire audio-frequency band. Their feeling is that trackability (expressed in cm/s for a given audio frequency) is more meaningful than a simple statement of stylus compliance.

Shure's most recent statistical data is reflected in the "scatter diagram" of Fig. 3. Here we see that the peak recorded velocity to be expected from modern phonograph records usually occurs at frequencies around 4 kHz. In order to easily judge trackability, Shure has recorded a complex signal consisting of three frequency components: 200 Hz, 2.1 kHz, and 17 kHz. These are presented at six different levels in the new test record, and correspond to six paral-

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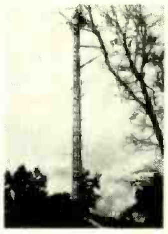

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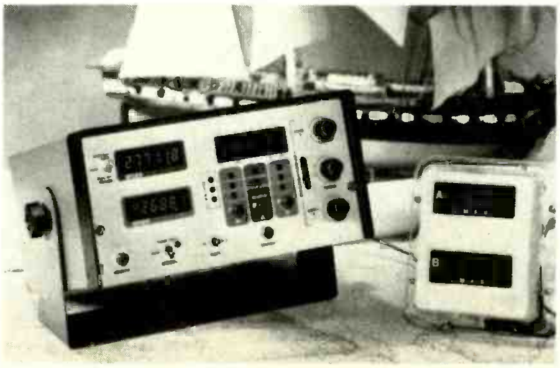
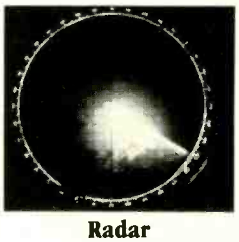


Direction Finders, Loran



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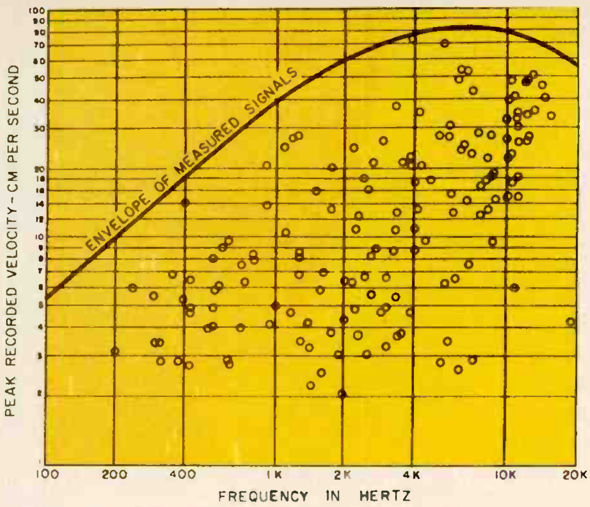

Fig. 3. Scatter diagram shows peak recorded velocities on modern stereo records as a function of frequency.

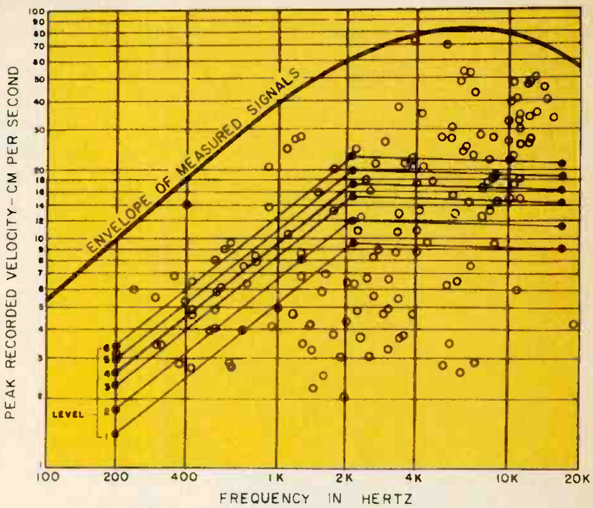

Fig. 4. How total trackability rating signals on test record are related to signals on modern stereo records.

TABLE I—INDENTATION FACTOR

Tip Geometry	Tracking Force 7.5 mN 0.75 gram	10 mN 1 gram	12.5 mN 1.25 grams	15 mN 1.5 grams	20 mN 2 grams	25 mN 2.5 grams
Spherical 15μ (0.0006″)	1.21	1.00*	0.85	0.76	0.63	0.54
18μ (0.0007″)	1.28	1.06	0.91	0.81	0.67	0.58
Biradial (Elliptical) 5μ × 18μ (0.0002″ × 0.0007″)	1.07	0.88	0.76	0.67	0.55	0.48
7.5μ × 18μ (0.0003″ × 0.0007″)	1.10	0.91	0.78	0.69	0.57	0.49
10μ × 18μ (0.0004″ × 0.0007″)	1.17	0.97	0.84	0.74	0.61	0.53
Hyperelliptical (HE) 5μ × 38μ (0.0002″ × 0.0015″)	1.25	1.03	0.89	0.79	0.65	0.56
Hyperelliptical (HEJ) 7.5μ × 38μ (0.0003″ × 0.0015″)	1.31	1.08	0.93	0.83	0.68	0.59
7.5μ × 75μ (0.0003″ × 0.003″)	1.52	1.26	1.08	0.96	0.79	0.68
3.8μ × 75μ (0.00015″ × 0.003″)	1.42	1.17	1.01	0.89	0.74	0.63
3.8μ × 100μ (0.00015″ × 0.004″)	1.52	1.26	1.08	0.96	0.79	0.68
2.5μ × 100μ (0.0001″ × 0.004″)	1.46	1.21	1.04	0.92	0.76	0.65
5μ × 50μ (0.0002″ × 0.002″)	1.33	1.10	0.95	0.84	0.69	0.60

*Reference

lel-line plots superimposed on Fig. 3 (Fig. 4). At the highest level, the peak recorded velocities are 3.3, 21.0, and 2.0 cm/s for the three frequency components. Taken in combination these individual velocity values are quite difficult to track successfully.

In conducting the trackability tests, the signal sequence from low to high frequency is played with the cartridge tracking force and anti-skating force properly adjusted. The user listens for the onset of mistracking (after having been instructed by a narration band that simulates mistracking noise so that actual mistracking can be recognized when it occurs). Based upon the highest band number that a given cartridge tracks successfully, Shure has assigned a score called the Trackability Factor (TF). Specifically, successful tracking of band 1 equals a TF of 45; 2 equals 56; 3 equals 71; 4 equals 79; 5 equals 89; and 6 (the highest velocity band) equals 100. To arrive at the Total Trackability Index (TTI)—a comprehensive figure-of-merit—one additional calculation is required.

Indentation Factor. Even when a cartridge does not mistrack a signal, some distortion may be produced by the stylus because it permanently modifies the record groove in the course of tracing groove-wall modulations. These distortions and groove modifications are caused by many factors, including stylus geometry and tracking force. Table I shows the relationship between tip geometry and tracking force as they affect the indentation factor.

The spherical-tip stylus, tracking with a force of 1 gram, was arbitrarily selected as a reference and assigned an Indentation Factor of 1.0. All other tip/tracking force combinations can be easily compared with this reference. For example, a hyperelliptical tip measuring 0.0003″ by 0.003″ played at 1 gram has an Indentation Factor of 1.26. The greater the Indentation Factor, according to Shure, the less deeply a given sty-

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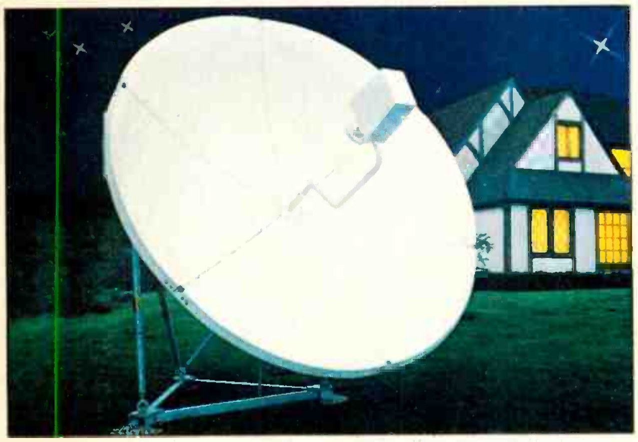

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lus will track, and the less wear and tear on the record.

Interestingly, tracking force has a much greater effect upon Indentation Factor than does tip geometry—a conclusion contrary to many expert assumptions. While the Indentation Factor is directly related to record life (and is used to calculate Shure's new figure of merit, the Total Trackability Index), it may also help in estimating the useful life of diamond tips.

To calculate TTI, first determine the Trackability Factor by listening to the test record. Then multiply this factor by the Indentation Factor (determined from the known stylus tip configuration). The product obtained is the TTI.

For example, Shure's new V15 Type V cartridge has a hyperelliptical stylus tip. If Level 5 of the Trackability Test is successfully played with 1 gram of tracking force, you get a trackability factor of 89. The Indentation Factor for the tip (0.0002" by 0.0015") is 1.03 (from Table I), and the resulting TTI product (89 times 1.03) is 91.7. Obviously, a higher TTI indicates better trackability.

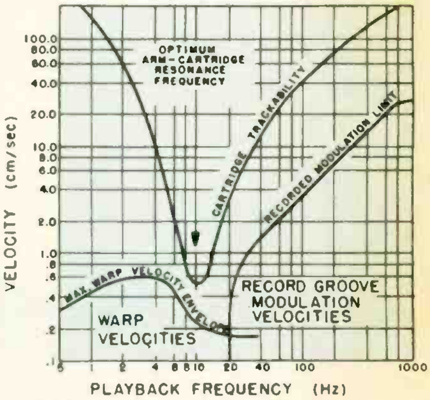
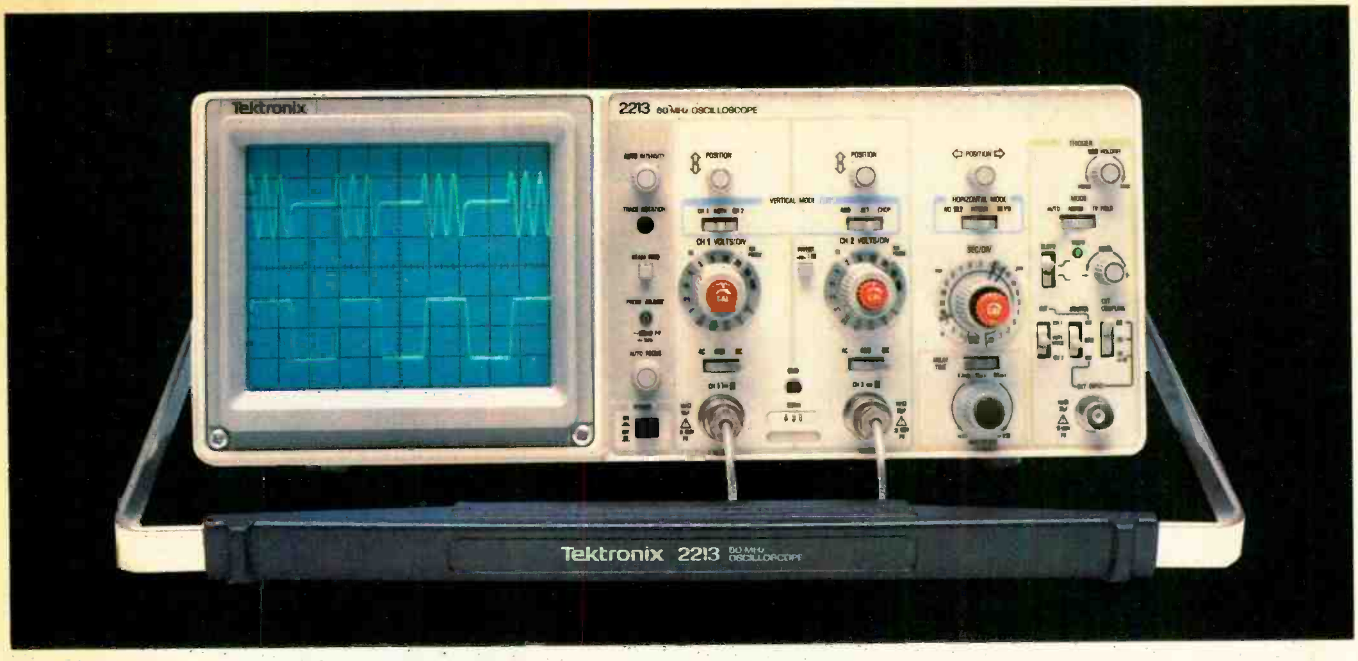


Fig. 5. Tonearm resonance should be between max. warp velocity and min. modulation limits.

Tonearm Resonance Tests. The last band of the TTR-117 test record examines tonearm resonance. It contains a pair of pilot tones at 2400 and 3000 Hz, plus a sub-audible tone used to excite the tonearm. The low-frequency excitation signal rises in 1-Hz increments from 5 Hz to 14 Hz. Tonearm resonance can be determined by listening for maximum wow and flutter in the audible test tones. As shown in Fig. 5, the most desirable point for arm resonance is between 9 and 11 Hz—above the subsonic record-warp frequencies, yet below the recorded program's lowest frequency.

Although the TTR-117 is offered as an accessory to the new Shure V15 Type V cartridge, it can be purchased separately to test the arm/cartridge portion of any stereo record player. It should prove valuable to anyone without a laboratory full of test equipment who still wants more than just subjective musical playback experiences when evaluating arm/cartridge performance. ◊



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Popular Electronics Tests

Kenwood KVA-502 Audio-Video Control Amplifier and KV-901 Video Cassette Recorder

KENWOOD, known primarily for its audio products, has recently introduced equipment to integrate video and audio. The new systems consist of a feature-laden VHS video cassette recorder (Model KV-901) and an audio-video control amplifier (Model KVA-502). The units are similarly styled and are sized so that the VCR can sit on top of the A/V amp to provide maximum operating ease and to save space.

Wedding the units provides a host of audio and video enhancement facilities in a compact entertainment center for improved functionality, quality, and audio-video creative capability. Additionally, the audio-video amp can be used as the heart of a stereo high-fidelity system for playing phono records and other audio source material.

In essence, the twin units examined here form the first commercial integration of two exciting mediums for consumers—video and audio.

AUDIO/VIDEO AMPLIFIER

Coordinated Entertainment. The Kenwood KVA-502 is a truly new product—designed for use in entertainment systems that coordinate audio and video program sources. Its heart is a high-quality audio control amplifier (50 W/channel) that can interface with two VCRs, one video disc player, a TV receiver or monitor, an audio tape deck, phono turntable, and AM or FM tuner. Kenwood calls the unit an Audio-Video Amplifier, clearly defining its dual role. Though designed to complement Kenwood's KV-901 VHS VCR, it's compatible with any VCR, regardless of format.

The KVA-502 measures about 17 3/8" W x 13¼" D x 4¼" H, and weighs 17.8 lb. Its exterior is finished in satin silver, with a black recessed control panel containing a number of small black knobs. The basic switching control functions are performed by light-touch rectangular pushbuttons. Suggested retail price is $400.

General Description. The unit's video switching functions are analogous to those of a typical audio amplifier. The playback output from either of two VCRs—VCR(A) or VCR(B)—can be selected by pressing the corresponding button. A recording can be made only on VCR(A)—the program source being a TV broadcast, VCR(B), or a video-disc player. (See operating controls on p. 24.)

The KVA-502 switches a vhf antenna between a VCR and the TV receiver. Normally the front-panel ANT SELECTOR is left on VIDEO, routing r-f signals through the VCR on their way to the TV set. However, when dubbing a tape from one VCR to the other, this switch can be used to connect the antenna directly to the receiver for off-the-air viewing. When the unit is shut off, however, the antenna output is routed directly to the TV, regardless of the ANT SELECTOR setting. Since the KVA-502 uses only the composite video (and audio) signal from a VCR, the VCR's internal r-f modulator is replaced by one in the amplifier (switchable to channel 3 or 4).

In addition to its video-switching functions, the KVA-502 can modify a video signal and improve its visual characteristics. The PICTURE control is analogous to a high-frequency audio tone control; boosting or reducing video band width to control VCR picture sharpness.

A special circuit, whose function switch is labeled DE-NOISER, is designed to reduce video-tape noise in the mid to upper audio-frequency range. Primarily, this is between 7 and 8 kHz, where the noise has its largest distribution. According to the manufacturer, the circuit operates automatically when switched "on" only if the input signal falls below a specified level within the selected frequency range. When input signals are relatively high, the noise is masked by it, so the de-noiser circuit is not activated. As a consequence, the relatively poor

(Continued on page 26)

KVA-502 AMPLIFIER OPERATING CONTROLS

Front Panel:

Switches

POWER: Controls ac power to the amplifier and one rear outlet.

ANT. SELECTOR (VIDEO/TV): Selects signals to be monitored on TV screen (from antenna or video machine).

VIDEO DUBBING: Connects video machines for dubbing either the video disc player (VDP) or VCR(B) playback on to VCR(A).

INPUT SELECTOR: Selects signal source to be seen or heard—VCR(A), VCR(B), VDP, AUDIO.

AUDIO DUBBING: Connects audio input of VCR(A) to selected audio source.

TAPE: For listening to audio tape playback.

TUNER: For listening to tuner signal (AM or FM).

PHONO: For listening to phono playback

SPEAKER A, SPEAKER B: Connects rear speaker outputs to amplifier.

DE-NOISER: Reduces audio noise from VCR playback.

LOUDNESS: Introduces loudness compensation on audio volume control.

MUTING: Reduces audio level 20 dB.

Controls

VOLUME: Adjusts audio volume.

BASS: Low-frequency tone control.

TREBLE: High-frequency tone control.

BALANCE: Adjusts left-right level balance (center detented).

MODE (MONO, ENHANCER, STEREO): Enhancer gives pseudo-stereo effect on mono signals.

MIC MIXING: Adds microphone signal smoothly to selected audio source, reducing program level simultaneously to make a smooth fade.

Jacks

PHONES: For stereo headphones.

MIC MIXER: For a medium-impedance dynamic microphone.

Rear Panel:

VHF IN: 75-ohm coaxial connector, from antenna output of VCR.

VHF OUT: 75-ohm coaxial connector, to vhf antenna input of TV receiver.

INPUT: Standard phono jacks for audio sources (PHONO, AUDIO)

TAPE (REC PLAY): Standard phono jacks, plus DIN socket, for audio tape-deck connections.

VIDEO: A group of phono jacks for interconnection with one or two VCRs. The VCR(A) position has both recording and playback video jacks; the VCR(B) and the video disc player position (VDP) have playback-only jacks. All have stereo audio outputs. A separate VIDEO OUT jack carries composite video to monitor (instead of the r-f carrier used for connecting to a TV receiver).

SPEAKERS: Insulated binding posts for two pairs of speakers.

AC OUTLETS: Three, one of which is switched.

CHANNEL: Slide switch on side of cabinet to select TV channel 3 or 4 for r-f modulator output.

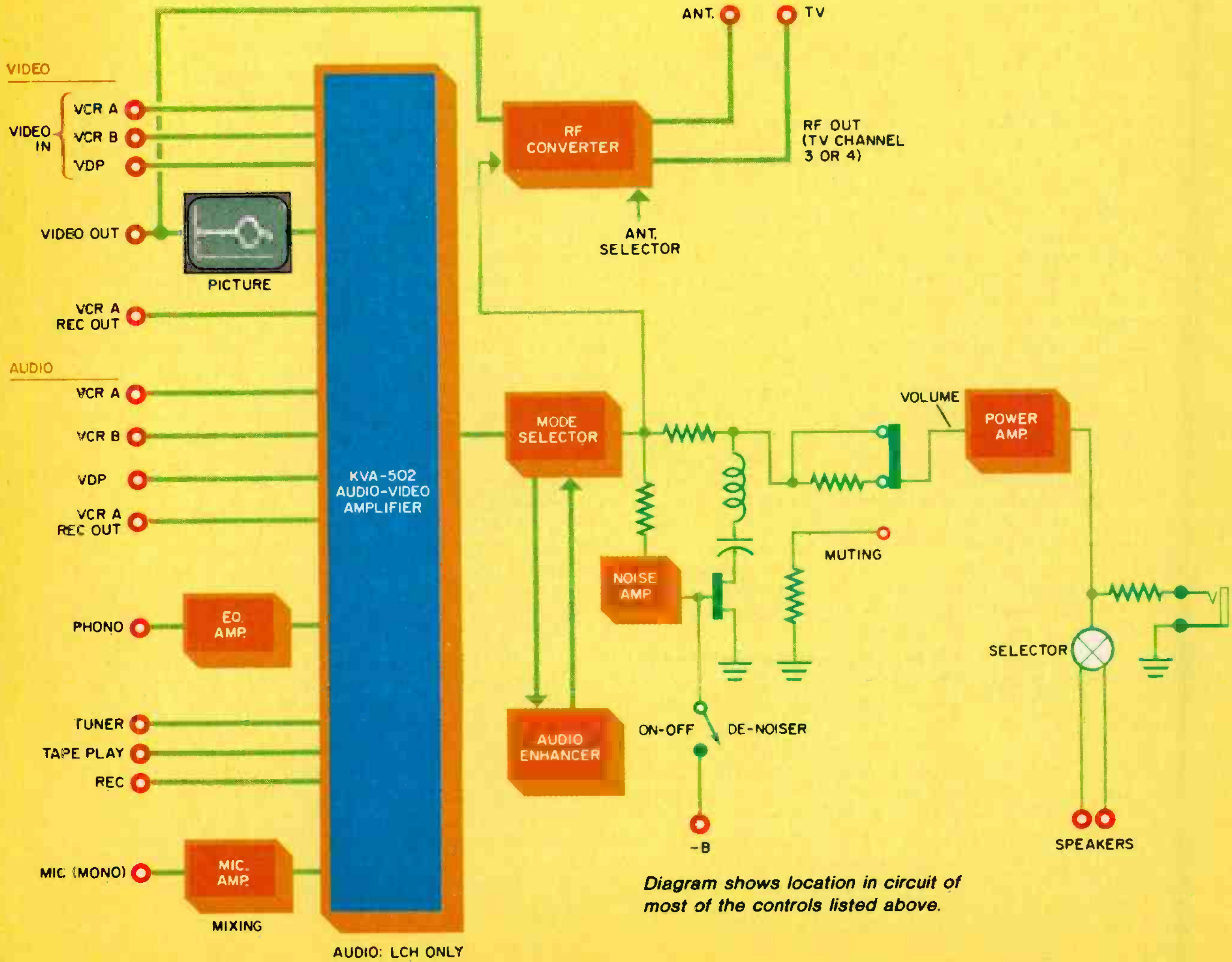

Diagram shows location in circuit of most of the controls listed above.

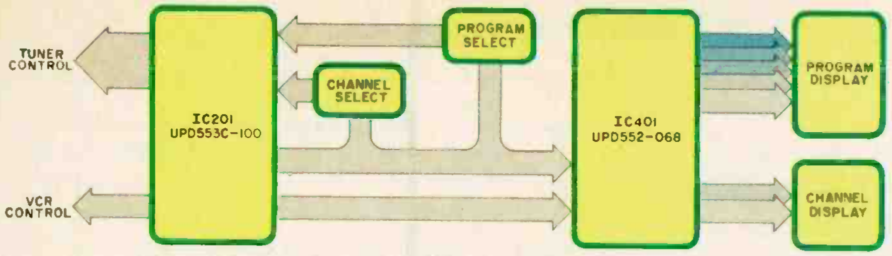

Fig. 1. Block diagram of the KV-901 TV-channel and program-selection system.

(Continued from page 24)
audio signal-to-noise ratio (about 40 dB) produced by recording on the narrow (1-mm) audio track of a VCR cartridge can be significantly improved as sensed by ear.

Though the audio section of the KVA-502 is conventional in most respects, two features distinguish it from most integrated amplifiers—the microphone mixer and the signal enhancer. Other amplifiers and receivers with a built-in microphone mixer contain blending circuits; this one is a fader control. As its clockwise limit is approached, the program source volume is reduced (eventually cut off completely) and replaced by the microphone signal. The fading action makes for a very smooth transition between program and microphone sources. The VOLUME control adjusts the combined level of the mixed signals, which also appear at the tape-recording outputs (most other microphone mixing systems we have seen affect only the speaker outputs).

The signal enhancer is intended to create a stereo effect from mono signals by driving the speakers with phase-shift and frequency-response differences in order to form a more diffused sound stage. According to Kenwood, the sound field is expanded by alternating direction of sound from right side to left side every 1.2 octaves.

Laboratory Measurements. Actual measurements on the KVA-502 were limited to its audio functions; observations of video were subjective.

The 1000-Hz harmonic distortion, when driving 8-ohm loads, was less than 0.01% at (and slightly above) the rated 50 W/channel output, and 0.038% at 70 W/channel output. Clipping occurred at 75 W/channel. With 4-ohm loads, the distortion was at least as low (typically 0.006%) up to 70 W and 0.08% at 100 W, where clipping occurred. The 8-ohm IHF clipping headroom was 1.76 dB.

The KVA-502 is not recommended for use with loads lower than 4 ohms; when we attempted to drive 2-ohm loads, fuses blew in the 6-A dc power supply. Delivering the rated 50-W output to 8-ohm loads, the distortion was less than 0.01% from 20 to 5000 Hz, increasing smoothly to 0.03% at 20,000 Hz. It was roughly the same at reduced power outputs.

The tone-burst signal of the IHF dynamic headroom test (20 ms of 0-dB, 1000-Hz signal, followed by 480 ms at a −20-dB level) produced a clipping power output of 94 W into 8 ohms and 139 W into 4 ohms, for a 8-ohm IHF dynamic headroom rating of 2.76 dB. Moreover, the KVA-502 was stable with complex reactive loads. Driving a standard IHF reactive load (which simulates a woofer near its resonance frequency), the clipping power was just over 75 W at 40 Hz for an IHF reactive load rating of 1.8 dB. The IHF slew factor was greater than our measurement limit of 25.

For a reference power output of 1 W, the KVA-502 required a 1000-Hz input of 20 mV (TUNER) or 0.29 mV (PHONO). The A-weighted noise level through either input was −77 dB referred to 1 W. The phono preamplifier input overloaded at about 180 mV at 1000 Hz and below, and at 168 mV at 20,000 Hz (equivalent 1000-Hz value). This gives plenty of leeway since average phono cartridges have outputs of 1 to 5 mV, depending on make and model. Phono-input impedance was 46 kilohms in parallel with 250 pF.

The tone controls had conventional frequency-response characteristics, with a sliding bass turnover frequency and treble responses hinged at about 2500 Hz. Loudness compensation boosted only the low frequencies as the volume-control setting was reduced. (Many designers prefer not to boost highs—an opinion that may be strengthened here owing to the tendency toward tape hiss on video tape's audio track.)

RIAA phono equalization was almost perfectly accurate, with less than 0.5-dB overall variation between 20 and 20,000 Hz. And when the input was loaded by the inductance of a typical phono cartridge, the high-frequency response was changed less than 0.3 dB.

User Comment. As an audio amplifier, the KVA-502 delivers especially fine performance at a modest but adequate power level. Although its 50-W/channel rating may not sound like much compared to some "audiophile" amplifiers, the unusually large dynamic headroom of the KVA-502 shows that it is capable of delivering undistorted program peaks on a par with many amplifiers having twice the power rating.

In other respects, too, such as its nearly ideal phono-preamplifier section, the KVA-502 meets the highest standards set by component audio amplifiers.

The KVA-502's video-control facilities add a new dimension in one package to audio-video entertainment. The switching facilities for selection of source and dubbing are excellent, though an r-f switcher would have made things even simpler when using two VCRs. Using the DE-NOISER switch, we totally eradicated tape hiss from a six-hour-play video tape, revealing a remarkably good sound that was not evident beforehand. Switching in the "stereo" mode produced a most welcome improvement in audio dimension. Rotating the picture control, we observed evident sharpening of the picture upon close inspection. Though not dramatic in normal situations, its effect will be more noticeable on dubbed tape than on a first taping. When the signal isn't sufficiently strong, some increase of noise will occur, however. The addition of the video equivalent of an audio "de-noiser" would be needed to circumvent this problem. At the extreme setting, color strength is sometimes affected.

Price of the unit is remarkably low for what it does. In fact, if one considers only the separate video accessories that would be necessary to match what the KVA-502 incorporates, then the fine stereo control amplifier is practically free. *—Julian Hirsch*

VIDEO CASSETTE RECORDER

General Description. The deluxe KV-901 VCR uses the VHS format and has two- and six-hour recording facilities with two-, four-, and six-hour playback. Speed selection for playback is automatic. To locate desired portions of a recording in both forward and reverse, the unit employs "Vue-Search." This feature will run the tape up to seven times normal speed in the SP (two-hour) mode and up to 21 times normal speed in the EP (six-hour) mode. The KV-901 employs two pairs of video tape heads, one for the 2-hour and 4-hour mode and the other for the 6-hour mode.

Other features include an air-damped top-loading cassette assembly; an automatic cancellation circuit that releases the pause control if left in position after five minutes; feather-touch controls using microprocessor logic circuits; automatic rewind when tape end is reached; and a brushless, direct-drive drum servo motor crystal-locked to the frame rate. A wired 10-function, remote-control head includes TV CHANNEL ADVANCE, PLAY, RECORD, AUDIO DUB, FAST-FORWARD, REWIND, FORWARD and REVERSE Vue-Search, PAUSE, and STOP.

The selection of unattended, pre-programmed recording is accomplished by a series of pushbutton controls, together with a detailed alphanumeric calendar/clock display and LED channel indicator. Two CPU chips are used to program the recording of up to eight different programs from any of 14 pre-tuned TV channels selected from among vhf channels 2-13 and uhf channels 14-83. This pre-programming feature can select events up to two weeks in advance.

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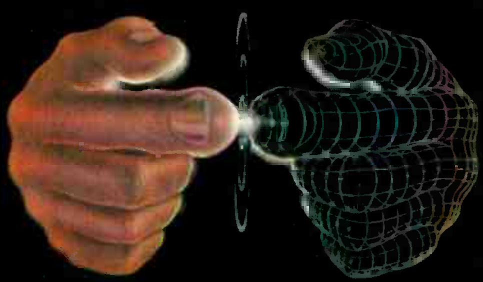

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Dimensions are essentially the same as those of the audio-video amplifier. Suggested retail price is $1200.

Microcomputer-Based Program Selection. The KV-901's program display shows the seven days of the week, an hour/minute/second read-out, and an a.m./p.m. indication. A set of pushbuttons and switches permits the user to enter information, which is displayed immediately. Channel selection is accomplished with 14 pushbuttons, each with its own LED indicator. A separate top panel covers the tuning adjustments for each channel. Of course, the vhf-uhf tuner is electronic, using precise voltages to control varactor capacitance. Separate varactors are used for each channel.

In the KV-901's TV-channel and program-selection system (Fig. 1), both ICs are 4-bit microprocessors, operating at a crystal-controlled clock frequency of 400 kHz. The *IC201* is a version of NEC's μCom-43 family. It contains a 2000 by 8-bit ROM, a 96 by 4-bit RAM, and has six 4-bit working registers. There are nine ports on *IC201*. One of them is a programmable 6-bit timer that uses internal as well as external clock signals for VCR control and program timing.

The *IC401*, a member of NEC's μCom-44 family, does not have a programmable timer, but is instead used to control the display and translate the data it receives from *IC201* into the correct alphanumeric indication. The *IC401* can supply 35 V for electrofluorescent displays, and, in fact, provides all of the KV-901's display voltages (except for driving the lamp filaments). This chip also controls the channel-indication LEDs. The *IC201* stores the program and channel selections, provides appropriate data to *IC401*, and controls the VCR's record start-and-stop operations.

Evaluation. Manufacturer's specifications claim a horizontal resolution of more than 240 lines. Our tests, using a standard monoscope (Indian head) test pattern, confirm this figure. The video signal-to-noise measured 45 dB, also confirming the figure given by Kenwood. Next, we recorded video from 1 to 4 MHz and found the 3-dB cutoff where Kenwood said it would be—at 3.0 MHz. Recordings of a staircase, window, and crosshatch pattern all produced excellent video images.

The color-bar patterns we recorded quantified the excellent pictures we obtained off-the-air. Examine the oscilloscope picture of the color-bar input signals (Fig. 2) and compare it with the color bar output signal from SP playback (Fig. 3) and the color bar output signal from EP playback (Fig. 4). Note that the high-frequency portions of these signals are almost identical.

The manufacturer's specifications call for a signal-to-noise ratio of better than 40 dB in the audio channel and a frequency response of 100 to 10,000 Hz at standard speed. Our measurement produced a signal-to-noise ratio of 42 dB and a bandwidth of 180 to 10,000 Hz. Although the low-frequency roll-off is not usually audible, we are aware that several other VCRs have this same characteristic.

User Comments. Kenwood's Model-901 VCR looks and performs like the deluxe video cassette recorder it is. Certainly, the quality of its video and audio compares well with similarly priced VCRs, as does the two-week, 14-channel program selector, which can program eight different channels. Perhaps the only features we could add to our wish list are the addition of the midband and superband cable TV channels in the VCR's programmable tuner, enabling one to get these extra channels if you're not a cable subscriber and they're not scrambled; a wireless remote control; and slow-motion.

For readers who wonder what you get in a higher-priced VCR that a lower-priced unit doesn't have, it's a lot more than a built-in two-week programmable unit with an electronic digital clock. For example, having a second pair of tape heads makes it possible to design head gaps specifically for use with slow- or fast-speed models. As a result, picture quality is improved, especially for the long-play mode. Furthermore, its feather-touch controls are vastly superior for operating ease than are mechanical controls of more modestly priced machines.

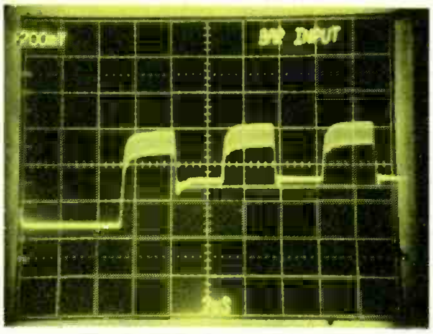

Fig. 2. Color-bar input signals.

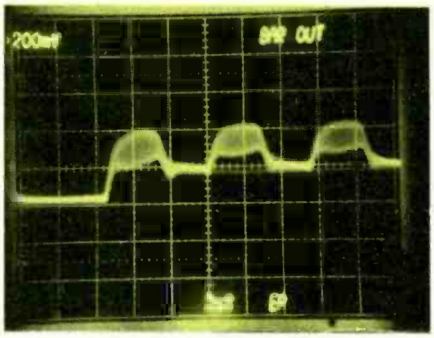

Fig. 3. Output signal from SP playback.

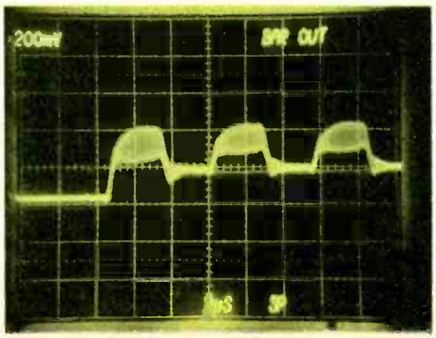

Fig. 4. Output signal from EP playback.

Additionally, start-up is lightning fast compared to the delay exhibited in lesser machines. And, mentioning "fast," it was a joy to search out a specific section on the video tape, either fast-forward or reverse, due to its impressive speed and accuracy. This feature is carried over to the remote control, too. You might have to use the counter, though, because the TV set's picture didn't always hold during this fast-search process. Other fine attributes attached to this function include a memory-set facility to automatically stop at a specific section of the tape and automatic switching-out of the audio circuit during search to eliminate raucous sounds. As a final note, one of our video recordists marveled at the even, balanced rewinding of the tape itself, a characteristic he does not enjoy with his present VCR. —*Walter Buchsbaum*

CONCLUSION

Kenwood has taken an imaginative step in uniting audio and video technologies with this set of cosmetically matched machines. Both units examined here—the VCR and the audio-video amplifier—operated superbly, as independent units and in combination.

Neither unit is quite at the state-of-the-art point, since each is missing some added fillips. But neither are their price points at the highest end. The VCR, whose innards are identical to the few near-top-of-line models of other brands (only a few manufacturers produce VCRs for the many companies offering them) has an especially functional design as a result of the use of the push pads. Each of these incorporates an indicator light and they are exceptionally large with the PLAY and STOP pads conveniently colored orange. This same color coding scheme is carried over to the remote control.

The Kenwood VCR has excellent slow-speed performance, as well as good high-speed reproduction of broadcasts. Thus it should have wide appeal to people who would, say, opt for a high-performance automobile but foresake extras such as a costly sun roof.

The only-one-of-its-kind audio-video amplifier stands by itself, of course. It packs a lot of features into one handsome unit to make a neat core for an entertainment center. To achieve similar functions would require using a jumble of add-on-boxes—though they would provide an extra *n*th of video control. Just add a pair of good speaker systems to take advantage of the excellent video sound potential offered.

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Audio Product of the Month

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Sony NR-500 Dolby-C Noise Reduction Processor

THE Sony NR-500 Noise Reduction Processor makes Dolby C noise reduction available for any tape deck (cassette or open reel). It connects between the tape deck and the system amplifier, and has front-panel bypass switches so that the recorder can be used with or without the NR-500.

A compact unit finished in satin silver, the NR-500 measures 17"W by 11¼"D by 2¼"H. It weighs about seven pounds and has a suggested retail price of $190.

General Description. The recently developed Dolby C noise-reduction system is an extension of the Dolby B system now incorporated in virtually every component-type cassette deck. In the B system the program is recorded ("encoded") with variable pre-emphasis in the upper middle and high frequencies that is determined by the program's spectral content and level. During playback, variable de-emphasis ("decoding") takes place.

Encoding and decoding are complementary, so that the overall frequency response through a record/playback cycle is flat. However, the playback decoding process also attenuates noise (about 10 dB at 5000 Hz). Successful system operation requires that the signal levels be matched closely during recording and playback.

The Dolby C system can be considered as the simultaneous operation of a Dolby B processor and a second similar circuit that operates at lower signal levels and extends the noise-reduction action down to 200 Hz. The end result is a noise reduction of 20 dB at 5000 Hz, giving a good cassette deck a total signal-to-noise ratio of around 75 dB. This permits a dynamic range comparable to that of any analog disc, including those cut from digital tape masters.

The successful use of either Dolby B or C requires a flat record/playback frequency response from the recorder. Any departures from flatness are doubled by the Dolby system—or by any of the other popular "companding" noise reducers. Since most of the response variation of a cassette (excluding low-frequency "head bumps") takes place at the highest frequencies, the Dolby-C sensing circuit was modified to make the system less sensitive to response variations above 10 kHz.

Also, an anti-saturation network has been added to the NR-500 to reduce tape saturation at high audio frequencies. The network introduces a fixed 4 dB recording roll-off at 10 kHz, with a complementary boost in the playback system. Although the playback boost reduces the noise reduction above 10 kHz, most audible hiss is below that frequency. Therefore, the anti-saturation network has a negligible effect on the overall signal-to-noise ratio.

Calibration. The Sony NR-500 is supplied with a calibration cassette, recorded with a 400-Hz tone at standard Dolby level (200 nWb/m is the 0-dB reference). For the initial system adjustment, it is played on the cassette deck being updated while the NR-500's CAL and DOLBY C buttons are engaged. The deck's playback level control is set to a convenient point, and must not be moved again.

When the tape is played, a pair of red LED arrows on the NR-500's front panel show whether the playback level is too high or too low. For each channel, set the PB CAL adjustments so that the red arrows are out and only the center green

LED is on. (Use a screwdriver or the tool supplied with the NR-500.) This calibrates the NR-500 playback system to the output of the tape deck.

Next, the recording levels are calibrated, using the same kind of tape that will be regularly employed for recording on the deck. The CAL tone from the NR-500 is recorded, and the deck's recording level controls are set to yield a "0 dB" recording level. Then the tape is rewound and played into the NR-500 to check that the playback level is identical to that from the calibration tape (green LED lit). If not, the CAL tone is re-recorded at slightly different record-level control settings. The process is repeated until playback into the NR-500 shows that the recording level has been matched to the calibrated level. A change of tape type may require a recalibration of the recording levels.

From this point on, the record level controls on the tape deck are not touched again. All recording level adjustment is done with the concentric front-panel knobs on the NR-500, using the recorder's meters in the conventional manner.

To record with Dolby C processing, the REC button and the DOLBY C button on the NR-500 are engaged and the recording is made in the usual manner.

CONTROLS AND INDICATORS

Front Panel

Pushbuttons

POWER: Switches power to NR-500.

CAL: Must be engaged when calibrating tape deck to NR-500.

REC: Must be engaged for recording.

PB: Must be engaged for playback.

DOLBY C: Must be engaged to use Dolby C circuits.

Screwdriver Adjustments

PB CAL: Two, for L and R channels. Adjust for PROPER LEVEL indication while playing Dolby level-calibration tape.

Knobs

REC LEVEL: Concentric knobs for adjusting recording levels after calibration.

Display

DOLBY C: Yellow indicator when DOLBY C button is on.

CAL INDICATOR: Red arrows indicate HIGH or LOW signal levels for each channel when calibrating. Green bar indicates PROPER LEVEL.

Rear Connectors

LINE IN: Connects to amplifier TAPE OUT.

LINE OUT: Connects to amplifier TAPE IN.

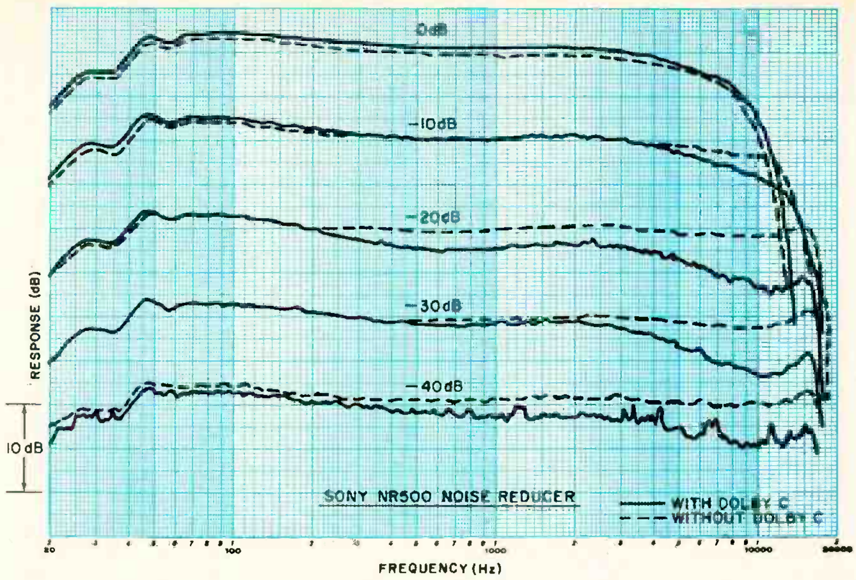
TAPE: Connects to tape deck LINE OUT.

REC OUT: Connects to tape deck LINE INPUT.

Other

MPX FILTER: Slide switch activates 19-kHz filter for recording FM broadcasts.

AC OUTLET: Unswitched.



Record/playback responses using Nakamichi 500 recorder and EX tape.

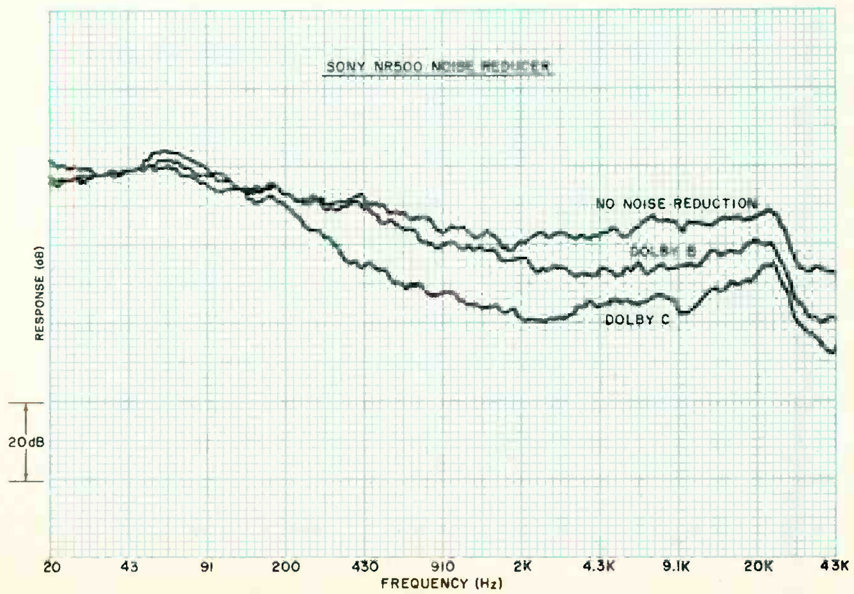
For playback, it is necessary to press the PB button. The NR-500 has only one set of processing circuits that are switched between encode and decode operation. If no external noise reduction is wanted, the DOLBY C button on the NR-500 is left in its OUT position, which extinguishes the yellow DOLBY C light on the panel.

When recording with a three-head tape deck, it is necessary to use a pair of NR-500s, one set to REC and the other to PB, to take full advantage of the recorder's tape-monitoring facility.

Laboratory Measurements. Although we made some measurements on the NR-500 alone, we also combined it with a two-head cassette deck to measure its effect on the noise and frequency response of a complete system, and for subjective listening tests. The recorder was a Nakamichi 500, using Nakamichi EX tape.

The signal-to-noise ratio of the tape deck, referred to standard Dolby level, was 50 dB with no noise reduction, and 68 dB with Dolby C and CCIR/ARM weighting. The noise-reduction measurements were made by playing a blank tape and displaying its noise output on an H-P 3580A spectrum analyzer—first with no noise reduction, then with just the recorder's own Dolby B system, and finally with just the Dolby C system of the NR-500.

The noise reduction of the Dolby B became significant above 2 kHz, and measured 5 to 8 dB over most of the range above that frequency. When we used Dolby C, the noise reduction began at 200 Hz, exceeded 15 dB up to 43 kHz



Noise spectrum playing blank tape on Nakamichi 500 recorder with EX tape.

(analyzer's upper limit), and was a full 20 dB from 2 to 10 kHz.

The frequency response of the Sony NR-500 alone was measured at a number of input levels. Encode and decode responses were tested separately. In general, the two sets of curves were complementary, although we made no special effort to match the levels. However, the fixed "cut" (recording) and "boost" (playback) of the anti-saturation network was clearly evident, with a gradual response change up to about 12 kHz and very rapid change from there to 20 kilohertz.

The record/playback response of the cassette deck, with and without the Dolby C, was measured at several indicated recording levels from 0 to −40 dB. We noted mistracking between the encode and decode processes, as evidenced by a change in frequency response when the Dolby C system was switched in or out. At most signal levels, and over the lower audible frequency range, the difference between the NR-500's on and off curves was less than 3 dB. But differences of 6 dB were noted between 5 and 15 kHz, and at recording levels of −20 dB or lower. However, these test-instrument measurements are really moot since we were unable to make distinctions by ear alone.

While our two-head recorder and single NR-500 processor setup made it impossible to compare incoming and outgoing signals with the flip of a switch, any audible changes that might have been noted were certainly not obvious. We heard no modification of the recorder's response with various musical programs. The noise reduction, however, was *very* obvious, especially when dubbing from good-quality, quiet discs at very low indicated levels on the recorder's meters (−10 to −20 dB). Recordings made at these low levels without noise reduction were intolerably noisy during playback.

The Sony NR-500 requires an encode input level of at least 77 mV (from the amplifier TAPE output) for proper operation, and delivers about 0.25 V of encoded signal to the recording inputs. During playback, the NR-500 should receive at least 77 mV from the recorder line outputs, and it returns approximately 0.44 V to the amplifier TAPE inputs. All of these levels are well within the normal operating range of most stereo system components. The LED system calibration indicators have a rated level accuracy of ±0.5 dB.

User Comment. When the original Dolby B noise-reduction system was introduced, more than 14 years ago, there were virtually no cassette (or open-reel) tape recorders equipped with it. During the several years it took for the tape recorder industry to build the Dolby system into their products, a number of companies marketed adapters so that the advantages of Dolby B could be enjoyed with existing tape machines.

Availability of the Sony NR-500 marks a parallel development. Every cassette deck today has Dolby B (or an equivalent), but just a few late models include Dolby C. The NR-500 makes Dolby C available at modest cost for anyone who now has a tape deck.

The Sony NR-500 works very well, as our tests show. However, switching manually between the record and playback modes is a bit awkward, though with some familiarization the mode switching becomes routine.

Obviously, it would not be worthwhile to spend $200 for this add-on feature if you own, say, a $240 deck without Dolby C since you could buy a new machine in this price range with it. But if you own a costly cassette deck and wish to overcome dull highs when recording fine source material or do not want to risk tape saturation by recording at a high level in order to squeeze out that better fidelity, then the Sony NR-500 is a most welcome component. With some two-dozen cassette decks selling without Dolby C for upwards of $600 only a year ago, not to mention such earlier expensive models, there are likely to be a lot of candidates for upgrading with this new product. —*Julian Hirsch*

CIRCLE NO. 101 ON FREE INFORMATION CARD

Popular Electronics Tests

Otrona "Attache" Portable Computer System

PORTABILITY and communication are rapidly becoming the watchwords of the Eighties, especially as they apply to microcomputer systems. The Otrona Attache exemplifies these characteristics.

The $3995 Otrona Attache is built for both good looks and ruggedness. Housed in a high-impact plastic case, the system boasts a flip-down, plug-in Selectric-style typewriter keyboard, 5" diagonal CRT screen, and built-in 5¼" double-density, double-sided floppy-disk drives having a capacity of 760K bytes, 48 tracks/in., and 10 soft-sectored format.

The basic Attache consists of a CRT monitor, dual floppies, 64K memory, CP/M, WordStar, Valet, operator utility, Charton graphics package, and BASIC-80. In addition, RS-232 serial jacks for adding a modem and printer are included, as is a direct video jack for attaching an outboard video monitor.

Although the machine is designed essentially for portable use, the manufacturer has added a single connector that conforms to STD-Z80A bus definitions. This connector is for adding an optional $295 STD expansion bus.

Besides the expansion bus, you can add a dc power adapter for 10-to-16-V and 20-to-32-V operation at $295. For portable power there is a strap-on battery option for 1.5-hour operation for $395; and a 10-hour option is to be available by midyear, though no price has yet been set. To carry everything

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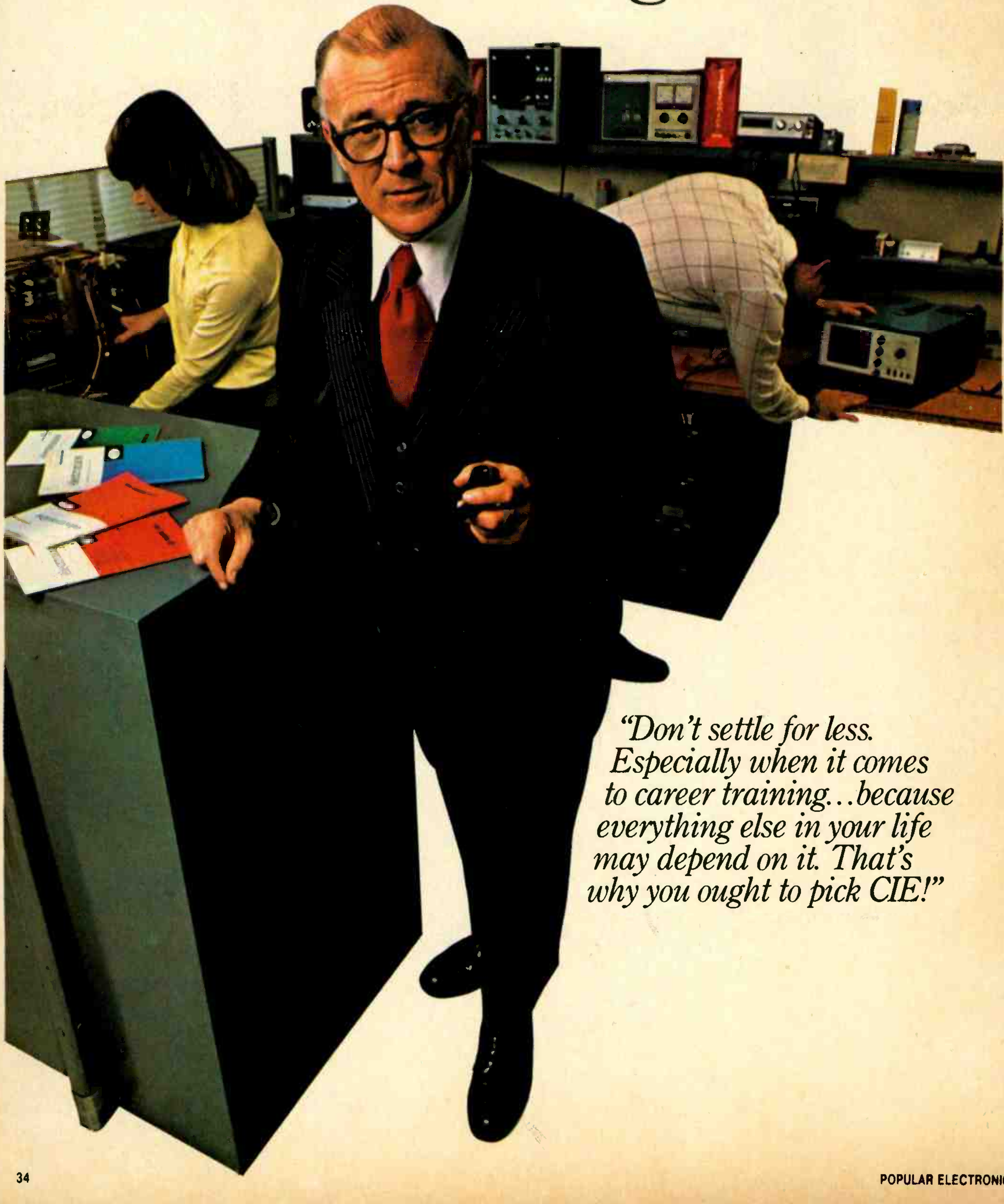

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around you'll need the accessory pouch for $49.

The complete Attache takes up less than ½ cu ft and weighs under 19.5 lb. This appears to be the smallest full-feature computer system currently on the market. And although the unit looks classy on the outside, what's inside the case makes it even more impressive.

Based on a 4-MHz Z80A microprocessor, the Attache uses an Am9517A direct memory processor for handling disk- and communication-port operations. In addition, the Otrona engineers designed in, rather than added on, a clock calendar, battery backup, graphics, and shielding for RFI and EMI.

The CRT display is unlike any other available microcomputer system. It has the ability to handle full raster-style graphics, underlining, super- and subscripts, and equations with Greek letters. In fact, the screen allows you to do anything that you can do on paper.

Software Functionality. The Attache is designed to operate with a standard configuration of 64K bytes of RAM. Handling of the memory, I/O ports, and disk system is the responsibility of the aforementioned Am9517A direct memory processor, which greatly increases system throughput.

To provide compatibility with other Z80-based systems, the Attache employs Digital Research's CP/M operating system, optimized to take advantage of the machine's features and provide a simple user interface.

Working in concert with CP/M are a number of application and utility packages. These include Micropro's WordStar 3.0; Valet, a specialized communications package utility; Microsoft's BASIC-80; and Charton, a graphic plotting package for the generation of line, bar, or pie graphs on the screen, or for output to an external printer such as the optional Epson MX-80 dot-matrix printer.

Even though most of the supplied packages are standard, Valet and Charton are unique to the Attache. The Valet communication package greatly extends the use of the machine by permitting it to interact with another computer, such as in a time-sharing system.

In operation, Valet allows you to develop a report using WordStar or Charton (or both, for that matter), and either send data to another system or download necessary information without disrupting the operation of the primary program.

Valet uses the interrupt structure of the machine to save the status of the primary program on a user stack, thus releasing the hardware stack for use by Valet. Pointers are maintained to provide entry to the primary program. By using interrupts and multiple stacks, it's possible to flip back and forth between a program and Valet's processes, giving the impression of multitasking and concurrency of operation.

Evaluation. The Attache evaluated was a basic unit without any add-on options. We did, however, have the use of a 12-in. monitor, which was connected via an RCA-type video jack. The flip-down keyboard connects to the system via an RJ11 phone plug and can be used totally detached or, if desired, hinge-connected to the system case. We found that both configurations worked well.

The keyboard's top row has special function keys that are activated by using a combination of escape (ESC) and control sequences. In WordStar for example, you can perform block moves, print, or set WordStar HELP levels all at the touch of a single key.

In addition, you can set-up key sequences to be used in communication with Valet or other modem control packages. The keyboard also offers audible feedback and responds exactly like an IBM Selectric.

In operation, we found that we could type text at 60 wpm without losing characters or causing typos due to slow keyboard response.

Although the keyboard is important, the display may be of more importance since it serves as the window into the system's operation. The 5-in. green-phosphor screen works well, even when creating full text pages and displaying WordStar menus. The display quality is equal to that of CRTs with bandwidths of 15 MHz.

Since the display is mapped directly into user memory and a paging technique is used to "paint" a picture on the display, video response is very rapid. The Am9517A handles the display and memory, which gives a four-fold increase in display speed over any—and we stress any—other system, including nonportables.

The display supports true full-dot graphics with a resolution of 240 by 320 dots (76,800 points). Since the resolution is so great and the screen response is at DMA (direct memory access) speeds, you can quickly draw figures either freehand or have displays created using calculations from BASIC or Charton.

The Attache can perform three-dimension transforms, show two-dimension representations with absolute perspective of image, and page figures in and out. In addition, we found that you can set up a graphics image and scroll characters around or through it.

For a speed test, we used our 10 GOSUB 10 BASIC program, which when executed, causes everything to be pushed on to the stack until you run out of memory. The response is an out-of-memory error. The time required to obtain this condition was insignificant since an error response was incurred immediately upon running the program on the computer.

User Comments. For the disk subsystem, we liked the quick response—CP/M took only seconds to sign on. Although we were unable to verify it, the Otrona designers have apparently created a CP/M BIOS (Basic Input/Output System) that doesn't need to be loaded into memory and then executed, or they have managed to more than quadruple the disk data rate.

We found that data could be written to and read from disk without a lengthy wait. We were able to enter other commands, during a SAVE or LOAD, and have them executed almost as quickly as they were entered.

Because the hardware is designed to operate in environments that may not be optimum, the Attache uses a switching power supply with full brown-out protection and a 2-second margin for power loss. This is sufficient for issuing a QUICK-SAVE command or even plugging the line cord back in if it is accidentally kicked out.

We checked with the local power company (California Edison) and found that most outages last less than 2 seconds. These interruptions are usually due to automatic switching equipment bringing major power sources on- or off-line and creating momentary interruptions on the power grid. Therefore, the 2-second margin used in the Attache should be sufficient to handle most power problems.

The Attache isn't restricted to using the software supplied since it can use any CP/M-compatible product available. Furthermore, the UCSD p-system, which is a unique collection of software systems, ranging from Pascal to Fortran, is available for the Attache, as are the necessary p-code interpreters.

As exciting as the machine is from a hardware and software point of view, be aware that it's designed for portable operation. If you need a development system, don't buy the Attache. But if you're looking for a multi-purpose system that travels well, definitely consider it. Don't be deterred by the $3995 price tag. The Attache is a high-quality machine, with ruggedness and reliability its main features. The computing power just happens to be there too.

What we didn't like about the Attache was the lack of an integrated modem. We felt that since the machine is portable and designed to operate with a remote system, Otrona should offer an add-on modem as an option. The Valet software ideally supports most modem functions and could be used to set up interactive remote communications.

Our minor gripes aside, the Attache is ideally suited for serious portable operation as well as desktop use. It's powerful, versatile, has good storage capability, and the keyboard is very comfortable for the user.

According to company officials, you can expect to see more add-ons for the Attache, including an A/D, D/A board (by mid-year), a Winchester disk (speculated to be Sony's 3½", 5M-byte model), and possibly a 16-bit processor.

—Carl Warren

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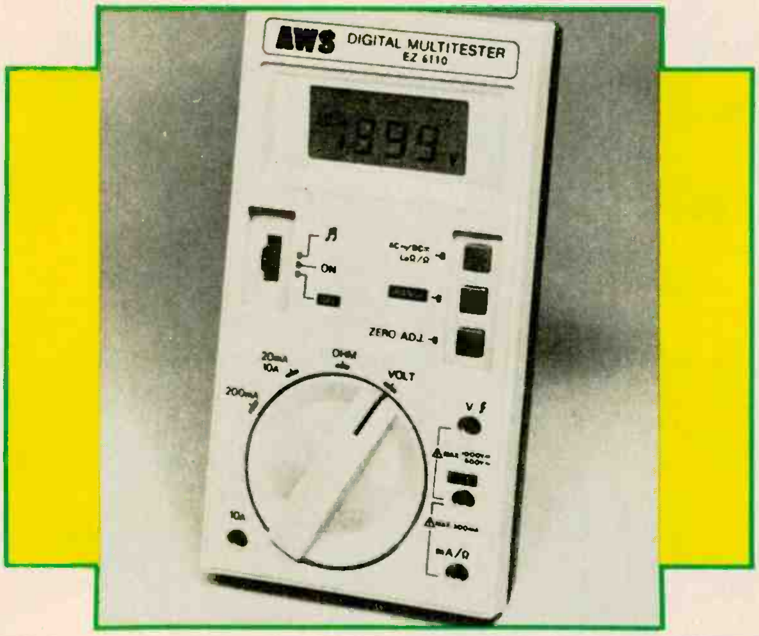
CIRCLE NO. 13 ON FREE INFORMATION CARD

Popular Electronics Tests

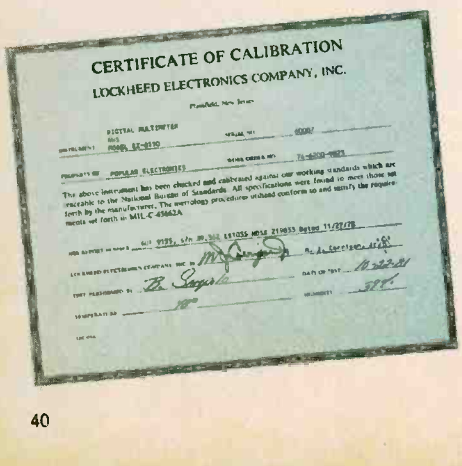
A.W. Sperry EZ-6110 Portable Digital Multimeter



THE Model EZ-6110 Digital Multimeter from A. W. Sperry Instruments, Inc., is a compact, battery-powered, digital test instrument for general-purpose measurements on the workbench and in the field. It has a 3½-digit, 0.4"-tall, high-contrast LCD readout and 24 measurement ranges.

There are five dc voltage ranges between 200 mV and 1 kV, four ac voltage ranges between 2 V and 600 V (frequencies between 40 and 500 Hz), two ac and dc current ranges of 20 and 200 mA, an ac/dc current range of 10 A, and five resistance ranges between 200 ohms and 2 megohms. Complete specifications are shown in the Table.

Major operational features include automatic range selection in the voltage and resistance modes, range hold at the user's option, autopolarity, auto indication of function in units and signs, autozero of the lowest ranges, and an audible continuity buzzer. A low-battery indicator is provided on the LCD readout. The ABS shock-resistant plastic case is 6⅛"H by 1⅛"D by 3⅜"W, and the instrument weighs 8.3 oz. Suggested retail price is $168.



General Description. The two most interesting features of the EZ-6110 are the auto-ranging (on the volts and ohms scales) and the audio tone that sounds when a resistance below 19 ohms is encountered.

To measure ac or dc voltages, simply place the single, four-position rotary-function switch to the VOLT position and depress the AC/DC pushbutton switch accordingly. (An AC symbol is displayed in the ac mode.) Now, with the color-coded test leads plugged into their respective COM and V sockets, sample the unknown voltage. The display indicates AUTO and starts by measuring mV, changing ranges upward as required until a stable digital reading is obtained.

The RANGE pushbutton switch enables the user to select and remain in any voltage or resistance measurement range. In this mode, the AUTO symbol is removed from the display. In the event of an overrange, the most-significant-digit (left-most) starts blinking. The OHM position of the function switch works in essentially the same way, except that the test leads are plugged into the COM and mAΩ connectors. When the power switch is placed in the "tone" position (indicated by a musical note), the internal continuity buzzer sounds if the measured resistance goes under 19 ohms. (In fact, the buzzer can be made to sound on any range where the reading falls below 19 units.) This mode makes the EZ-6110 ideal for "eyes-off" continuity measurements.

In the LO resistance ranges, measurements are typically made with less than 0.33 V of dc, thus enabling the instrument to make accurate in-circuit resistance measurements of components that may be in parallel with semiconductor junctions. By using the RANGE pushbutton, any of the five ranges can be quickly selected.

Both ac and dc currents can be measured with the 20 mA/10 A or 200 mA positions of the main function switch. There is no autoranging in these functions, and the 10-A input has its own connector.

When using the 200-mv (ac or dc) voltage range, as selected by the RANGE pushbutton, the test leads should first be calibrated. To do this, short the test leads until the display drops below four digits. Then depress the ZERO ADJ pushbutton until the display goes to 000 ± 1 digit. The instrument is now calibrated to the end of its test leads. The ZERO ADJ should also be used to account for the resistance of the test leads and protective fuse when making accurate resistance measurements. As a reminder, ADJ appears in the display if the ZERO ADJ function is used.

The EZ-6110 is said to run about 300 hours on a pair of AA cells that fit within an enclosure on the underside of the meter. The same enclosure also holds

MANUFACTURER'S SPECIFICATIONS

	Range	Accuracy		Resolution	Input Resistance	Max Input Volts
	200 mV	±0.5%*	±0.2%**	100 μV	100 MΩ	1000 V
	2 V	±0.5%*	±0.2%**	1 mV	10 MΩ	1000 V
	20 V	±0.5%*	±0.2%**	10 mV	10 MΩ	1000 V
DC Volts	200 V	±0.5%*	±0.2%**	100 mV	10 MΩ	1000 V
(Autoranging)	1000 V	±0.5%*	±0.2%**	1 V	10 MΩ	1000 V
	2 V	± 1%*	±0.4%**	1 mV	10 MΩ	750 V rms
	20 V	± 1%*	±0.25%**	10 mV	10 MΩ	750 V rms
AC Volts	200 V	± 1%*	±0.25%**	100 mV	10 MΩ	750 V rms
(Autoranging)	600 V	± 1%*	±0.25%**	1 V	10 MΩ	750 V rms

Frequency Response: 40 Hz to 500 Hz

	Range	Accuracy		Resolution	Input Resistance	Max Input Current
DC Milliamperes	20 mA	± 1%*	±0.2%**	10 μA	10 Ω	200 mA
	200 mA	± 1%*	±0.2%**	100 μA	1 Ω	200 mA
AC Milliamperes	20 mA	± 1.3%*	±0.25%**	10 μA	10 Ω	200 mA RMS
	200 mA	± 1.3%*	±0.25%**	100 μA	1 Ω	200 mA RMS
DC Amperes	10 A	± 1%*	±0.25%**	10 mA	0.01 Ω	10 A
AC Amperes	10 A	± 1.3%*	±0.25%**	10 mA	0.01 Ω	10 A RMS

	Range	Accuracy		Resolution	Test Current	Max Input Voltage (ac/dc)
Resistance (ohms)	200 k	±0.5%*	±0.2%**	0.1 Ω	1.5 mA	250 V
	2 k	±0.5%*	±0.2%**	1 Ω	300 μA	250 V
	20 k	±0.5%*	±0.2%**	10 Ω	30 μA	250 V
	200 k	±0.5%*	±0.2%**	100 Ω	3 μA	250 V
	2000 k	± 1.8%*	±0.25%**	1 kΩ	0.3 μA	250 V
Low Resistance (ohms)	2 k	± 1%*	±0.5%**	1 Ω	150 μA	250 V
	20 k	± 1%*	±0.5%**	10 Ω	15 μA	250 V
	200 k	± 1%*	±0.5%**	100 Ω	1.5 μA	250 V
	2000 k	± 2%*	±0.5%**	1000 Ω	0.15 μA	250 V

*Percent of reading
**Percent of full scale

the protective fuse and a spare fuse. Access is via a small sliding door.

User Comments. The Model EZ-6110 Digital Multimeter was checked by the Lockheed Electronics Instrumentation Measurements Laboratory (Plainfield, NJ) against standards traceable to the National Bureau of Standards and was found to meet or exceed its claimed specifications in all respects.

We used the EZ-6110 on our workbench for several weeks. During this period, the instrument performed extremely well. The autoranging function was a pleasure to use, since we no longer had to operate a range switch and could keep our eyes on the circuit probes. You can really appreciate this when trouble-shooting a pc board packed with components since any slip of the probe tip can cause problems.

The easy-to-read LCD display provides all the information required for any measurement with its polarity symbol, the AC symbol for ac measurements, and the Ω and kΩ symbols for resistance measurements. And we found the audio-tone feature ideal for making eyes-off continuity measurements in cramped quarters.

Since the instrument is so small, it is easy to slip into a pocket for field work. The rectangular plastic case is easy to grip and is almost skidproof. In the interest of safety, all controls—except for the heavily built function switch and the LCD readout—are recessed below the case surface. We found the ABS plastic case really is shatterproof when the meter was accidentally dropped from a low roof during an antenna installation. After picking the EZ-6110 out of the mud, it was wiped off and worked good as new.

The EZ-6110 hand-held digital multimeter rates high, and we can seriously recommend this state-of-the-art portable instrument as an addition to your trouble-shooting toolkit.—*Les Solomon*

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*In kit form, F.O.B. Benton Harbor, MI. Also available the completely assembled Zenith Z-19 at $895. Prices and specifications are subject to change without notice.

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CIRCLE NO. 14 ON FREE INFORMATION CARD

CP-202C

Popular Electronics
JUNE 1982

BIG COMPUTER PERFORMANCE FROM A POCKET COMPUTER

THE WIDE PRINTOUT

A simple interface and some software added to a Pocket Computer enable it to "talk" to the larger TRS-80 Model I, producing easy-to-read hard copy at low cost

BY CASS AND DAN LEWART

THE handheld computer, programmable in BASIC, brought portable computing power to us in late 1980. Called the TRS-80 "Pocket Computer" from Radio Shack (also Sharp's PC-1211), it has a wide repertoire of instructions and is user friendly. Although an accessory printer is available, it prints only 16 characters per line on narrow adding-machine paper. This is fine for portable use, but is obviously deficient for serious work at home since the format is so difficult to read.

Hardware/software information presented here enables anyone with a TRS-80 Model I with two disk drives and a standard printer to transfer list-


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ings from the Pocket Computer to the big machine. The result is hard copy in conventional width that can also be viewed on a video screen. And the cost should be less than $50.

Description. When a program is CSAVEd from the Pocket Computer, instead of being fed into the cassette interface and tape recorder, it outputs to an inexpensive "black box" that plugs into the expansion interface of the TRS-80 Model I. When CSAVEing, the Pocket Computer sends binary pulses representing "tokens" corresponding to the BASIC statements and line numbers. The TRS-80, in turn, reads the characters off the data bus, groups them into tokens, and translates these tokens into line numbers and BASIC statements. The BASIC program can then be formatted, printed, or stored for future use. (Statements could possibly be executed on the Model I if the user can resolve differences between the two BASICs.)

Reading and interpreting the output of the Pocket Computer then becomes a purely software problem. A machine-language program reads the binary pulses off the bus, a BASIC program does the token conversion and formatting, and listings are displayed on the screen. Hard copy can then be produced by a standard printer.

```
10:"Z"PAUSE "DE
   MONSTRATION
   PROGRAM"
20:PAUSE "SPECI
   AL NON-ASCII
    CHARACTERS"
   :PAUSE "π,^,
   √,¥ AND E"
30:FOR I=1TO 10
   :INPUT "HOW
   MANY $?";Z
40:B=Z*3E2:
   PRINT "EQUAL
   S ";B;" ¥":
   NEXT I
```

Fig. 1. A demonstration program printed on the regular Radio Shack/Sharp printer is shown at left. The same program printed on a Paper Tiger IDS440G printer using the circuit described in this article is below.

```
10:"Z"PAUSE "DEMONSTRATION PROGRAM"
20:PAUSE "SPECIAL NON-ASCII CHARACTERS":
   PAUSE "π,^,√,¥ AND E"
30:FOR I=1TO 10:INPUT "HOW MANY $?";Z
40:B=Z*3E2:PRINT "EQUALS ";B;" ¥":NEXT I
```

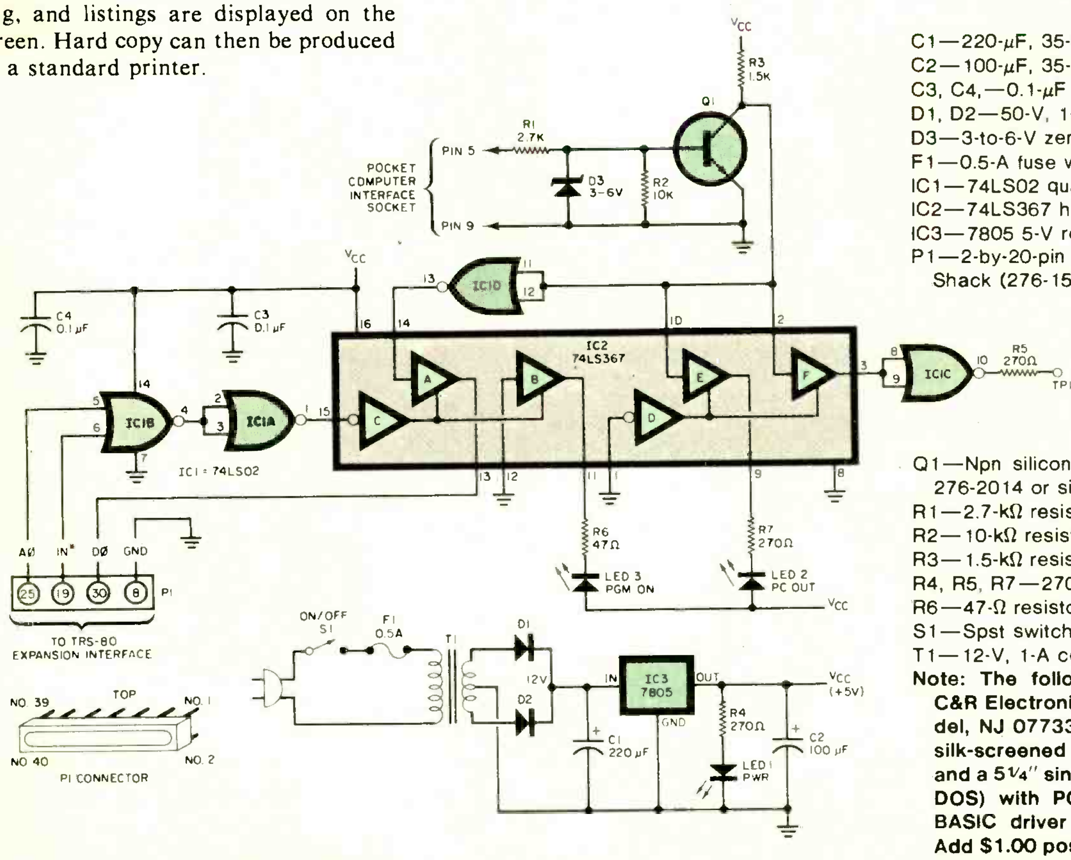


Fig. 2. Schematic of the interface circuit. Included is a regulated power supply.

PARTS LIST

C1—220-µF, 35-V electrolytic
C2—100-µF, 35-V electrolytic
C3, C4,—0.1-µF disc capacitor
D1, D2—50-V, 1-A silicon rectifier
D3—3-to-6-V zener diode
F1—0.5-A fuse with holder
IC1—74LS02 quad NOR gate
IC2—74LS367 hex tri-state buffer
IC3—7805 5-V regulator
P1—2-by-20-pin edge connector Radio Shack (276-1558)
Q1—Npn silicon transistor (Radio Shack 276-2014 or similar)
R1—2.7-kΩ resistor
R2—10-kΩ resistor
R3—1.5-kΩ resistor
R4, R5, R7—270-Ω resistor
R6—47-Ω resistor
S1—Spst switch
T1—12-V, 1-A center-tapped transformer

Note: The following is available from C&R Electronics, P.O. Box 217, Holmdel, NJ 07733: a drilled, glass-epoxy, silk-screened pc board for $12.95, and a 5¼" single-density disk (without DOS) with PCREAD/CMD and three BASIC driver programs for $16.95. Add $1.00 postage and handling. New Jersey residents add 5% sales tax. If you have a single-drive system, enclose a disk with TRSDOS, NEWDOS+ or NEWDOS80 and deduct $2.50. Your disk will then be returned with the PCREAD programs.

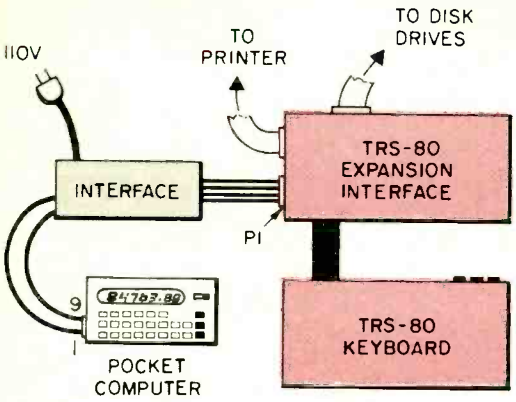


Fig. 3. Use this arrangement to connect the interface circuit between the Pocket Computer and the TRS-80. Keep the four leads between the new circuit and the TRS-80 Expansion Interface as short as possible.

The printer the authors used normally operates in the character (ASCII) mode. However, when a token describing a special non-ASCII or graphics character is encountered, the printer switches from ASCII to the graphics mode, where each matrix dot can be individually addressed. Thus, the printer can create a replica of such a character. If your printer does not provide a graphics mode, then π could be printed as Pi, $\sqrt{}$ as Sqr, etc. An example of a listing obtained with a Paper Tiger IDS440G printer is shown in Fig. 1.

The Pocket Computer tokens can be saved on tape or disk with the DOS DUMP command for future listing. The BASIC statements can also be saved as ASCII files for formatting with a word processor. (Using the low-cost circuit with appropriate software allows the Pocket Computer to communicate with the Model I, but not vice versa. This would require a more complicated interface and software.)

Circuit Operation. The circuit shown in Fig. 2 interfaces the Pocket Computer with the TRS-80 Model I.

Data pulses from the Pocket Computer, representing BASIC tokens, are amplified by *Q1*, buffered by *IC1D*, and applied via pin 14 to one three-state buffer within *IC2*. The output of this buffer (pin 13) is applied to the D0 (data-zero) line of the TRS-80 via a 40-pin connector plugged into the TRS-80 Expansion Interface. The A0 address line and the IN* line from the TRS-80 are also coupled via this connector to the inputs of *IC1B*. When these two inputs go low simultaneously, which happens when the TRS-80 issues an IN A (port) command, the output of *IC1B* goes high. This signal is inverted by *IC1A* and

TABLE I—PCREAD/CMD MACHINE-LANGUAGE PROGRAM

```
BREAK   EQU   2            ;BREAK KEY BIT
CORNER  EQU   3C3FH        ;CORNER OF SCREEN
EOF     EQU   0F0H         ;END CODE OF RECORDING
FIRST   EQU   0F100H       ;FIRST BYTE OF BUFFER
NEWDOS  EQU   402DH        ;ENTRY TO NEWDOS
PORT    EQU   00H          ;CASSETTE INPUT PORT
RETARG  EQU   0A9AH        ;RETURN HL TO BASIC
ROW7    EQU   3840H        ;KEYBOARD ROW 7
        ORG   0F000H       ;61440 DECIMAL
PCREAD  DI                 ;DISABLE INTERRUPTS
        LD    IX,0         ;ZERO IX
        ADD   IX,SP        ;SAVE SP IN IX
        LD    HL,FIRST-1   ;POINT TO BUFFER-1
        CALL  RDBYTE       ;READ CHECKSUM BYTE
        LD    E,0          ;ZERO CHECKSUM
        CALL  RD8B         ;READ PASSWORD
RD80B   LD    E,0          ;ZERO CHECKSUM
        LD    B,10         ;READ 10*8 BYTES
NXT8    CALL  RD8B         ;READ 8 BYTES
        DJNZ  NXT8         ;READ NEXT GROUP
        JR    RD80B        ;ZERO CHECKSUM
RD8B    PUSH  BC           ;SAVE BC
        LD    B,8          ;READ 8 BYTES
RDBYCK  CALL  RDBYTE       ;READ BYTE
        LD    (CORNER),A   ;DISPLAY ON SCREEN
        INC   HL           ;MOVE BUFFER POINTER
        LD    (HL),A       ;PUT BYTE IN BUFFER
        CP    EOF          ;IS IT END CODE?
        JR    Z,DONE       ;YES, BRANCH
        AND   0FH          ;LESS SIGNIFICANT NIBBLE
        LD    C,A          ;SAVE IN C
        LD    A,D          ;SWITCHED BYTE
        AND   0FH          ;MORE SIGNIFICANT NIBBLE
        ADD   A,E          ;ADD MSN TO CHECKSUM
        JR    NC,NOOV      ;SKIP ON NO OVERFLOW
        INC   A            ;INCREMENT CHECKSUM
NOOV    ADD   A,C          ;ADD LSN TO CHECKSUM
        LD    E,A          ;UPDATE CHECKSUM
        DJNZ  RDBYCK       ;READ NEXT BYTE
        CALL  RDBYTE       ;READ CHECKSUM BYTE
        CP    E            ;IS IT CORRECT?
        JR    NZ,ERROR     ;NO, BRANCH
        POP   BC           ;RESTORE BC
        RET                ;RETURN
ERROR   LD    HL,-1        ;BAD LOAD
        JR    RSTSP        ;BRANCH
DONE    LD    HL,0         ;GOOD LOAD
RSTSP   LD    SP,IX        ;RESTORE SP
        EI                 ;ENABLE INTERRUPTS
        JP    RETARG       ;RETURN HL TO BASIC
RDBYTE  PUSH  BC           ;SAVE BC
        LD    C,0          ;ZERO BYTE
        CALL  RDNIB        ;READ HI NIBBLE
        CALL  RDNIB        ;READ LO NIBBLE
        LD    D,A          ;SWITCHED BYTE
        RRCA               ;SHIFT UNTIL CORRECT
        RRCA               ;BY
        RRCA               ;ROTATING
        RRCA               ;FOUR TIMES
        POP   BC           ;RESTORE BC
        RET                ;RETURN
RDNIB   LD    A,(ROW7)     ;READ PORT
        BIT   BREAK,A      ;IS BREAK KEY PRESSED?
        JR    NZ,ERROR     ;YES, BRANCH
        IN    A,(PORT)     ;READ PORT
        BIT   0,A          ;IS BIT 0 OFF?
        JR    NZ,RDNIB     ;NO, TRY AGAIN
        LD    D,A          ;SAVE PORT DATA
        LD    B,4          ;READ 4 BITS
NEWBIT  CALL  RDBIT        ;READ BIT
        RR    C            ;SHIFT CARRY INTO C
        DJNZ  NEWBIT       ;READ NEXT BIT
        CALL  RDBIT        ;DELAY FOR ONE BIT
        LD    A,C          ;SWITCHED DATA BYTE
        RET                ;RETURN
RDBIT   PUSH  BC           ;SAVE B
        LD    B,65H        ;LOOP 101 TIMES
SAME    IN    A,(PORT)     ;READ PORT
        CP    D            ;HAS IT CHANGED?
        JR    NZ,CHANGE    ;YES, BRANCH
        DJNZ  SAME         ;NO, CHECK AGAIN
CHANGE  LD    D,A          ;SAVE PORT DATA
        RRCA               ;SHIFT BIT INTO CARRY
        POP   BC           ;RESTORE B
        RET                ;RETURN
        END   NEWDOS       ;BY DANIEL S. LEWART
```

passed to pin 15 of *IC2* to "open" gates A and B via gate C. Gate A then passes the Pocket Computer data to the D0 bus of the TRS-80. Gate B, in turn, sinks current from *LED3* (PGM ON) which, when glowing, indicates that the TRS-80 is ready to accept data from the Pocket Computer.

Gates E and F of *IC2* are always "open" due to control gate D being kept "on" by the ground at its input. Thus, gate E allows *LED2* (PC OUT) to glow as data flows from the Pocket Computer, while gate F, after inversion by *IC1C*, drives test point 1 (*TP1*).

Power is derived from a conventional full-wave rectifier (*D1* and *D2*). The rectifier output is filtered by *C1*, and regulated to 5 V by *IC3*. An indication that power is applied to the circuit is provided by *LED1* (PWR).

Construction. The circuit can be fabricated on a small piece of perf board using point-to-point wiring, or a small pc board can be made. Use sockets for *IC1* and *IC2*.

The pc board and the small associated power supply can be mounted within almost any desired enclosure. The four leads going to the TRS-80 Expansion Interface (Fig. 3) should be as short as possible, and terminated in a suitable connector. The two leads that connect to the Pocket Computer can be fabricated from #22-gauge tinned copper wires. Strip about 1/4 in. of insulation from the ends of two #22 leads and they will fit perfectly into the socket of the Pocket Computer.

The power line cord can exit through its own hole in the enclosure. The power switch (*S1*) and the three LEDs (suitably identified) mount on the upper surface of the selected enclosure.

After construction, turn *S1* on and note that *LED1* glows. Using a dc voltmeter, make sure that there is 5V on pin 14 of *IC1* and pin 16 of *IC2*. Temporarily short input leads A0, IN*, and GND together. This should cause *LED3* to glow. If it does, remove the short. The interface is now ready for connection to the TRS-80.

Software. The heart of the project is the machine-language program PCREAD/CMD (Table I). This software detects the beginning and end of transmissions from the Pocket Computer, interprets the binary pulses, and stores them as hexadecimal numbers in the Model I memory. The program also performs the timing function necessary to read the 500-baud signals from the Pocket Computer, and sets a blinking display block in the upper-right corner of the video monitor screen to indicate when the data is being read. Detailed

TABLE II—PRINTER DRIVER PROGRAM FOR MX-80

```
100 POKE &H40B2,&HEF:POKE &H40B1,&HFE:CLEAR 2000
110 DEFINT A-Z:DIM D$(255),P$(255):DEFUSR=&HF000
120 CMD"PCREAD/CMD"
130 FOR I=1 TO 11
140     READ A,B
150     FOR J=A TO B
160         IF I<7 THEN READ D$(J):ELSE READ T$:D$(J)=T$+" "
170         NEXT
180     NEXT
190 D$(0)=CHR$(13)
200 D$(18)=CHR$(34)
210 A$=CHR$(27)+CHR$(75)+CHR$(5)+CHR$(255)
220 '23=YEN,25=PI,26=SQR,57=CARET,75=EXP
230 P$(23)=A$+CHR$(168)+CHR$(104)+CHR$(62)+CHR$(104)+CHR$(168)
240 P$(25)=A$+CHR$(130)+CHR$(252)+CHR$(128)+CHR$(252)+CHR$(130)
250 P$(26)=A$+CHR$(8)+CHR$(4)+CHR$(254)+CHR$(128)+CHR$(128)
260 P$(57)=A$+CHR$(24)+CHR$(32)+CHR$(64)+CHR$(32)+CHR$(24)
270 P$(75)=A$+CHR$(254)+CHR$(254)+CHR$(146)+CHR$(146)+CHR$(146)
280 INPUT"HOW MANY CHARACTERS PER LINE";W
290 IF W<11 THEN 280
300 PRINT"1)PC LOAD  2)DISK LOAD  3)LIST  ",
310 INPUT"4)PRINT  5)DISK SAVE  6)EXIT";G
320 ON G GOTO 350,420,470,470,870,950
330 GOTO 300
340 'LOAD FROM PC
350 IF (INP(0) AND 1)=1 THEN 360
360 PRINT"TURN ON POCKET COMPUTER"
370 IF (INP(0) AND 1)=0 THEN 370
380 PRINT"CSAVE PC PROGRAM"
390 IF USR(0) THEN PRINT"BAD LOAD" ELSE PRINT"GOOD LOAD"
400 GOTO 300
410 'LOAD FROM DISK
420 LINEINPUT"LOAD FROM WHICH FILESPEC? ";F$
430 CM$="LOAD "+F$
440 CMD CM$
450 GOTO 300
460 'LIST (OR PRINT)
470 M=&HF100
480 C$="":N=0:K=0
490 FOR I=1 TO 7
500     GOSUB 820
510     IF B>0 THEN C$=D$(16*L+H)+C$
520     NEXT
530 M=M+1
540 CLS:PRINT C$
550 B=PEEK(M):M=M+1
560 IF B<(&HE0) THEN 630
570 IF B=(&HF0) THEN 300
580 IF B>(&HE0) THEN C$=CHR$(B-&HB0) ELSE C$=" "
590 GOSUB 820
600 IF (C$<>" " OR H>0) THEN C$=C$+CHR$(H+&H30) ELSE C$="  "
610 C$=C$+CHR$(L+&H30)+":"
620 GOTO 650
630 C$=D$(B)
640 C1$=P$(B)
650 PRINT C$;                                    :'OUTPUT STRING
660 IF G=3 THEN 550
670 IF C$=CHR$(13) THEN LPRINT S$:S$="":N=0:K=0:GOTO 550
680 E=LEN(C$)
690 IF C1$>"" THEN C$=C1$:C1$="":E=1
700 N=N+E
710 IF N>W THEN 750
720 S$=S$+C$
730 IF (C$=":" OR N=4) THEN LPRINT S$;:K=N-4:S$=""
740 GOTO 550
750 IF K=0 THEN 790
760 LPRINT:LPRINT"    ";
770 N=N-K:K=0
780 GOTO 720
790 LPRINT S$:LPRINT"    ";
800 S$=C$:N=4+E:K=0
810 GOTO 730
820 B=PEEK(M)                                    :'READ BYTE
830 H=INT(B/16):L=B-16*H
840 M=M+1
850 RETURN
860 'SAVE TO DISK
870 LINEINPUT"SAVE TO WHICH FILESPEC? ";F$
880 M=&HF108
890 IF PEEK(M)<240 THEN M=M+1:GOTO 890
900 IF M>(&HF698) THEN PRINT"NO PROGRAM LOADED":GOTO 300
910 CM$="DUMP "+F$+" F100H,"+RIGHT$(STR$(65536+M),5)+",402DH"
920 CMD CM$
930 GOTO 300
940 'EXIT
950 END
960 DATA 17,29," ",QUOTE,?,!,#,%,YEN,$,PI,SQR,",",;,":"
970 DATA 48,57,(,),>,<,=,+,-,*,/,^
980 DATA 64,75,0,1,2,3,4,5,6,7,8,9,.,EXP
990 DATA 81,93,A,B,C,D,E,F,G,H,I,J,K,L,M
1000 DATA 94,106,N,O,P,Q,R,S,T,U,V,W,X,Y,Z
1010 DATA 130,132,>=,<=,<>
1020 DATA 144,146,TO,STEP,THEN
1030 DATA 160,173,SIN,COS,TAN,ASN,ACS,ATN,EXP,LN,LOG,INT,ABS
1040 DATA           SGN,DEG,DMS
1050 DATA 176,183,RUN,NEW,MEM,LIST,CONT,DEBUG,CSAVE,CLOAD
1060 DATA 192,197,GRAD,PRINT,INPUT,RADIAN,DEGREE,CLEAR
1070 DATA 208,222,IF,FOR,LET,REM,END,NEXT,STOP,GOTO,GOSUB,CHAIN
1080 DATA           PAUSE,BEEP,AREAD,USING,RETURN
```

17	SPACE	100	T
18	QUOTE	101	U
19	?	102	V
20	!	103	W
21	#	104	X
22	%	105	Y
23	YEN	106	Z
24	$	130	>=
25	PI	131	<=
26	SQR	132	<>
27	,	144	TO
28	;	145	STEP
29	:	146	THEN
48	(	160	SIN
49	)	161	COS
50	>	162	TAN
51	<	163	ASN
52	=	164	ACS
53	+	165	ATN
54	–	166	EXP
55	*	167	LN
56	/	168	LOG
57	^	169	INT
64	0	170	ABS
65	1	171	SGN
66	2	172	DEG
67	3	173	DMS
68	4	176	RUN
69	5	177	NEW
70	6	178	MEM
71	7	179	LIST
72	8	180	CONT
73	9	181	DEBUG
74	.	182	CSAVE
75	E	183	CLOAD
81	A	192	GRAD
82	B	193	PRINT
83	C	194	INPUT
84	D	195	RADIAN
85	E	196	DEGREE
86	F	197	CLEAR
87	G	208	IF
88	H	209	FOR
89	I	210	LET
90	J	211	REM
91	K	212	END
92	L	213	NEXT
93	M	214	STOP
94	N	215	GOTO
95	O	216	GOSUB
96	P	217	CHAIN
97	Q	218	PAUSE
98	R	219	BEEP
99	S	220	AREAD
		221	USING
		222	RETURN

Fig. 4. Token equivalents for converting hexadecimal number characters into BASIC statements.

function of the program is shown in the "Remark" column in the listing.

A BASIC driver program (PCREAD/BAS) then takes the hexadecimal numbers characters stored in the Model I computer memory (equivalent to the Pocket Computer program listing), forms them into tokens, and translates the tokens into BASIC statements according to Fig. 4. (This was first derived by Norlin Rober.)

Three versions of a printer driver program were written in disk BASIC for Epson MX-80 with Graftrax, Paper Tiger IDS/440G, and for printers without graphic capabilities. The version for the MX-80 is listed here (Table II). Minor modifications would be required for other graphic printers. These programs are available on diskette (see Parts List). The BASIC programs give the option to specify the maximum number of characters per line. The text will break at whole tokens when the maximum number of characters per line is exceeded (again see Fig. 1).

Checkout and Operation. Connect the Pocket Computer to the interface as shown in Fig. 3. With both units powered up, CSAVE a program and note that *LED2* on the interface blinks. If you have a scope, observe the rectangular pulses at *TP1* as the Pocket Computer outputs in the CSAVE mode.

Now turn everything off and plug the interface *P1* connector into the Model I Expansion Interface as shown in Fig. 3. Turn on the power for the TRS-80 Model I, the interface, and the pocket computer, run a BASIC driver program that calls PCREAD/CMD. When prompted, CSAVE a program from the Pocket Computer. You then have the options of displaying, printing, or saving the program. ◊

A NEW, EFFECTIVE ANTI-BURGLARY SYSTEM

Here's a wireless theft-prevention system that sounds an alarm before a burglar enters the home

BY RAYMOND L. KIRBY

INTRUSION systems to protect one's valuables and life have become increasingly popular as burglaries continue to rise. The theft-prevention system presented here operates in an effective manner using unusual means to thwart thieves.

Firstly, it's a pre-entry deterrent since it is activated by attempted forced-entry noises such as the sound of breaking glass, splintering wood, metal striking metal, etc. At the same time, it ignores such "normal" sounds as talking, telephone ringing, and the doorbell. Secondly, it does not require running of wires and installation of switches, and so on. As a consequence, the system alerts the user to forced-entry efforts *before* the thief can enter the home, and installation is utterly simple.

The pre-entry warning system described in this article features a sound discriminator that can cover a 3000-square-foot area, a 110-dB siren, battery backup in case of power-line failure, the ability to turn on lights, an exit delay, duration control, remote arm/disarm, and compatibility with many other instrusion alert systems. Best of all, this system can be built for under $200.

Circuit Operation. As shown in Fig. 1, the ceramic microphone picks up the entire gamut of sounds within the protected area. The microphone signal is amplified by *IC1A*, which has some frequency rolloff due to *R2* and *C2*. Stage gain is determined by *R4*, which is set during calibration.

After level selection by *R5*, the audio signal is fed to bandpass filter *IC1B*. The feedback network consisting of *C5*, *C6*, *R8*, and *R9* peaks this circuit at approximately 16 kHz. Thus, conventional speech and household noises will not pass the *IC1B* filter—but, the high-frequency (mechanical) noises caused by attempted forced entry will. The filtered audio signal is then applied to timer *IC2A* of Fig. 2.

When the filtered audio signal applied to pin 6 exceeds about 4 V, *IC2A* is activated. The timing circuit consists of *R13*, *R14*, and *C8*, with *R13* permitting a duration adjustment between 10 seconds and two minutes. This range can be shortened or lengthened by changing the value of *R14*.

When pin 5 of *IC2A* goes high, *C9* charges and causes pin 13 of *IC2B* to go high. This, in turn, causes *Q1* to turn on, thus keeping pin 6 of *IC2A* high to prevent self-activation. Diode *D1* prevents rapid discharge of *C9* via pin 5 of *IC2A*. This hold-off lasts approximately five seconds. Since pin 9 of *IC2B* goes low during this time, *LED1* remains off. However, after the brief timing interval, pin 13 goes low and pin 9 goes high. This shuts off *Q1*, arming the circuit, and the high at pin 9 turns on *LED1*, signifying that the system is ready to activate.

Transistor *Q9* is also coupled to pin 6 of *IC2A*. As long as a short exists across the N.C. LOOP terminals, *Q9* is cut off. When the short is removed, *Q9* goes into conduction and shuts down *IC2A*, similar to the action of *Q1*. To prevent false activation under low-voltage conditions, transistors *Q2* and *Q3* of Fig. 3 form a Schmitt trigger. The collector of *Q3* is connected

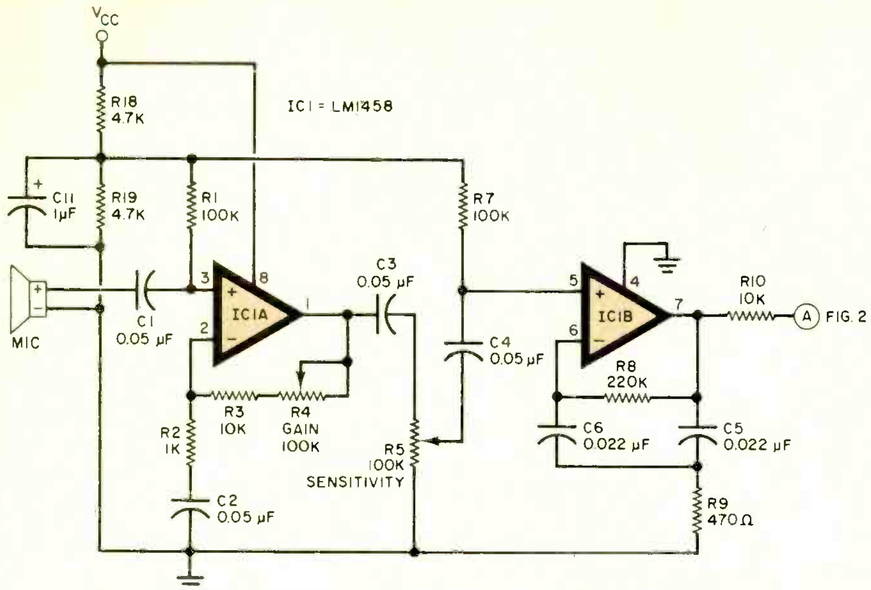


Fig. 1. Sensitivity to sounds in the protected area is determined by R5.

to the reset inputs of *IC2* (Fig. 2) and when it goes low as a result of power fluctuation, it resets the dual timer.

When power is initially supplied, *C13* (Fig. 3) starts to charge through *R26* and *R28*. During this charging interval, *Q4* is turned on, and since its collector is also connected to the reset inputs of *IC2*, it keeps the timers turned off. When *C13* is fully charged, *Q4* turns off and releases the reset line, enabling dual-timer *IC2*. Transistor *Q4* can be turned on at any time by simply shorting the key-switch terminals that apply a positive voltage to the base of *Q4* via *R17*. This action will keep the collector voltage low, thus disabling *IC2*.

The circuit of Fig. 4 shows the two-tone siren oscillator and audio amplifier. One half of *IC3* with *R32*, *R33*, and *C17* form the low-frequency oscillator, while the other half of *IC3* with *R34*, *R35*, and *C18* form the high-frequency oscillator. The audio amplifier consists of *Q6*, *Q7*, and *Q8*. They drive an 8-ohm 10-W trumpet horn (EXT SPKR).

When *IC3* is triggered by the signal from *IC2A* to produce the siren sound, transistor *Q5* is also turned on. When this occurs, relays *K1* and *K2* are powered. The former connects ac line power to socket *SO1* that can then apply power to a lighting system, while *K2* can be used to activate an external device. If desired, the siren can be silenced by operating switch *S2*—*SO1* remains energized even when the siren is turned off.

The pre-entry detector's power supply is shown in Fig. 5. Diodes *D8*, *D9*, and *D13*, connected between voltage regulator *IC4*'s ground terminal and actual ground, cause this regulator to add about 1.5 V to the output so that it can charge 12-V battery *B1*. When *S1* is closed, power is applied to the circuit and *LED2* is lit.

Construction. The circuit can be assembled by point-to-point wiring on a section of perforated board, or a pc board using the foil pattern shown in Fig. 6. The component installation of Fig. 7 illustrates the necessary external connections that must be made. All components can be mounted within the selected enclosure (see parts list). Note also that there is an optional 8-terminal barrier strip at the rear of the pc board.

Sensitivity control *R5* and duration control *R13* should have shafts long enough to pass through holes drilled in the rear of the selected enclosure. The rear panel also supports switched ac receptable *SO1*, the fuseholder, the line cord and strain relief, and the battery connector.

The front of the enclosure should support the ceramic microphone (which must be given a clear "view" of the area to be covered), the two LEDs suitably marked as ARMED and POWER ON, power switch *S2*, and siren ON/OFF switch *S1*. Make a sound hole for the trumpet horn.

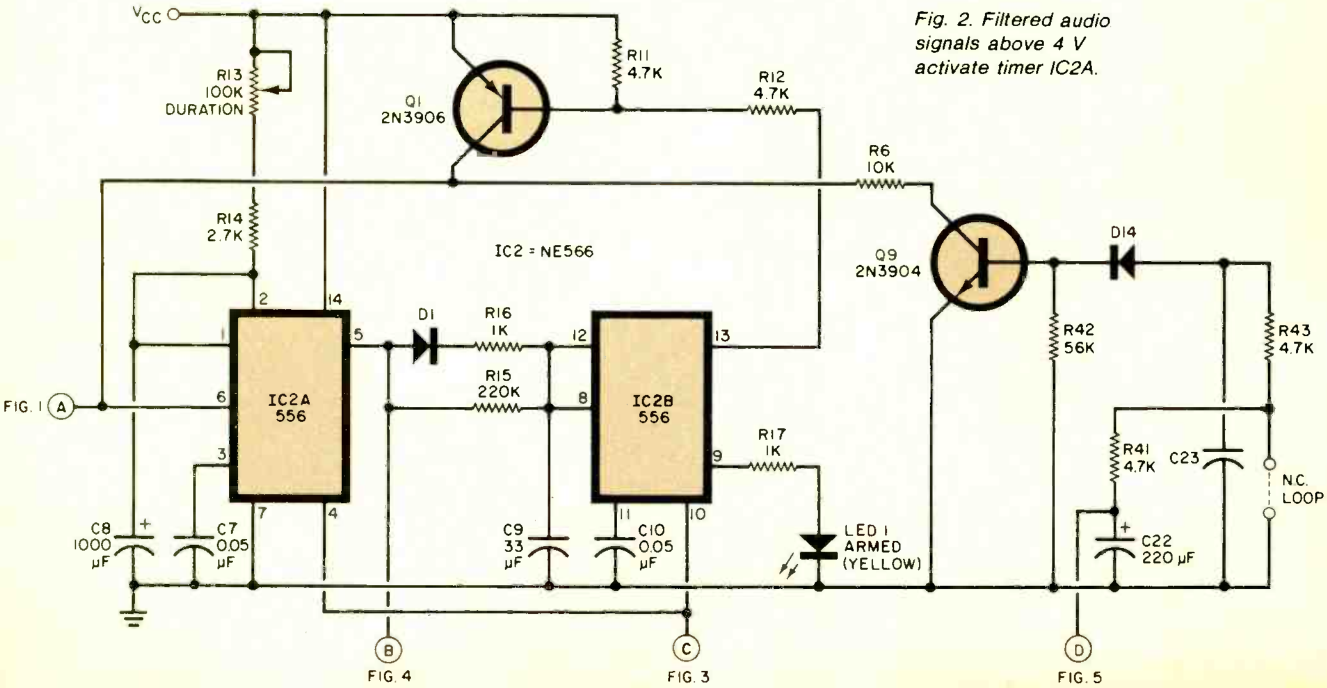


Fig. 2. Filtered audio signals above 4 V activate timer IC2A.

PARTS LIST

B1—12-V, 2.6-Ah gell cell
C1,C2,C3,C4,C7,C10,C15,C19,C20—0.05-μF, 50-V ceramic disc capacitor
C5,C6—0.022-μF, 100-V, film capacitor
C8,C12—1000-μF, 16-V, electrolytic
C9—33-μF, 16-V, electrolytic
C11—1-μF, 50-V, electrolytic
C13—2200-μF, 16-V, electrolytic
C14—2200-μF, 50-V, electrolytic
C16,C17,C24—22-μF, 16-V, electrolytic
C18—0.01-μF, 50-V, ceramic disc capacitor
C21—100-μF, 16-V, electrolytic
C22—220-μF, 50-V, electrolytic
D1 through D14—1N4004 diode
F1—5-A, 3 AG fuse and holder
IC1—LM1458 op amp
IC2,IC3—NE566 dual timer
IC4—7812 12-Volt regulator
K1,K2—Spdt relay, 12-Volt coil
LED1—Red light emitting diode
LED2—Yellow light emitting diode
MIC—Ceramic microphone element
Q1—2N3906 transistor
Q2 through Q6,Q9—2N3904 transistor
Q7—2N6124 transistor
Q8—TIP32A transistor
The following are ¼-W, 5% resistors unless otherwise specified:
R1,R7—100 kΩ
R2,R16,R17,R27,R29,R30,R37—1 kΩ
R3,R6,R10—10 kΩ
R4,R5,R13—100-kΩ linear-taper potentiometer
R8,R15—220 kΩ
R9,R22—470 Ω
R11,R12,R18,R19,R21,R28,R32,R36,R38,R41,R43—4.7 kΩ
R14,R23,R33—2.7 kΩ
R20,R40—100 Ω
R24—1.8 kΩ
R25—10 Ω
R26,R27,R34—27 kΩ
R31—55-Ω, 5-W
R35—47 kΩ
R39—560 Ω
R42—56 kΩ
SPKR—8-Ω, 5-W trumpet loudspeaker
S1,S2—Spst switch
T1—28-V CT, 1-A transformer (Triad F40X or Stancor P8609)
Misc.—Line cord, suitable enclosure, 8-contact terminal strip, battery terminal, mounting hardware, etc.

Note: The following is available from Kirby Engineering Associates, P.O. Box 509, Pelham, AL 35124: complete kit including enclosure at $195. Also available separately: pc board at $12; all components except enclosure/chassis at $140; oak enclosure at $25; and prefabricated chassis at $30.

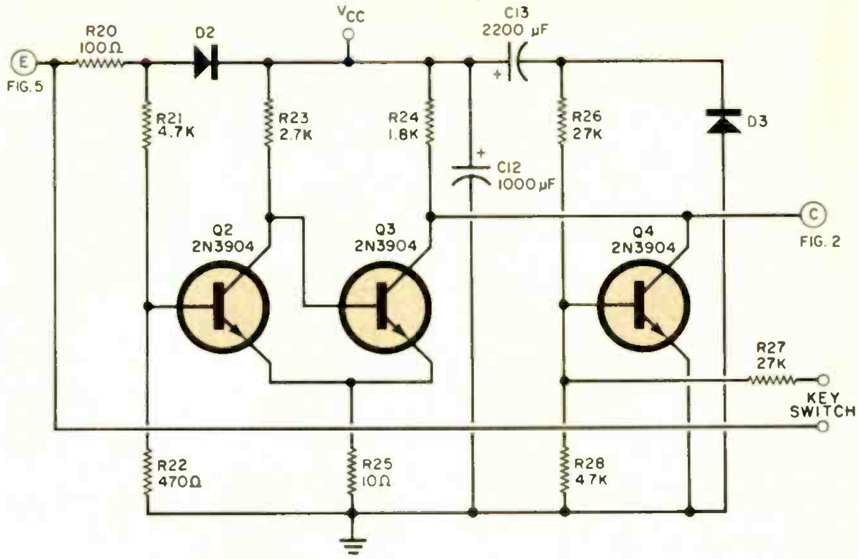


Fig. 3. Transistors Q2 and Q3 form a Schmitt trigger that prevents false activation under low voltage conditions.

Checkout. Carefully inspect all wiring for inadvertent shorts circuits, especially in the 117-V ac area. Turn the power off, and connect a short circuit across the N.C. LOOP terminals. Adjust SENSITIVITY control *R5* to about one-quarter full scale (clockwise about ¼ turn) and set DURATION control *R13* to minimum (completely counterclockwise).

Place POWER switch (*S2*) to the ON position, then place SIREN switch *S1* to its ON position. After approximately one minute, the yellow (ARMED) LED should glow, indicating that the system is armed.

Now take a metal object, such as a tool or coin, and tap a glass about 10 feet from the microphone. The system should activate for about 10 seconds and the ARMED LED should extinguish. About five seconds after the alarm stops, the ARMED LED will again glow, indicating that the system is armed and ready once more. Potentiometers *R4* and *R5* can now be set (by experimentation) to determine the desired sensitivity. Here's how:

Turn the SIREN switch OFF, and adjust SENSITIVITY control *R5* to its fully counterclockwise (off) position. When the yellow (ARMED) LED glows, note that no sounds will activate the alarm. Turn the SIREN switch back ON, remove the short across the N.C. LOOP terminals, and note that the system activates. Replace the short across the N.C. LOOP terminals.

Plug a 117-V ac lamp into *SO1* and note that it does not light. Adjust SENSITIVITY control *R5* about ¼ turn clockwise, and place the POWER switch to ON. When the yellow (ARMED) LED lights, strike a glass tumbler with a metal object and note that the lamp turns on. The on time can be increased by adjusting DURATION control *R13*. Once activated, the lamp should remain lit for about two minutes, then turn off.

Reactivate the system again, then place a short across the two terminals called Key Switch. This should immediately disarm the system. Determine that the system does not activate with this short, then remove the short.

Connect an ohmmeter across the two terminals marked SWITCHED LINE. When the system is activated, the resistance should drop to zero indicating relay operation. This pair of connectors can be hooked to any external device that will operate from a simple switch closure. Note also that there is a pair of EXT SPKR connectors for use with a remote speaker.

Placement and Calibration. The pre-entry detector should be placed in an area central to the main points of entry in your home—usually the den, living room, or foyer. It should be at least three feet above the floor, facing the open area to be protected. An exact location cannot be specified and usually requires some trial-and-error testing to determine optimum placement in a particular home.

The only calibration required is to properly set the internal sensitivity control, *R4*. Usually about half way is recommended. Remember you have full control with the front-panel SENSITIVITY control, *R5*. Gain control *R4* is used mainly to set the upper limit.

To test the unit, face the microphone toward the area to be protected, then using a metal object (tool,

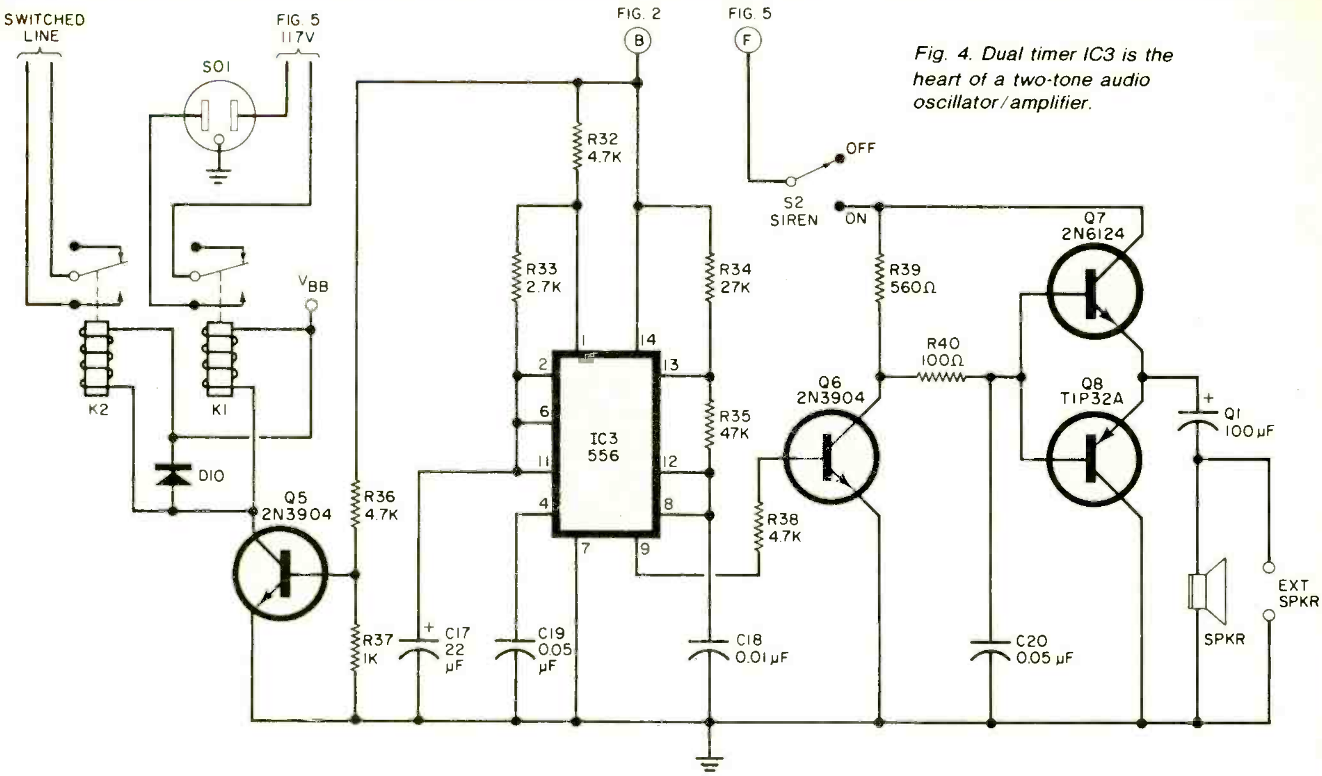
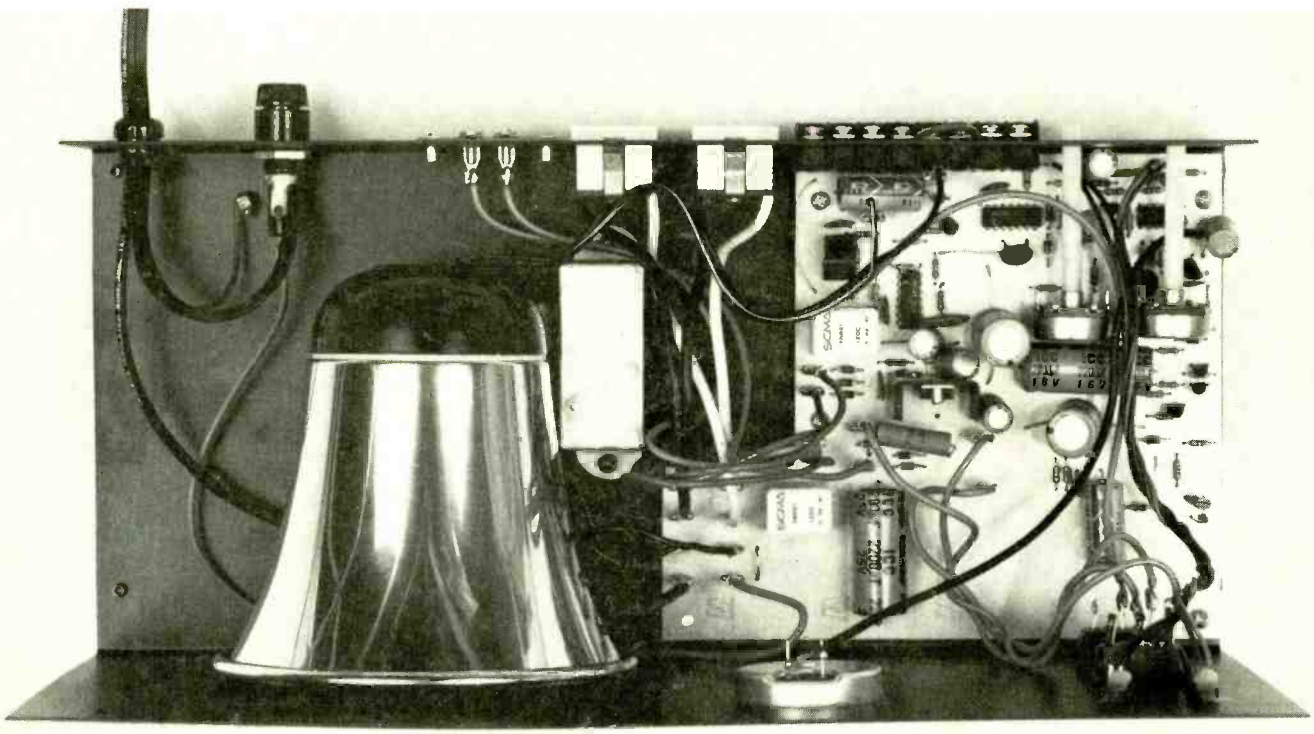


Fig. 4. Dual timer IC3 is the heart of a two-tone audio oscillator/amplifier.

coin, etc.) tap on various windows, metal doors, etc. Adjust the SENSITIVITY control for the desired results. The N.C. LOOP can be wired to any closed-loop detection system, remote from the ultrasonic detector, for further coverage of doors, windows, etc.

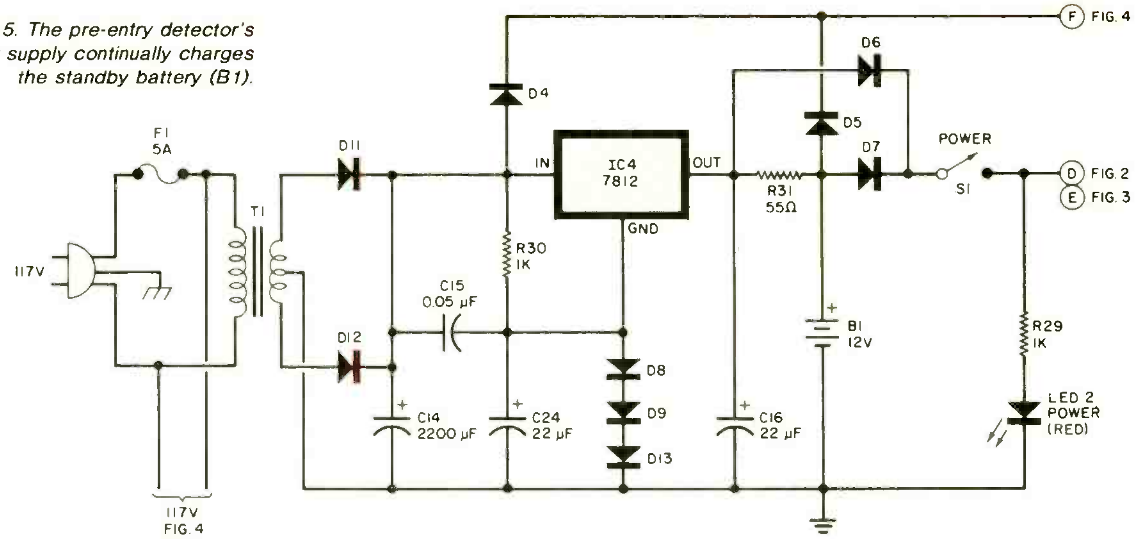
Auxiliary Functions. Ac control is performed by plugging any desired ac device (lamp, flood light, TV, etc.) into switched ac receptacle *S01*. Do not exceed 200 W. When the alarm is triggered, the external device should turn on.

A normally open, remote key switch can be wired to the Key Switch connectors for arming or disarming the system from outside your house. When the Key Switch is closed, the unit is disarmed. The N.C. LOOP provides an interface with other types of



Inside view of pre-entry detector component layout based on author's pc board layout.

Fig. 5. The pre-entry detector's power supply continually charges the standby battery (B1).



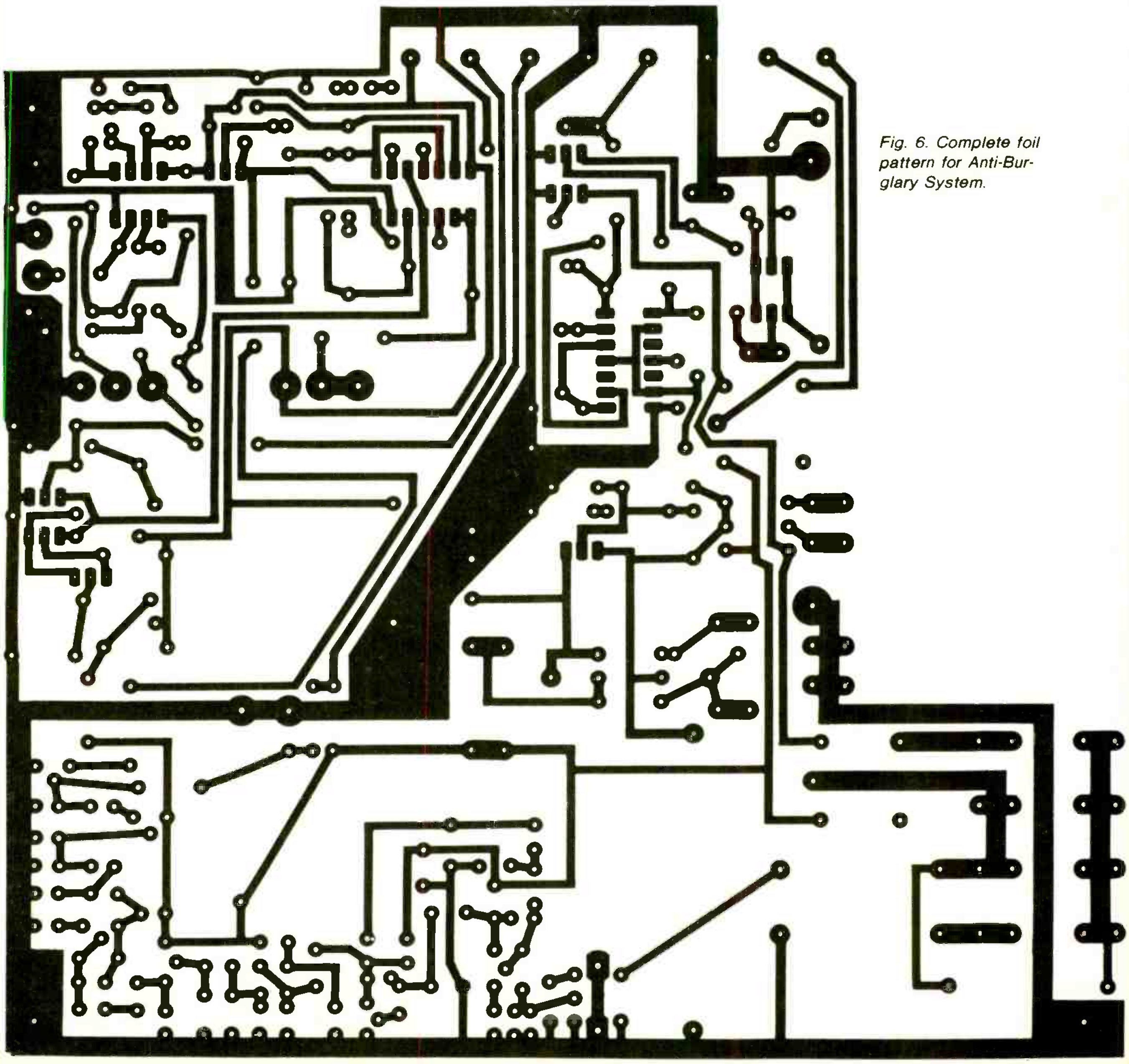


Fig. 6. Complete foil pattern for Anti-Burglary System.

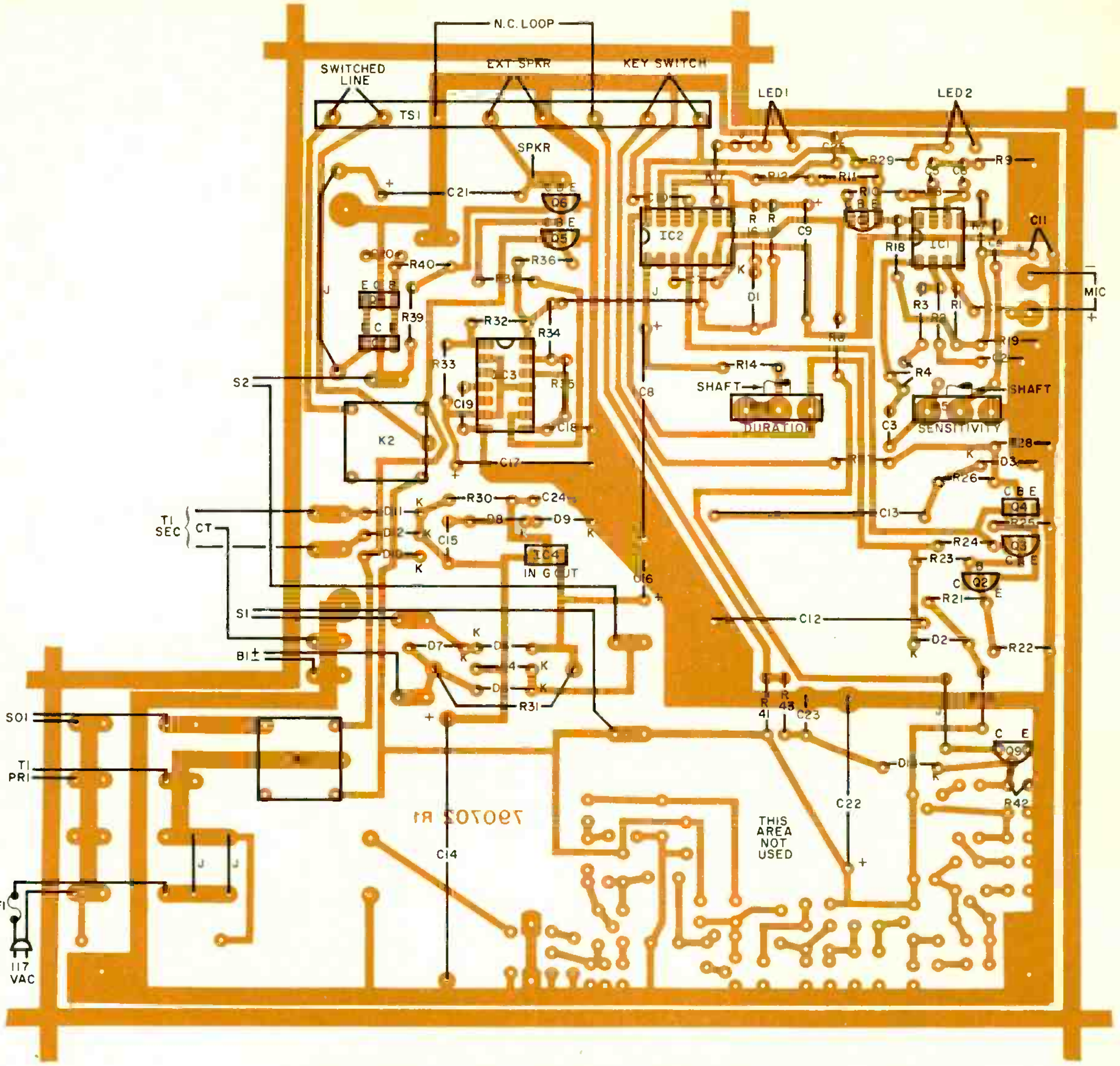


Fig. 7. Component layout for the project's pc board.

alarm systems. These terminals can be used either with a hardwired system of switches arranged in series, or with a wireless system. And any 8-ohm, 10-W speaker horn can be attached to the EXT SPKR connectors to provide an audible alarm.

When the system activates, a contact closure appears across the SWITCHED LINE terminals. This can be used to activate a dialer or any other device requiring a contact closure.

All backup system power should be supplied by a 12-V, 2.6-amp-hour "gell cell" lead-acid battery. *Do not* use a dry cell or any other battery type, as the charging circuit is designed for the gell cell. When the line cord is plugged in, the battery is being charged continuously. About 14 hours is needed to completely charge a discharged gell cell. A fully charged gell cell will operate the intrusion alarm system for about 48 hours. ◇

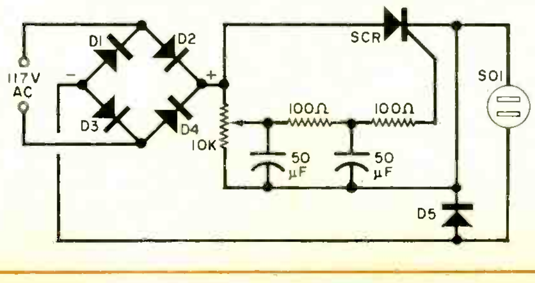
Solid-State Speed Control

BY HARRY J. MILLER

Drilling holes in different types of metals is often easier with a variable-speed electric drill. If you don't own a multi-speed drill, you can add this little circuit to your present single-speed drill to make it more useful.

Only a few simple electronic components are required. The bridge rectifier provides the full-wave, pulsating direct current for the SCR switch and controls the angle of fire of the SCR. The diode, *D5*, is used to counter the back voltage developed by the drill motor. The speed of the drill is varied by the 10,000-ohm potentiometer.

Diodes *D1* to *D4* should be rated at 200 V PIV and have a current rating of at least 12 A. Diode *D5* can be rated at 2 A. The SCR should have a PIV of about 300 V and a current rating of 25 A.



ENHANCE TV SOUND WITH STEREO

Synthesizer produces impressive stereo sound from the mono output of any TV receiver or video cassette recorder

BY JOEL M. COHEN

STEREO sound for TV broadcasts has not yet been established in the U.S. Anyone who has listened to it in Japan, however, quickly becomes aware that it provides a quantum jump to a higher level of listening pleasure, even with inexpensive speakers. Now you, too, can enjoy the benefits of stereo TV sound through use of the device presented here.

The project to be described is a stereophonic sound synthesizer. It generates synthetic stereo from a monophonic source such as produced by TV sets, video cassette recorders, and most video disc machines when interconnected with any stereo system.

Synthetic Stereo Theory. The perceived advantage of stereo over mono sound reproduction is a clear sense of more spaciousness and, thus, more realistic audio. Theoretically, accurate stereo reproduction relies on precise time and phase relationships between the channels and requires a centrally located listening position. This is because a person senses the location of a real sound source by the difference in arrival times of sound at the ears. Much stereo material, however, uses differences in amplitude between the two channels as a less critical way of indicating the relative positions of particular sounds. This amplitude-based stereo does not give as fine a focused sonic image, but it is more tolerant of listening position. For example, a sound which appears only in the left speaker cannot sound as if it is coming from the right side of the room.

On the same basis, if a mono signal could somehow be broken up so that some of it were put in the left channel and some in the right channel, it would begin to sound very much like most stereo material. Thus, the basic technique for generating synthetic stereo is to divide the mono signal and distribute it between the two channels. The simplest example of such a device is a crossover network, where the bass is fed to one channel and the treble to the other. As you can imagine, there's a substantial difference between that and true stereo.

The professional technique for generating synthetic stereo involves the addition and subtraction of mono signal components. The mono signal is presented to both the left and right channels. It is also passed through one

or more bandpass filters. The output of these filters is then added to one channel and subtracted from the other. The frequencies passed by the bandpass filters then increase in volume in the channel to which they are added and decrease in volume in the channel from which they're subtracted. This technique has been used for many years to process old monophonic recordings into simulated or "rechanneled" stereo records.

How the VSP-1 Creates Stereo. The Stereo Synthesizer uses a simpler, but much more effective "add and subtract" system to create a very believable stereo illusion. It is based on the comb filter effect.

If a signal is delayed and then mixed back with itself, the frequency response of the system ends up with a series of peaks and dips. When there are many of these, the amplitude vs frequency plot looks like the teeth on a comb.

In this synthesizer, a bucket-brigade device (BBD) is used to generate the delay for the comb filter. With a BBD delay line, you can break the audio spectrum up into as many pieces as you wish with much less complexity than using many individual bandpass filters. But, if the spectrum is too finely divided, the difference between channels will disappear. Each individual sound source will seem to spread across the whole width of the space between the speakers because every slight shift in pitch will move the sound from one channel to the other.

Extensive listening tests have shown that the most stable and convincing stereo simulation is obtained by dividing the spectrum evenly into approximately 1-kHz pieces. The delay line in the device is therefore set for approximately 0.5 ms.

Circuit Operation. Figure 1 is a block diagram of the synthesizer, and Fig. 2 is a plot of the frequency response for the two output channels. The signal fed into the delay line is derived directly from the input. Since the delayed output feeds a phase splitter, the original signal (delayed by 0.5 ms) is added to the right channel and subtracted from the left.

At very low frequencies, the delay is much less than the wavelength of the signal. Thus, the delayed signal cancels the original signal in the left channel and adds to the level in the right channel. Low bass, then, is approximately 6 dB louder in the right channel and almost totally missing from the left channel. At 1 kHz, however, the delay of one-half millisecond equals one-half the wavelength of the signal. Therefore, the two phases are effectively reversed and the level drops in the right channel and doubles in the left channel.

For the purpose of the preceding description, the delayed signal was considered to be exactly equal in amplitude to the main signal. Therefore, the maximum amplitude was increased by 6 dB, and the minimum amplitude was a complete null. (If the delayed signal were slightly lower in amplitude than the main signal, the peak would be less than double in one channel and above zero in the other. This would result in *less* of a sense of stereo spread.)

In the synthesizer, however, the delayed signal is actually set at a slightly higher level than the main signal. The result is that, while one channel is at maximum amplitude, the opposite channel has a small out-of-phase output. This effectively widens the image slightly beyond the boundary of the loudspeakers and, at the same time, adds presence, moving the apparent sound source forward into the room.

Figure 3 is a detailed schematic of the circuit. The main power supply is a conventional, regulated ±15 volts. The additional +14-V source is a special low-noise positive voltage for the BBD and phase splitter stages.

The left input signal is selected by *S1B* from one of two inputs. It passes through a 16-Hz, high-pass, subsonic filter formed by *C1* and *R1* plus *R2*, to the input of the mixer/buffer amplifier *IC1D*. Resistor *R27A* (one-half the volume control) sets the gain of that amplifier, which directly drives the output via a current-limiting resistor, *R24*.

Since the gain is a maximum of one, the volume control acts as an attenuator. This is necessary because television-derived audio signals can be much higher than conventional audio sources (the typical output of a tuner, for example, is 500 mV).

Switch *S2* selects either the stereo or mono mode. In the stereo source mode, the right input signal, which is selected by *S1A*, passes through a high-pass filter (formed by *C2* and *R21* plus *R22*) and into the mixer/buffer amplifier *IC1A*. In the mono source mode, the junction of *R21* and *R22* is grounded, thereby removing the right input signal from the right-channel amplifier. The input to the right-channel amplifier now comes via *R23* from the output of the delay-line driver stage *IC1C*.

The noninverting delay-line driver, *IC1C*, takes its input from one-half the left-channel input signal at the junction of *R1* and *R2*. Its output is also one-half the left input signal, which assures that the signal peaks in the delay line are well below maximum. Note that since *R23* is exactly one-half of *R21* plus *R22*, the output level of the right channel will be the same in both stereo and mono source modes. The output of the delay-line driver passes through a 15-kHz, low-pass, anti-aliasing filter formed by *R3* and *C4*. Capacitor *C3* blocks the BBD input bias voltage set by *R5* and filtered by *C5*. The stereo synthesizer function is bypassed by grounding the junction of *R3* and *C3* through *S3A*, thereby removing the signal from the delay-line input.

The BBD is driven by a two-phase clock formed with five of the six

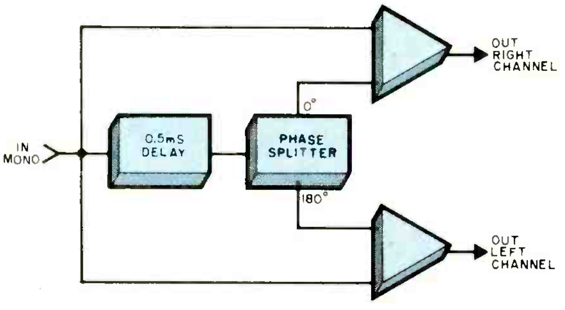


Fig. 1. The delayed signal is added to the right channel and subtracted from the left.

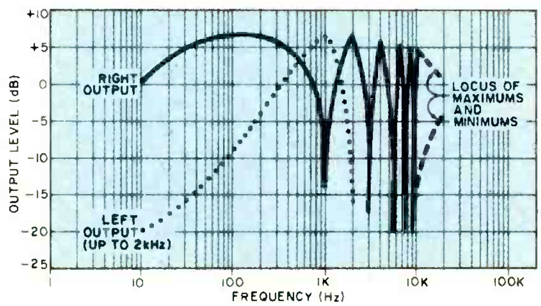


Fig. 2. At low frequencies, the delayed signal cancels the original in the left channel.

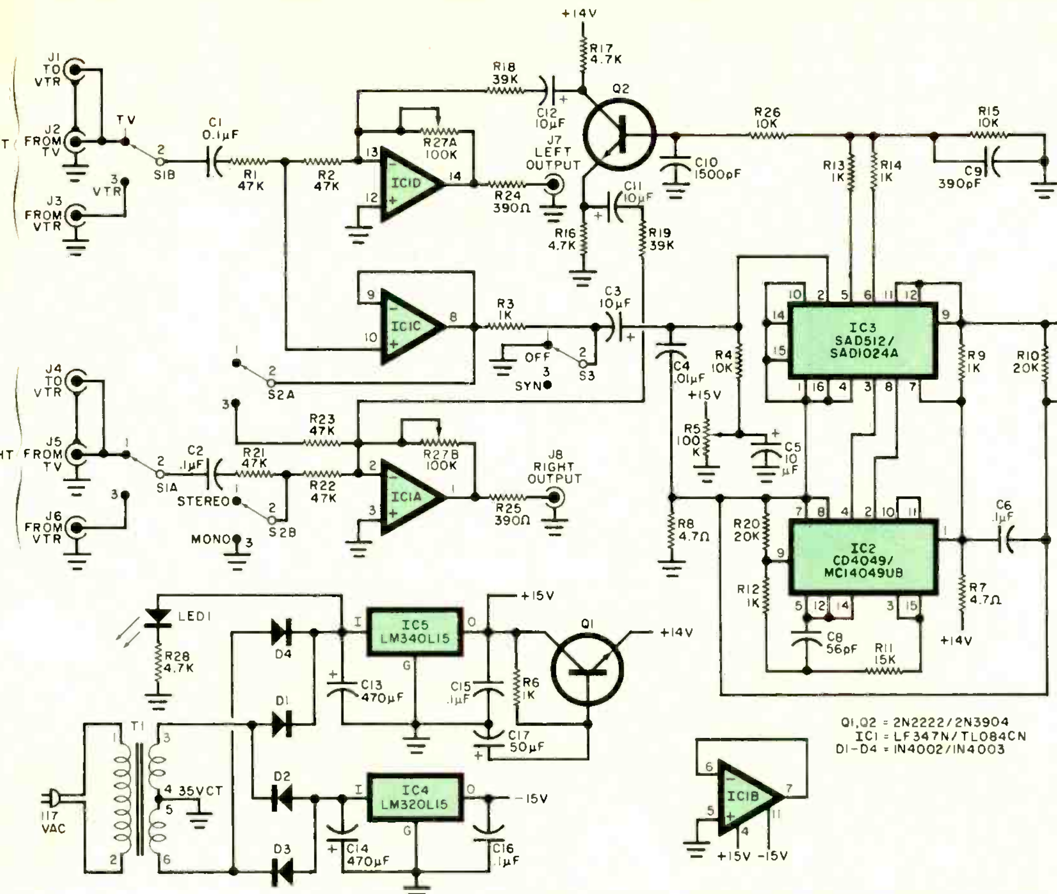


Fig. 3. The bucket-brigade device (IC3) is driven by a two-phase clock formed by inverters in IC2.

CMOS inverters in *IC2*. The nominal clock frequency is 550 kHz. The SAD512 (*IC3*) is a 256-stage, bi-phase, n-channel, bucket-brigade circuit that operates as an analog shift register. It is identical in function and pinout to one-half of the SAD1024A, which may be used in its place.

The delay time through *IC3* is 465 µs. (256 times the period of 550 kHz.) Its balanced output goes through *R13* and *R14* and is filtered by *C9* and *R15* and *R26* and *C10*. The signal is then applied to *Q2*, a buffer and phase splitter. The in-phase delayed signal at the emitter of *Q2* is ac coupled by *C11* and summed via *R19* into the right-channel mixer amplifier. The out-of-phase delayed signal at the collector of *Q2* is ac coupled by *C12* and summed via *R18* into the left-channel mixer.

When the delayed signal is exactly in phase with the original, the output from the right channel increases to about 6.5 dB and the output from the left channel goes out-of-phase at −20 dB. In Fig. 2, the actual amplitude of these peaks and nulls can be seen to vary across the spectrum as a result of the selected filter corner points, so that the out-of-phase component for

PARTS LIST

C1,C2,C6,C15,C16—0.1-µF disc ceramic capacitor
C3,C5,C7,C11,C12—10-µF, 35-V aluminum electrolytic
C4—0.01-µF axial ceramic capacitor
C8—56-pf axial ceramic capacitor
C9—390-pf axial ceramic capacitor
C10—1500-pf axial ceramic capacitor
C13,C14—470- or 1000-µF, 35-V aluminum electrolytic
C17—50-µF, 35-V aluminum electrolytic
D1 through D4—IN4002 or IN4003 rectifier
IC1—LF347N or TL084CN quad BiFET amplifier
IC2—CD4049 or MC14049UB CMOS hex inverter
IC3—SAD512 (single) or SAD1025 (dual) n-channel BBD
IC4—LM320L15 −15-V regulator, 100 mA
IC5—LM340L15 +15-V regulator, 100 mA
J1 through J8—dual RCA phono jack, right-angle pc mount
LED1—Fairchild MV5053 or equivalent
Q1,Q2—2N2222 or 2N3904 NPN transistor
The following are 1/4-W, 5%-tolerance resistors unless otherwise noted:
R1,R2,R21,R22,R23—47-kΩ
R3,R6,R9,R12,R13,R14—1-kΩ
R4,R15,R26—10-kΩ
R5—100-kΩ trimmer potentiometer
R7,R8—4.7-Ω
R10,R20—20-kΩ
R11—15-kΩ
R16,R17,R28—4.7-kΩ
R18,R19—39-kΩ
R24,R25—390-kΩ
R27—dual 100-kΩ potentiometer
S1 through S3—3-switch assembly (3 dpdt or 1 dpdt and 2 4 pdt).
T1—35-VCT, pc-mount, Dale PL-12-09 or equivalent
Misc.—Printed-circuit board, chassis, cover, line cord, strain relief, LED clip, hardware, and knobs.

Note: The following is available from Sound Concepts, Inc. P.O. Box 135, Brookline, MA 02146: complete kit with all electrical and mechanical parts (KVSP-1) at $90.00. Also available separately: pc board (KVSP-2) at $16.00; transformer (KVSP-3) at $7.50; phonojacks, switches, pots (R27,R28) and knobs (KVSP-4) at $12.50; semiconductors D1-D4, LED1, Q1 and Q2, IC1-IC5, and sockets for IC1, IC2, and IC3 (KVSP-5) at $18.00. Add $2.00 for shipping and handling. Massachusetts residents, add 5% sales tax. If possible, give a street address for UPS delivery. Outside the continental U.S., add 10% or $5.00 minimum for parcel post.

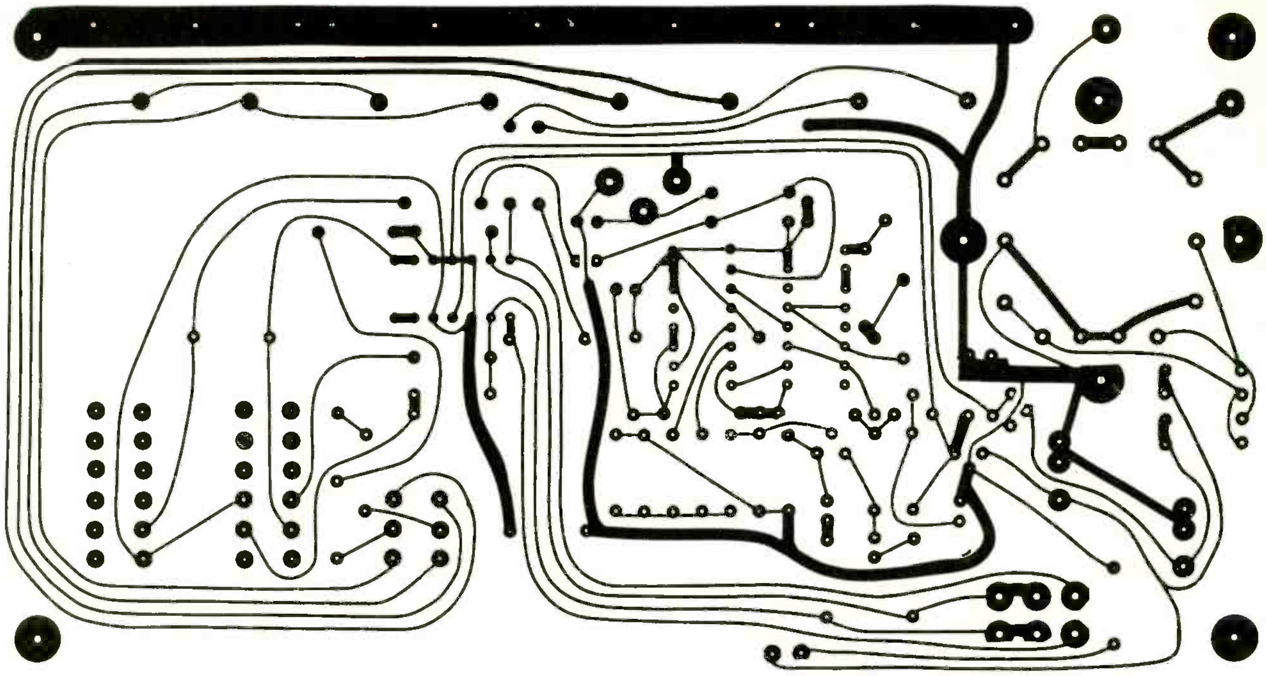


Fig. 4. Actual-size foil pattern for printed-circuit board.

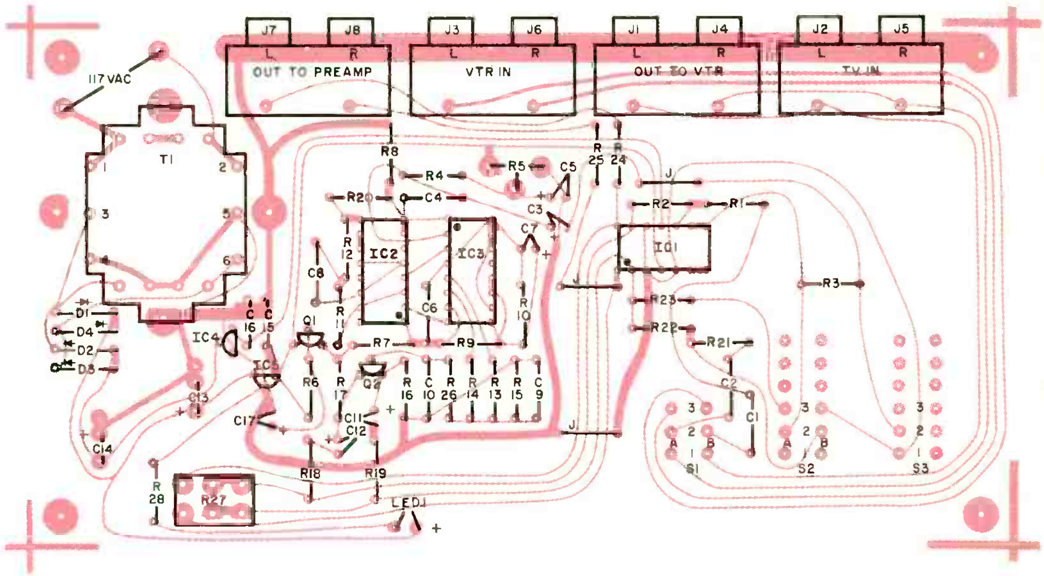


Fig. 5. Follow this component layout scheme for the pc board.

additional stereo-spread effect occurs only at the low and middle frequencies. In between the maximum and minimum extremes, the relative amplitudes in the two channels vary with frequency to create a full pseudo-stereo spread.

Construction. There are no panel-mounted parts in the project. All electrical-mechanical components are on the circuit board (Fig. 4). Almost everything is obvious from the parts-layout diagram (Fig. 5), but you should be careful about a few things.

Be sure that the transformer is mounted with pins 1 and 2 facing the back of the board. Once the transformer has been firmly pushed down and seated into the board, the two tabs should be bent under the board for mechanical strength and soldered to the pads on the foil side, grounding the transformer's frame. The extra pads around the transformer are for an alternate dual-primary substitute.

Cut off the plastic tabs at the rear of the dual phono jack assemblies. Snap the front ground tabs into the slots in the ground bus at the back of the board and solder them in place. Also solder the center terminals of the jacks, and be sure that the jacks themselves are lined up parallel to the board's surface. The volume control should be firmly inserted so that its shaft is parallel with the top surface of the board before you solder it. The switches either have shoulders on the pins or three plastic spacers that set them 3/32 inch above the board's surface. It is important that all these components be firmly seated and parallel with the board if they are to pass properly through the holes in the kit chassis.

The negative terminal is marked on the parts layout for each of the electrolytic capacitors. Those supplied in the kit have the negative terminal marked on the body of the capacitor. If you purchase your own, check to see whether the negative or positive terminal is identified.

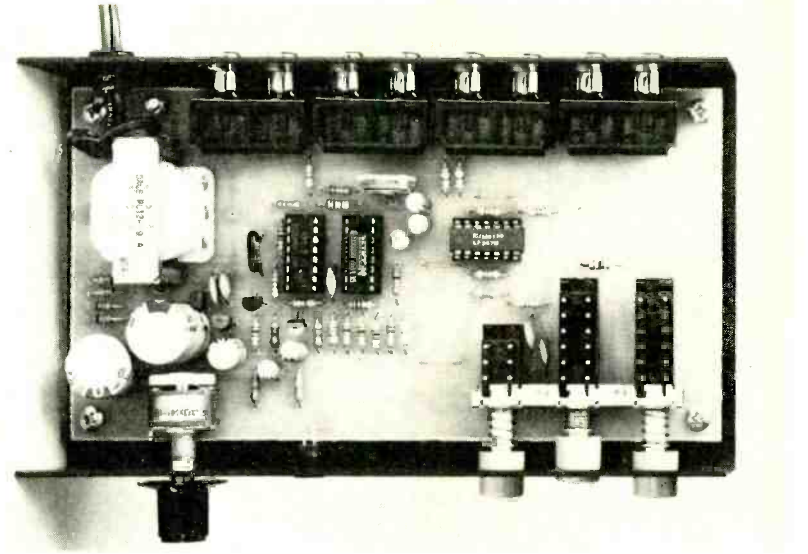
Integrated circuits *IC4* and *IC5* are voltage regulators that look like transistors. They mount with the center lead bent back toward the curved side of the body. The two npn transistors mount differently, with the center lead bent forward toward the flat side of the body before insertion. The dual-in-line ICs have a small indented dot adjacent to pin 1. Be sure to use that for location, and do not pay attention to the way the brand is oriented. In addition to the normal components, three wire jumpers are required as shown on the parts layout.

The leads on the LED should be preformed, so that it aligns with the window in the kit chassis. Hold the LED so that it faces you with the positive lead on your right. Then make a 90-degree bend downward 3/16 inch behind the back of the lens body. Insert the leads into the circuit board so that there is 1/2 inch from the bend down to the top surface of the board (LED facing forward). Then solder the leads.

To insert the board into the chassis, push *S1*, *S2*, and *S3* to the "in" position and tilt the front edge of the board down into the chassis. Put the volume control shaft through its hole and push the front edge of the board against the inside front panel.

At this point, the back edge of the board can drop down, and the board can move back so that the phono jacks extend through the rear panel. The four pc-board mounting holes should line up with the standoffs in the bottom of the chassis. Four No. 6, 1/4-inch sheet-metal screws are used to mount the board onto the standoffs.

The volume control and switch knobs can now be attached and the line cord on its strain relief brought through its hole on the back panel. Be careful of stray strands from the power cord hitting the grounded mounting screw in the left rear corner when you solder the line cord to the terminals on the pc board. The cover slips over the chassis and is held in place with four No. 440 Phillips-head screws. Four self-adhesive, black-rubber, furniture-protecting bumpers may be affixed to the bottom of the chassis or the cover to complete the assembly.



Internal view of the author's prototype shows convenient arrangement of controls on front panel and jacks on rear.

Test and Alignment. There is only one adjustment necessary. Start by setting the bias on pin 2 of the BBD, (*IC3*) to approximately 4.5 V. To optimize the adjustment, put a high-impedance dc voltmeter probe on the arm of *R5* to ground. Place an oscilloscope probe at the junction of *C11* and *R19* to observe the filtered output of the BBD. Put a signal generator into the left TV-input jack. The generator should be at 1000 Hz and 1.5 V rms. Switch *S1* should be out, and *S2* and *S3* in for this test.

If the bias is set too low, the bottom of the sine wave will be clipped; if it is too high, the top of the sine wave will be clipped. The optimum adjustment is in the center, where there is either no clipping or just a slight symmetrical clipping of the top and bottom of the waveform (Fig. 6).

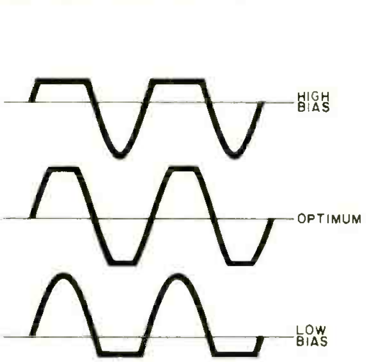


Fig. 6. Optimum bias adjustment causes minor clipping top and bottom.

Connection and Use. Although labeled TV and VTR, the two inputs may come from any mono or stereo source in the signal range of 100 mV to 1 V. You could, for example, put the synthesizer in the tape loop of your preamp or receiver and use it with mono records and AM or mono FM broadcasts. Whatever your source, if it only has a single mono output line, it should be connected into the left input terminal on the unit. When listening to it, *S2* should be in the mono position.

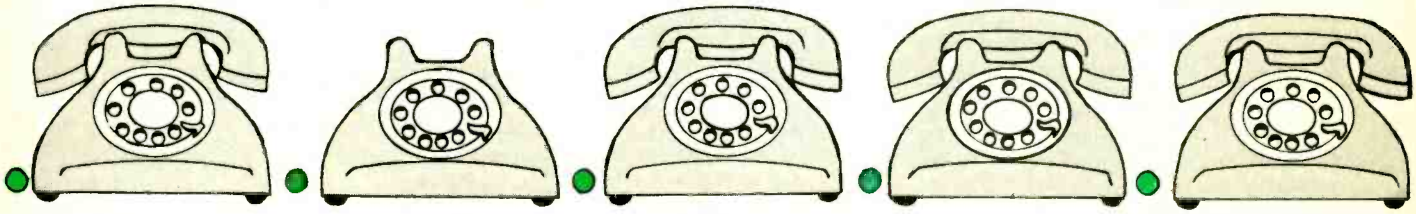
With the volume control turned all the way up, the synthesizer has a gain of one. Its primary function is to equalize the volume of signals coming out of the unit to the others in your stereo system. As mentioned previously, this is done because video sound voltages are typically 10 to 20 dB higher in level than FM tuners or phono preamps.

With *S2* in STEREO and *S3* at OFF, only the volume-control function is active on the unit. You should note that, since there is only a single inverting amplifier between the input and output of the synthesizer, it inverts the phase of both channels by 180 degrees.

TV Connection. If your TV set has an audio output jack, it is a simple matter to connect it to the synthesizer. The next best alternative is an earphone jack, which also allows for easy connection. If you're audio-quality conscious, you have other options. The best would be to buy and use a separate TV sound tuner. This would enable you to take advantage of the hi-fi sound (50 to 15,000 Hz) broadcast by the networks. Should you wish to make a hardwire connection internally to, say, the sound detector output, you should check to be sure there will be no ac flow between the TV set and your stereo sytem. Another option is to connect to the loudspeaker in the television set, though this will diminish the sound quality. ◇

BUILD A TELEPHONE STATUS MONITOR

Automatically turns on indicator lamps at extensions when a phone on the line is in use



BY BRADLEY ALBING

IF YOU have phone extensions in your home, chances are you've interrupted a conversation or been interrupted yourself on occasion. The phone-line status monitor described in this article indicates that the phone line is in use by turning on indicator lamps at all phone extensions whenever one phone is off its hook. At the same time, it can automatically cut off sound from nearby stereo or television sets.

Circuit Operation. In Fig. 1, the terminals marked R and T (ring and tip) connect directly across the telephone line and monitor the line voltage. When the phone is "on-hook" (not in use), the line voltage is about 48 to 50 V dc. When the phone is "off-hook" (in use), the line voltage drops to about 6 to 10 V dc. This voltage drop occurs because of the IR loss along the lines between the central office and the phone. Also, central-office relays that monitor phone-line status add to this loss.

Regardless of line polarity, a positive voltage appears at the cathode of *D7*. If the phone is on-hook, the voltage will be high enough to cause *D7* to conduct. When *D7* conducts, an LED lights and turns on the phototransistor in *IC1*. Optoisolator *IC1* isolates all the status monitor circuitry from the phone line and prevents any imbalance in the line current. (An imbalance could introduce ac hum into the line or otherwise degrade performance of the phone.)

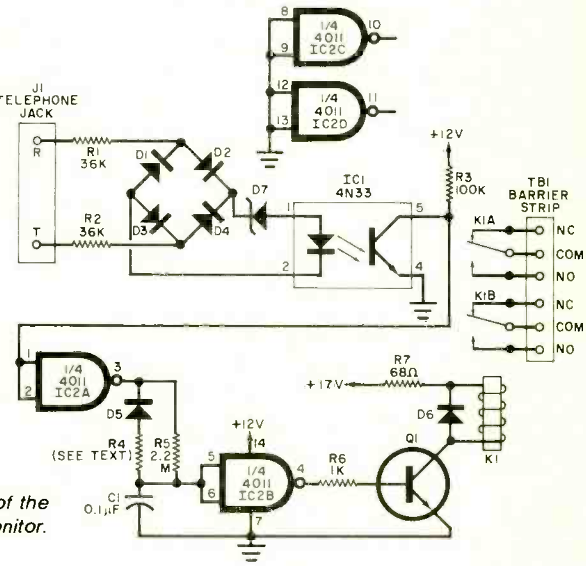


Fig. 1. Schematic of the Telephone Status Monitor.

PARTS LIST

C1—0.1-μF disc capacitor
C2—1000-μF, 25-V dc aluminum electrolytic
C3—100-μF, 25-V dc aluminum electrolytic
D1 through D6—1N914 diode
D7—1N5252, 24-V, ½-W zener diode
D8 through D10—1N4001, 1N4002, or 1N4003, 1-A rectifier
D11—1N759, 12-V, 400-mW zener diode
F1—3AG, ½-A fuse
IC1—4N32 or 4N33 optoisolator
IC2—CD4011B, quad dual-input CMOS NAND gate
J1—Modular telephone jack
K1—Dpdt relay; coil: 12 V dc; contacts: rated 3 A or more (Magnecraft W67PCX-2 or equivalent)
Q1—TIP29A power transistor

The following are ¼-W resistors, except where noted:
R1, R2—36 kΩ
R3—100 kΩ
R4—100 kΩ or 1 MΩ; see text
R5—2.2 MΩ
R6—1 kΩ
R7—68-Ω, ½-W
R8—270 Ω
T1—24-V ac, ct, 600-mA transformer
TB1—6-terminal barrier block

Note: The following is available from BFA Electronics, P.O. Box 212, Northfield, OH 44067: complete kit (LSM) of parts including metal enclosure (which is *not* machined) at $30, postage and handling included. Also available separately from the same source is the pc board (LSM board) at $6 including handling and postage. Allow 6 weeks delivery.

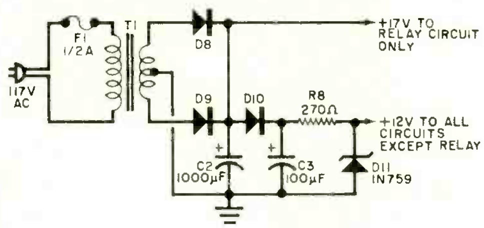


Fig. 2. Schematic diagram of a simple power supply for operating the circuitry of Fig. 1.

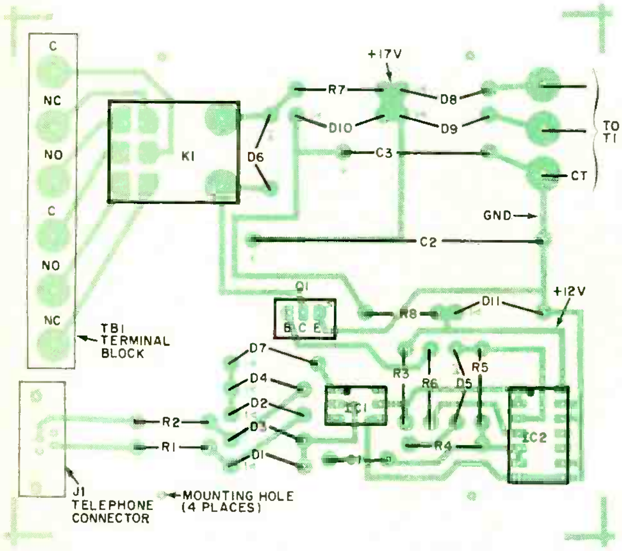


Fig. 3. Component placement guide for the Telephone Status Monitor's printed-circuit board.

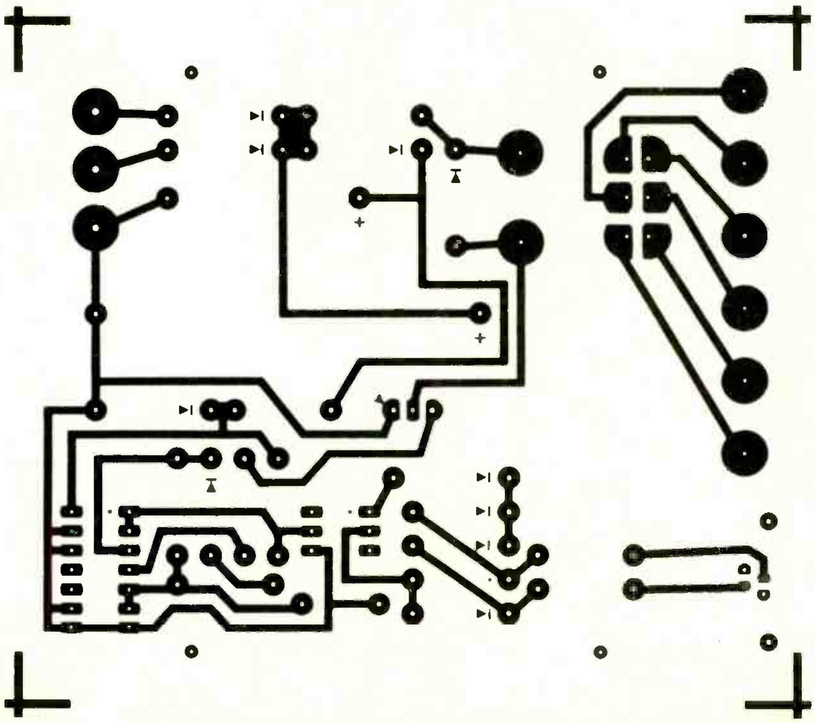


Fig. 4. Full-size etching and drilling guide for the project.

With the phototransistor on, pins 1 and 2 of NAND gate *IC2A* are low and pin 3 is high. Ignoring for the moment the time delay of the *R4*, *R5*, *D5*, *C1* network, pins 5 and 6 are high and pin 4 is low, *Q1* is off and the relay is disengaged. These conditions reverse when the phone is off-hook.

Because rotary-dialing pulses momentarily open the circuit, they could appear as a series of quick on-hook conditions. These pulses would then cause the relay to chatter. To prevent this chattering, the delay network formed by *R4*, *R5*, *D5*, *C1* introduces a short delay for the signal going to pins 5 and 6 of NAND gate *IC2B*.

The selected value for *R4* also determines the conditions(s) that energize the relay. If *R4* is 100 kΩ, the relay will engage when the phone rings as well as when the phone is off-hook. If *R4* is 1 MΩ, the relay will energize only for off-hook conditions (ring-up conditions are ignored).

The normally–open contacts of *K1* can be wired to turn on indicator lamps placed by each phone to show whether or not the line is in use. Also, the normally closed contacts can be used to disconnect stereo or TV speakers whenever the phone is in use.

Figure 2 shows a simple power supply for operating the circuitry of Fig. 1. The parts layout diagram for this project is given in Fig. 3, while the foil pattern is shown in Fig. 4. ◇

LEVEL INDICATOR
FOR BOAT GAS TANKS

Stop gas overflow when refueling by monitoring your tank level with a simple comparator circuit

BY JERRY J. HAYES

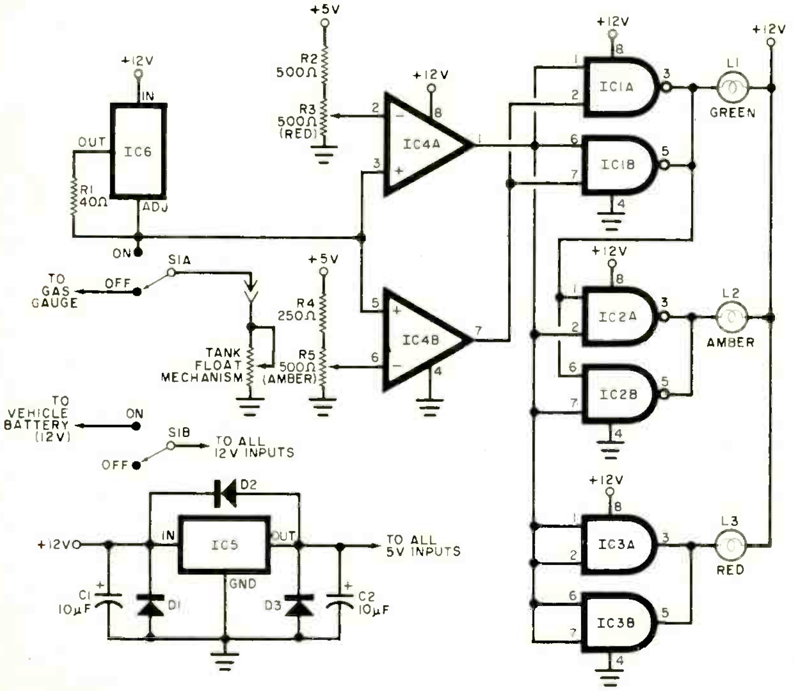
EVEN though most motor boats have fuel gauges, it is difficult for one person servicing the boat to tell how full the tank is before fuel starts spilling out the overflow vent. That's because the fill opening is typically a small-diameter screw plug located some distance from the gas gauge. Since a standard gas pump nozzle cannot be inserted, the pump's automatic shutoff mechanism will not operate. And with overflow vents usually located lower than the fill opening, refueling is often reduced to messy guesswork.

But such problems are quickly overcome by employing a simple comparator circuit that can be switched across the fuel tank's resistive float mechanism. (Normally the resistive float connects to the gas gauge.) As shown in the schematic, this circuit controls three lamps that turn on and off in sequence as the tank fills; the green lamp is on only when there is more than two gallons of air space in the tank; green goes off and an amber bulb lights when 1.5 to 2 gallons of air space remains; then amber is extinguished and a red bulb lights when there is only 1 to 1.5 gallons of air space left.

An accurate estimate of this remaining air space is particularly important when adding fuel to two-cycle outboard engines. That's because two-cycle engines are powered—and lubricated—by a 50-to-1 fuel/oil mixture that must be maintained every time the engine is refueled. Unless some air space is purposely left in the tank after the gasoline is aboard, adding the necessary oil will only cause valuable fuel to be displaced out the overflow vent.

Circuit Description. A dpdt switch controls battery power to this circuit and electrical access to the tank float mechanism. This switch and the three indicator lights should be located close to the tank fill pipe for easy access during fueling.

The *LM317* functions as a current source. It provides a constant 30 mA to the float mechanism. Assuming that float resistance decreases as fuel level rises, the 30-mA level was selected because it produces a voltage across the float (when the tank is full) that is in the operating range of the *LM358* dual op amp. The 500-ohm trimpots (labeled "amber" and "red")



PARTS LIST

C1,C2—10-μF decoupling capacitor
D1 through D3—1N4148 diode
IC1, IC2—DS3632N dual-peripheral power driver
IC3—DS3631N dual-peripheral power driver
IC4—LM358N dual op amp
IC5—LM340T-5.0 5-V voltage regulator
IC6—LM317T 3-terminal adjustable voltage regulator
L1—Lamp holder, green (Littlefuse 930-405X-710GN)
L2—Lamp holder, amber (Littlefuse 930-405X-710AN)
L3—Lamp holder, red (Littlefuse 930-405X-710RN)
R1—40-Ω, 1% resistor
R2—499-Ω, 1% resistor
R3,R5—500-Ω trimpot
R4—249-Ω, 1% resistor
S1—Dpdt switch (Alco MTE-206N)
Misc.—Three miniature bayonet-base lamps 13 V, 0.33 A, 3.0 MSCP; Bud box; hookup wire, mounting hardware, etc.

and their associated series resistance provide the reference points for switching these two lamps on and off. The *3631/3632* drivers provide decode logic and drive capability for the high-current/high-brightness lamps. High brightness is necessary because of frequent use in full sunlight. Parallel drivers are needed to handle the high lamp currents.

Calibration and Modification. The setting of the two 500-ohm potentiometers determine when the amber and red warning lamps come on as the fuel tank fills. Calibrate these settings by carefully siphoning measured amounts of fuel from a full tank then adjusting the potentiometers so that corresponding "trip points" exist. Then the comparators, together with the driver/logic, will always provide an accurate indication of fuel level. Now, whenever the red lamp goes on, sufficient space remains in the tank for adding oil.

Many modifications can be made to this circuit since there aren't any critical components. Almost any op amp can be used for the comparator sections; most any 5-V regulator will work well, the constant-current source could be a series resistor or a FET; and the driver/logic can be any gate capable of handling the current levels involved. This current is strictly a function of the display chosen: LED, incandescent lamp, etc.

For gas tank monitoring applications, the first thing to check is whether your tank-float mechanism either increases or decreases in resistance as the tank is filled. In the case where resistance increases, you must reverse the inputs to the op-amp comparators relative to the connections shown in the schematic. Depending on parts availability and personal inclination, the circuit can be simplified to use only one or two indicator lamps. It would then need only one op amp—a 741 would do nicely. (One caution—gas fumes are explosive. The on/off switch in the parts list is splashproof, but not explosion-proof. Avoid mounting the switch where gas vapor can accumulate.)

Don't think that this circuit is strictly limited to boat fuel-tank monitoring. Actually, any kind of liquid level sensing is possible, provided there is a resistive-type float mechanism available. You could easily adapt the circuit to monitor bilge water below deck, home heating-oil supplies, and—for blind persons—bathtub water level (in this case use the driver/logic to control a Sonalert). ◇

PROCESSING **ANALOG** SIGNALS FOR **DIGITAL** SYSTEMS

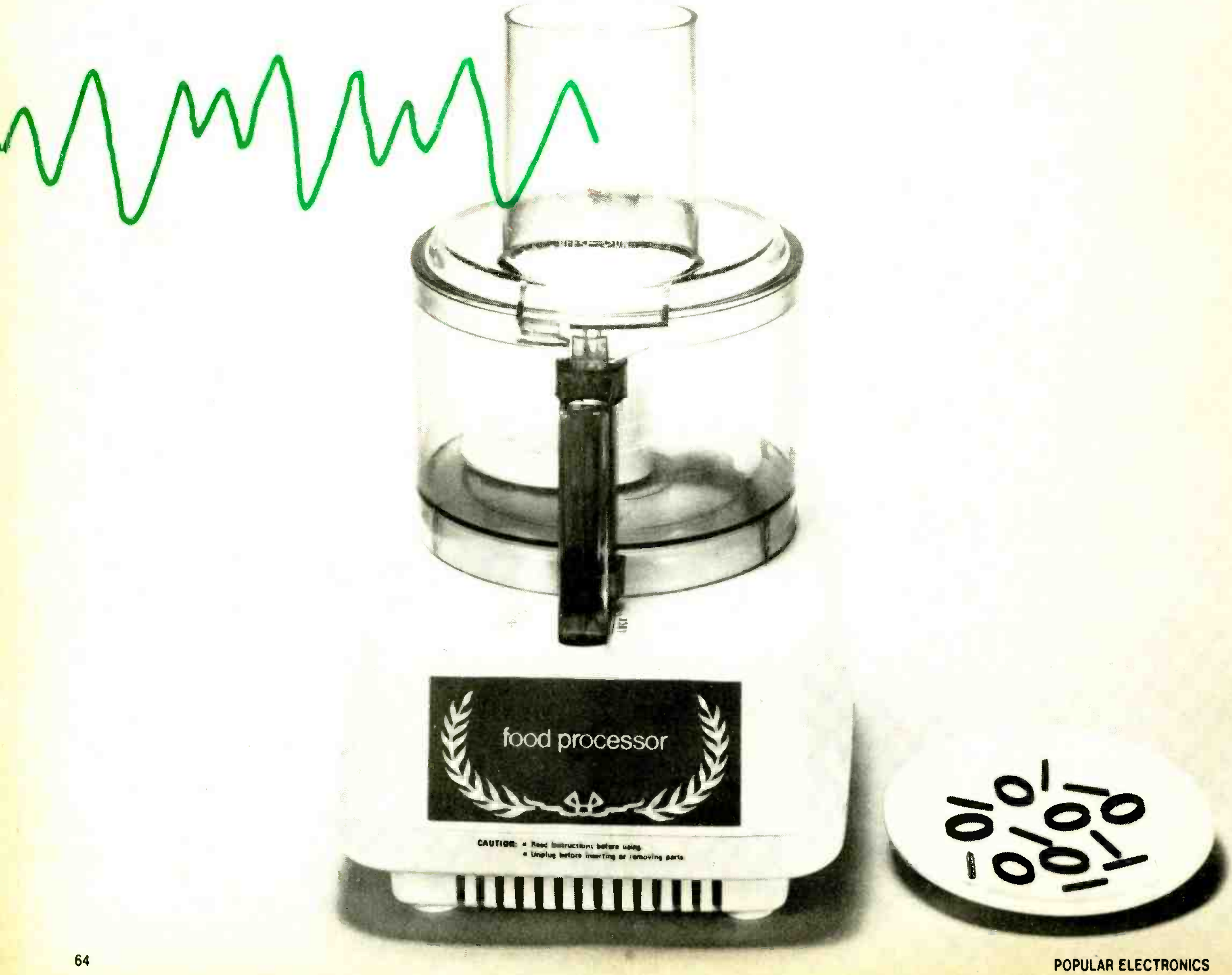
How to create interfaces between "real world" fast-changing signals and microcomputers

BY DONALD K. PEARSON

ARMED with the latest microprocessor-based computer peripherals, more and more people are designing and building interfaces between their microcomputers and the world at large. But most are not prepared for the difficulties that arise when trying to control or collect data from rapidly changing physical phenomena. Many waveforms traditionally regarded as commonplace—like audio signals—actually change over periods of a few microseconds. And it is not immediately obvious how to best route these fleeting events through a computer.

Common to all analog/digital interface applications is a technique called sampling. With this approach, the analog input level is periodically measured (sampled), each sample is assigned a digital number representing its amplitude, and all further signal processing—including eventual analog reconstruction—is done with just the digitized data samples.

Assuming this is understood, there still remains the question of how often "periodically" is. It seems obvious that the more often the samples are taken, the more accurately the recovered signal may be reconstructed. For example, if an input signal is corrupted with noise you could, in principle, fit most of the



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data to some "reasonable" curve, rejecting all data points that are too far displaced. The fastest possible sampling rate has the disadvantage that extremely fast—hence, expensive and possibly touchy—electronics are required. Thus, the "best" approach would be to sample the input signal only as often as necessary to achieve the required accuracy.

Optimum Sampling. Consider three possible results of sampling a 1-kHz sine wave at 1 kHz (*i.e.*, once every millisecond) shown in Fig. 1. The example of Fig. 1 shows that this sampling rate is unsatisfactory in that it does not define a 1-kHz sine wave. In fact, the samples alone suggest that some dc voltage—from the positive value shown in Fig. 1A, to the negative value shown in Fig. 1B—is present. And if samples are taken during zero crossings (Fig. 1C), the "logical" conclusion says that *no* signal is present!

The result of sampling the same 1-kHz signal at 1.25 kHz (*i.e.*, every 800 μs) is shown in Fig. 2. Note that these samples can be fit exactly to a 250-Hz sine wave "alias," indicating that the sampling rate is still too low. Figure 3 shows the two possible results of sampling a 1-kHz sinewave at 2 kHz (every 500 μs) and demonstrates that 2-kHz sampling is almost fast enough—provided we *do not* sample exactly at the zero-crossings (Fig. 3B). However, by sampling the 1-kHz waveform at 2.85 kHz (every 350 μs), it is always possible to reconstruct the correct sinewave from the samples, independent of the "phase" difference between the samples and the zero crossings of the signal (Fig. 4).

These examples illustrate the Nyquist (or Shannon, depending on which engineering text you read) Sampling Theorem, which states that a sine wave may be faithfully reconstructed from its samples provided these are taken *faster* than twice the signal frequency. If samples are taken less often, aliasing occurs. This means signal frequencies higher than half the sampling rate (Nyquist frequency) are effectively converted to lower-frequency signals (Fig. 2).

Note that the sampling theorem only reveals how best to sample sine waves. This suggests another problem since we generally don't know the input waveform in advance. To apply sampling theory to more complex signals, consider how the sum of two sine waves might be reconstructed from a set of samples.

If samples are taken fast enough to reconstruct the higher-frequency sine wave, these samples will also be sufficient to reconstruct the lower-frequency sine wave (and, therefore, the complete signal). Thus, the sampling theorem is extended to arbitrary sums of sine waves simply by sampling faster than twice the frequency of the highest-frequency sine wave in the sum.

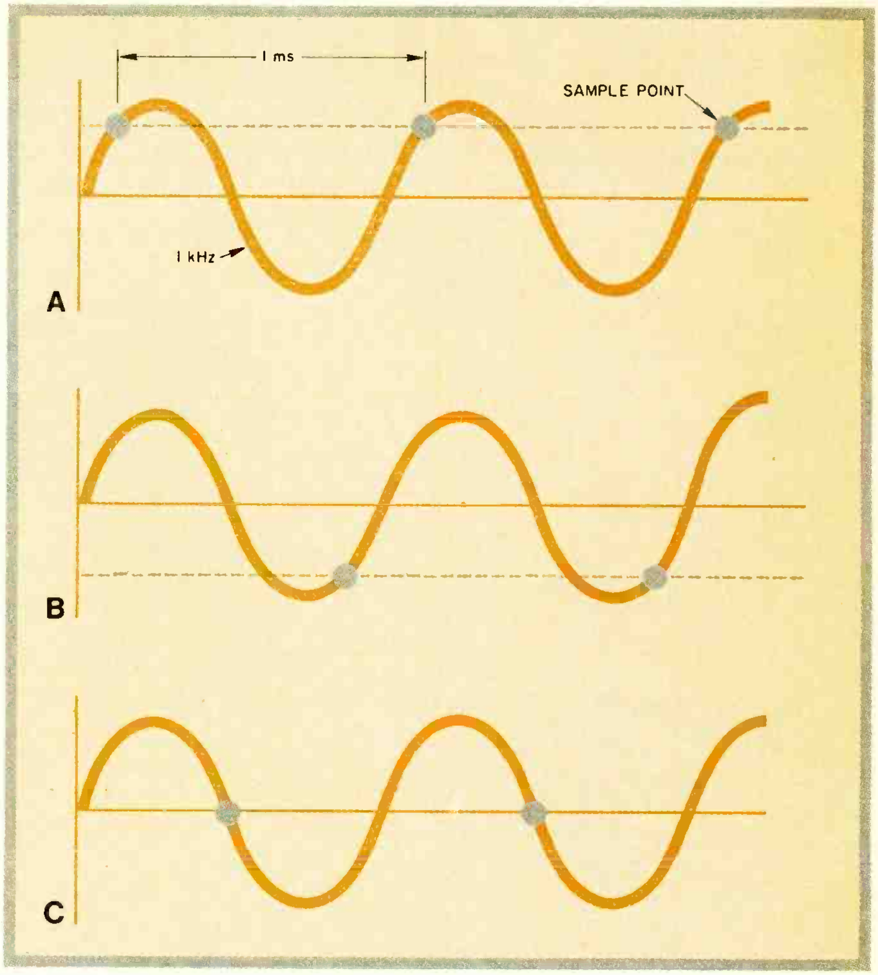


Fig. 1. A 1-kHz sine wave sampled at 1 kHz. Samples indicate (A) positive dc input; (B) negative dc; (C) no input.

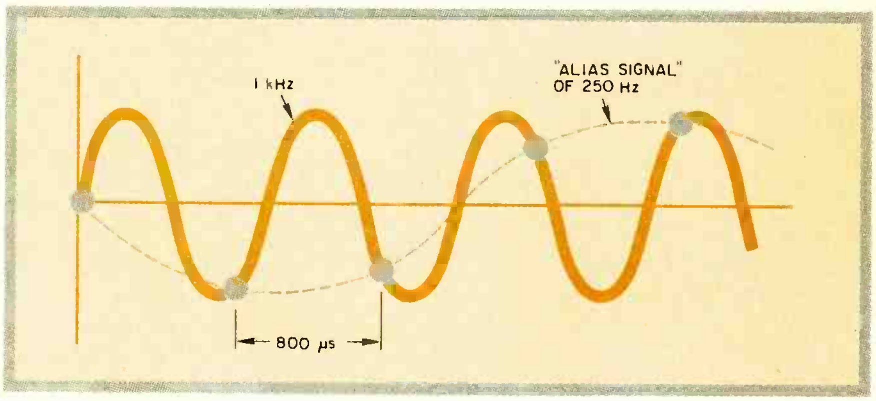


Fig. 2. When a 1-kHz sine wave is sampled at 1.25 kHz, the samples give an "alias signal" of 250 Hz.

It turns out that almost any complex waveform can be constructed from the sum of enough sine waves. This is the basis of Fourier analysis, and is demonstrated in Fig. 5, which shows how sine-wave sums can approximate a sawtooth waveform. The more sine waves included in the sum, the better the sawtooth approximation. It can be shown that a sawtooth waveform of frequency f can, in principle, be constructed *exactly* from sine waves of frequency f, 2f, 3f . . . provided they are mixed in the ratios 1:1/2:1/3, etc.

Clearly, it is not possible to sample faster than twice the maximum frequency in an *infinite* series of sine waves, but practical considerations eliminate this theoretical possibility. For example, in

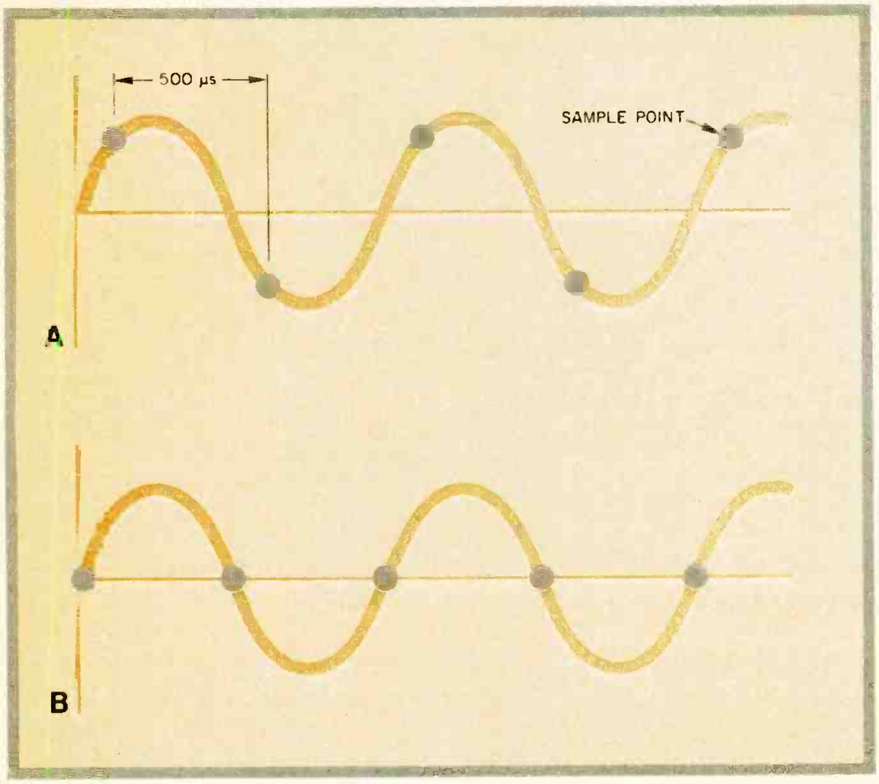


Fig. 3. Samples at 2 kHz on zero-crossings indicate no input.

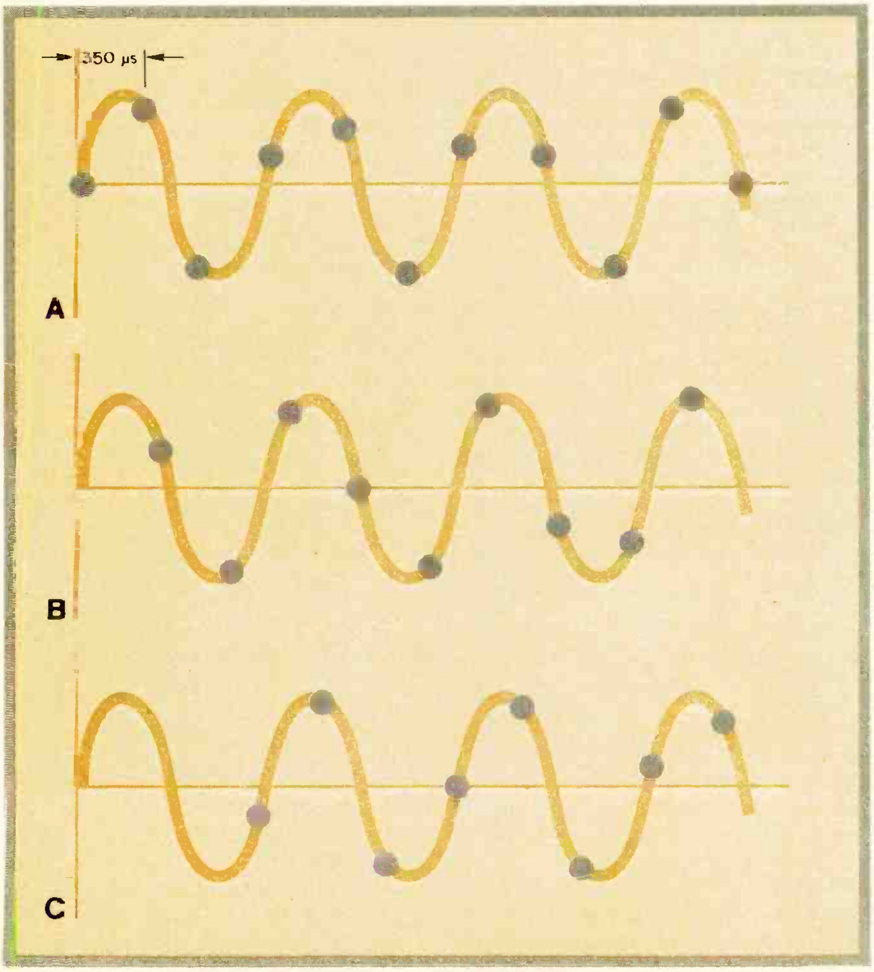


Fig. 4. Results of sample at 2.85 kHz depend on starting point.

the sine-wave sequence for the sawtooth signal of Fig. 6C, the highest frequency components have progressively lower amplitudes. This means an approximation of the sawtooth with several low-frequency sine waves will have a negligible difference from the "true" signal. Also, since all real electronic circuits have some upper limit on the frequency (bandwidth) to which they will respond, all real signals are *band-limited* anyway, and can be made up from a finite number of sine waves. Other than in textbooks, there are no perfect waveforms having infinitely small rise or fall times.

Note, also, that by band-limiting the real-world input signal, it is possible to resolve ambiguities where several different waveforms can be fitted to the same set of sample points (Fig. 6). For example, if the signal traverses a 2-kHz low-pass filter, and we collect the samples shown, we can immediately rule out the waveforms of Fig. 6B and 6C since they cannot be constructed without sine-wave components much higher than 2 kHz.

The fact that signals above, say, 1 MHz cannot be digitized by low-cost electronics must not be arbitrarily used as an input signal band-limit, since it clearly isn't possible to collect and process signals at 2 MHz (as directed by the sampling theorem). We can, however, filter the input signal to artificially band-limit it to some much lower value. Then our data-collection system can be designed to sample the input at more than twice this maximum frequency.

Hardware. The typical data collection system for digitizing analog waveforms includes a sensor, a signal-conditioning amplifier, a filter to prevent aliasing, a sample-and-hold circuit to sample the input signal, an A/D converter to convert each sample to a digital word, a parallel I/O port to interface this data to the microprocessor, and, finally, the processor itself, which uses the data (Fig. 7). Note that the aliasing filter must come *before* the sample-and-hold. Once the signal is sampled, any aliasing that can occur already has, and filtering after that point cannot undo it. This means that digital filtering cannot be used in place of the analog aliasing filter (although digital filtering may be useful elsewhere).

In a biofeedback application, for example, all the signal frequencies are between 3 Hz and 28 Hz. The aliasing filter's cutoff frequency can be 40 Hz and sampling can be done at 80 Hz. This allows 12.5 μs for the other electronics and the microprocessor software to collect and process each data sample before the next one is ready. If the aliasing filter was not in the circuit, any 60-Hz

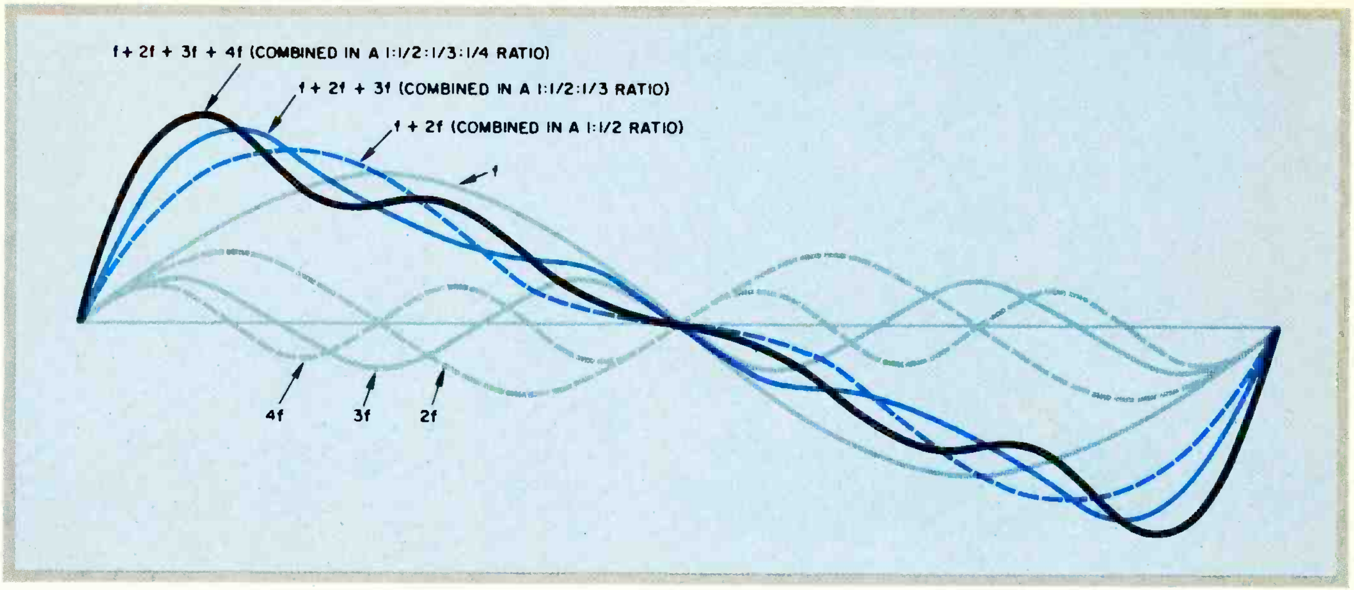


Fig. 5. Approximation by Fourier analysis of a 1-kHz sawtooth waveform.

power-line noise present on the signal of interest would be aliased to 20 Hz and would appear as part of the collected data. Digital filtering could be used to separate signals of 3.5-7.5 Hz, 7.5-13 Hz, and 13-28 Hz (theta, alpha, and beta rhythms, respectively) to obtain their relative levels.

The choice of an anti-aliasing filter is not quite the simple matter it seems at first. In practice, such filters do not reject all components above the cutoff while leaving those below completely unaffected. Real filters don't have the abrupt cutoff assumed for an ideal filter. In addition to the passband and the stop-band, there is an "in between" transition band. Here input signals are attenuated significantly but not entirely. Accounting for the transition band requires some thought and depends on the digitizing system's application.

A dramatic example of the difference between filter types is shown in Fig. 8. The simple RC filter, commonly used to remove ripple from power supplies, is not very effective as an aliasing filter. Although the higher frequencies are attenuated, the width of the transition band is considerable.

For example, to insure that aliasing errors due to full-scale inputs above the Nyquist frequency are 1% or less, it is necessary to make the "corner frequency" of the simple RC filter one one-hundredth of this value. For a Nyquist frequency of 1 kHz, everything between 10 Hz and 1 kHz falls in the transition region, a highly undesirable situation. Alternatively, if the corner frequency is set equal to 1 kHz, the Nyquist frequency must be 100 kHz. Now sampling at 200 kHz is required—extremely difficult (probably impossible) on any reasonable hardware budget.

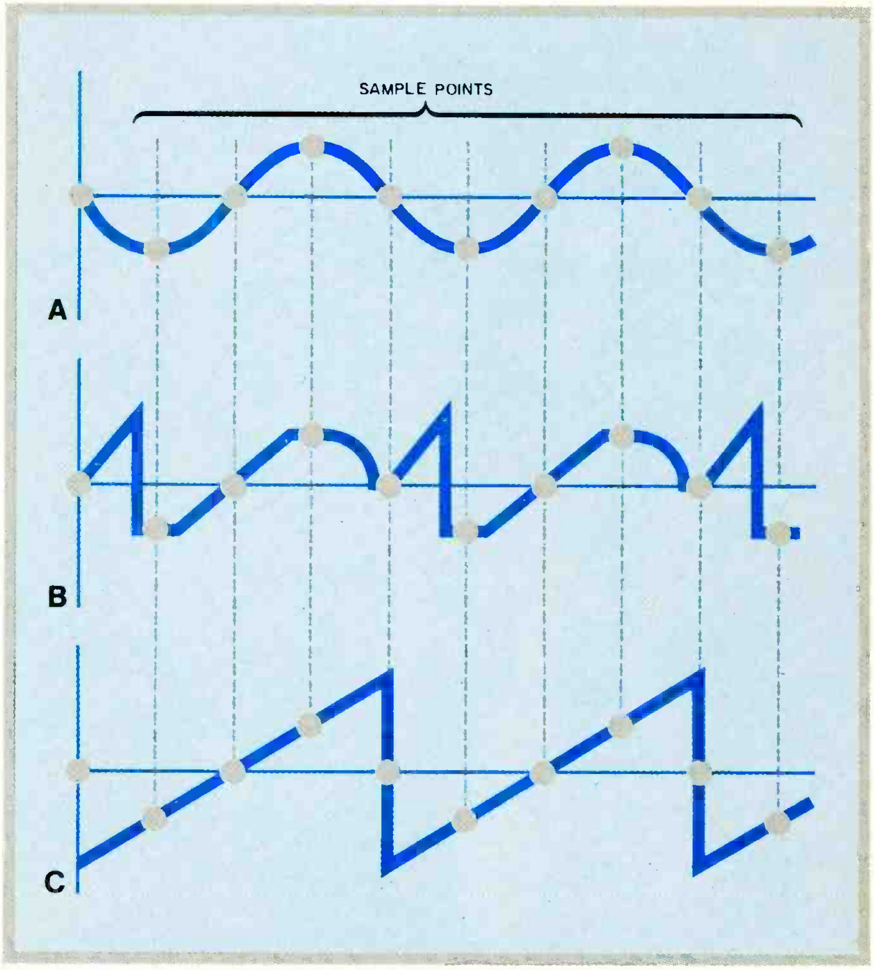


Fig. 6. Three completely different 1-kHz waveforms can be made to fit the same set of 4-kHz samples.

However, by employing multistage active filters like the sixth-order elliptic filter also shown in Fig. 8 and described in the National Semiconductor Special Function Data Book, transition bands can be significantly reduced. With a corner frequency of 1 kHz, the elliptic filter attenuates all frequency components above 1.3 kHz to 1% (or less) of their input value. Now signals up to

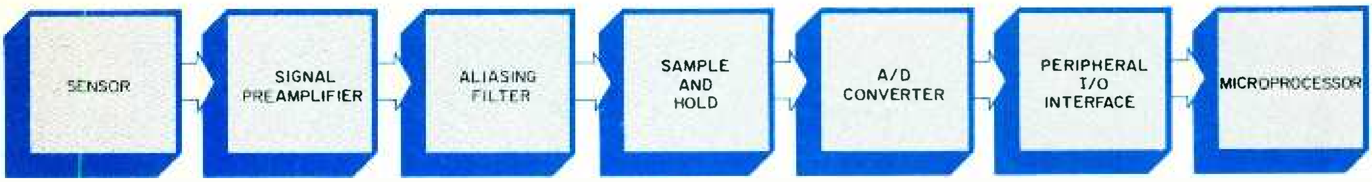


Fig. 7. Block diagram of a typical data collection system.

about 1 kHz can be collected at a sampling rate of 2.6 kHz, while aliasing error is limited to 1%. It is possible to do even better by using still more intricate filters, but their design can be complex and messy.

Another significant design problem involves speed. Data conversion electronics and processing software must be fast enough to collect and use each data sample before the next one is taken. In the 200-kHz sampling problem just mentioned, a signal sample must be taken, allowed to settle, converted to a digital word, entered into the processor, and then subjected to any required processing—all in 5 μs.

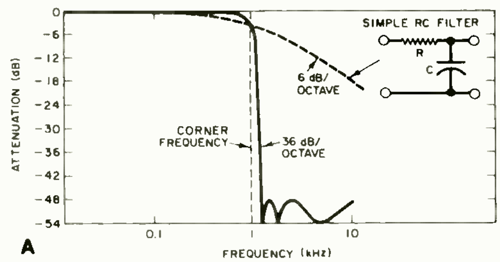
While clever design can allow some processes to occur simultaneously (one sample may undergo A/D conversion while the microprocessor handles the previous one), no individual step can take longer than 5 μs. Although sample-and-holds can settle this fast, A/D converters running at this speed are expensive, and most microprocessors cannot perform any meaningful data processing this quickly.

Sampling at 2.6 kHz, on the other hand, allows 385 μs between samples, permits the inexpensive A/D converters to be used, and greatly improves the software timing restrictions. Thus, by employing a sixth-order elliptic filter and an 8-bit A/D converter, it is possible to adapt the system of Fig. 7 to a wide range of data collection and control applications at frequencies as high as about 1 kHz.

Digital "Can-Do's." Applications for digital signal processing are limited only by imagination and programming skill. While several possibilities have already been mentioned, others include capacitance and inductance measurement systems, ac motor speed control, and the determination of audio amplifier frequency responses. It is important to emphasize, however, that software (not hardware) generally sets the limits. You can often find A/D converters, amplifiers, sample-and-holds, and other hardware fast enough to handle a given requirement, yet lack the needed cleverness with software.

If, for example, the application is plotting a few cycles of an ac signal on a printer one time, the data collection may be completed long before the printing. This demands very simple real-time software—high data requirements can be met without too much difficulty. However, if you want to process audio data in real time, the task may well be beyond your machine's capabilities. Multiplication alone may require more processing time than the total available. A typical 8080 multiplication routine may execute in 270 to 300 μs, which automatically limits the data rate to a maximum of about 3 kHz.

Whatever your application, take a good look at the whole system before you start building to get a reasonable idea about difficulty. While few things are "impossible" if you want to do them bad enough, it is best to know beforehand when a system will require $1500 video-speed A/D converters, 43 processors, and 128K bytes of RAM. ◇



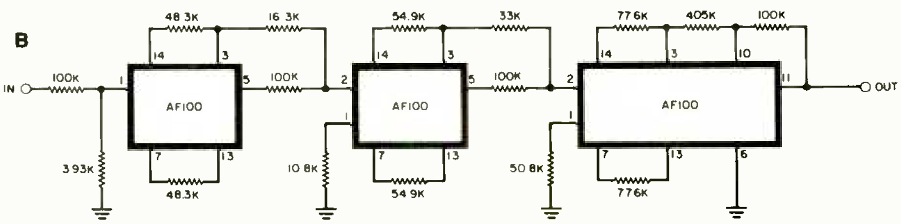


Fig. 8. At (A) is the attenuation/frequency curve for the simple RC filter given in the box. At (B) is a schematic for a sixth-order elliptical filter.

FILTER PARAMETER PRIMER

Order of a filter is given by the highest power of frequency (or radian frequency) that appears in the e_{out}/e_{in} transfer function. In most active filters, the order is equivalent to the number of energy-storage capacitors used (a fifth-order filter uses five capacitors). The higher the order number, the steeper the transition between frequencies in the bandpass and frequencies rejected. The rate of rolloff at the corner frequency is 6N dB/octave, where N is the order number. Thus, a sixth-order filter has 6 x 6 or 36 dB/octave rolloff. Low- and high-pass filters can be from 1 to 6th order, while bandpass filters are normally even-order only.

Corner or Break Frequency is the frequency where a filter's response falls 3 dB (or 0.707 of its peak in-band value) on the edge of the passband.

Elliptic Filters, also known as Cauer or Zolotarev filters, are equiripple (error oscillates at equal amplitudes) in the pass and stop bands. They have a much steeper transition region than Butterworth or Tchebyscheff filters. Their very steep falloff outside the band makes them very powerful.

Shannon Sampling Theorem states that if a function of time f(t) contains no frequencies higher than W hertz, it is completely determined by giving the value of the function at a series of points 1/2W seconds apart.

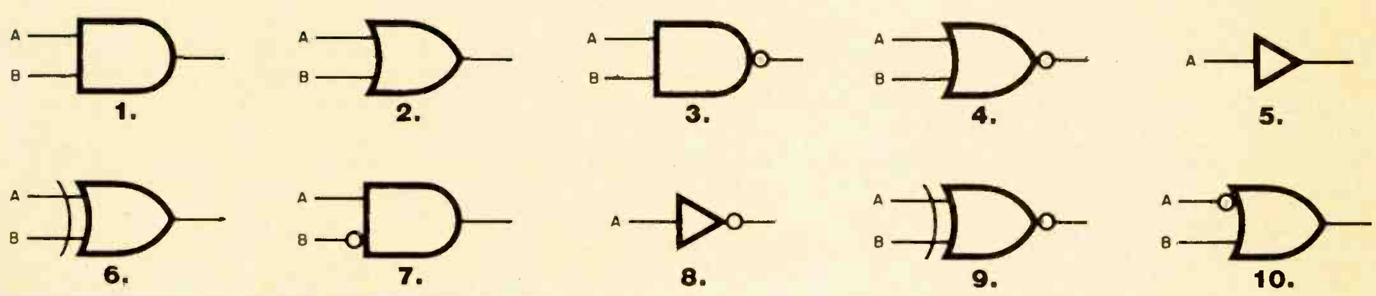
Transfer Function of an active filter is simply what you get out of the filter compared to what you put in. It is usually expressed as the ratio e_{out}/e_{in}. The transfer function usually includes both amplitude and phase information, and is sometimes expressed in terms of a complex variable, S.

LEARNING QUIZZES FOR ELECTRONICS

BY FREDRICK W. HUGHES

Digital Logic Quiz

Boolean expressions help to explain the operation of digital logic gates. Match each of the following logic symbols to its proper Boolean expression.

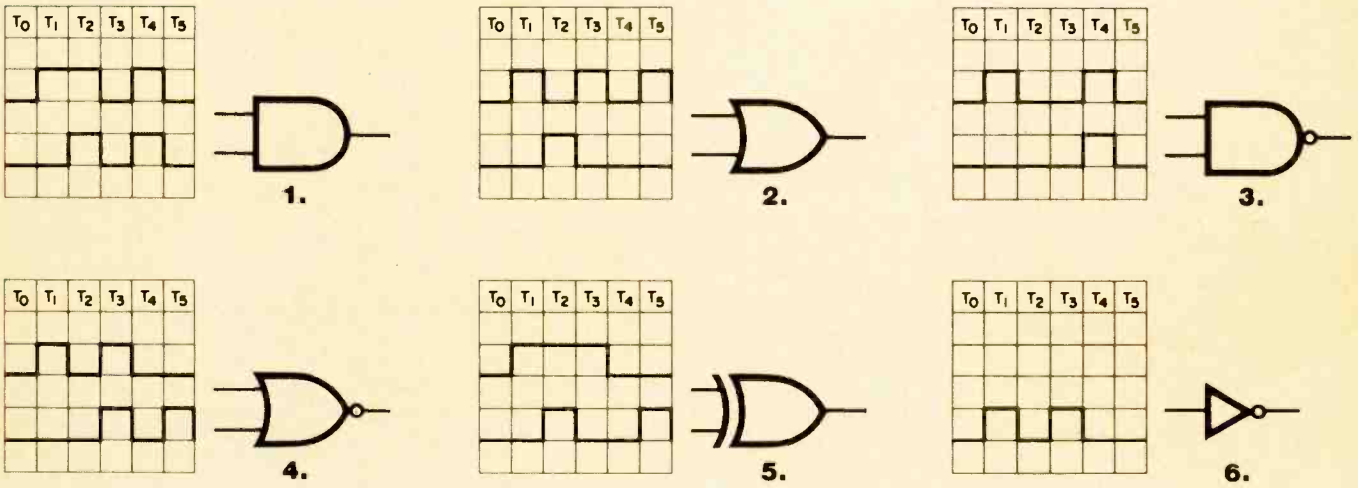


Choices: a. $A \cdot \bar{B}$ b. $A+B$ c. $A \cdot B$ d. $\bar{A}$ e. $\bar{A}+B$ f. $A\bar{B}+\bar{A}B$ g. A h. $\overline{A+B}$ i. $AB+\bar{A}\bar{B}$ j. $\overline{AB}$

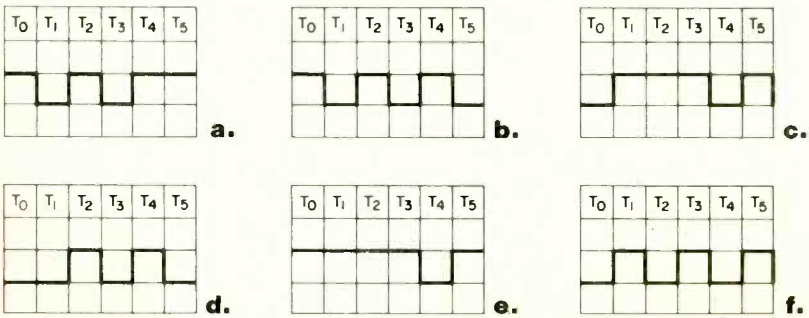
Answers: 1. c, 2. b, 3. j, 4. h, 5. g, 6. f, 7. a, 8. d, 9. i, 10. e.

Digital Logic Quiz

Digital logic gates turn on with various input conditions. For the input pulses shown, select the proper output for each gate. Be sure to check the input to output time relationships.



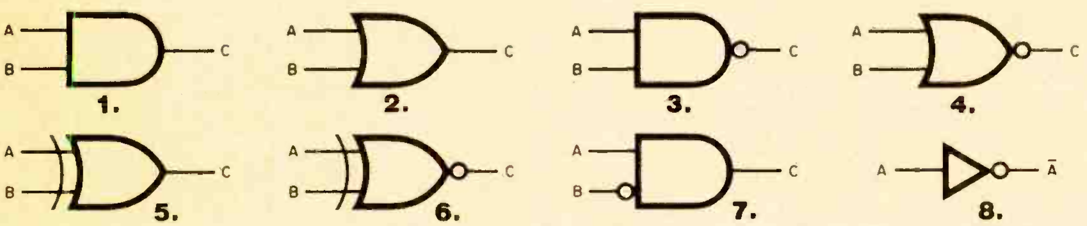
Choices:



Answers: 1. d (AND gate, all inputs high to get a high output.) 2. c (OR gate, any input high to get a high output.) 3. e (NAND gate, any input low to get a high output.) 4. b (NOR gate, all inputs low to get a high output.) 5. f (Exclusive-OR gate, either input high, but not both, to get a high output.) 6. a (INVERTER, the output is the opposite of the input.)

Digital Logic Quiz

A truth table shows the resulting output condition of a logic gate for all possible input logic conditions. Match each logic gate with its proper truth table.



Choices:

a.

A	B	C
0	0	1
0	1	1
1	0	1
1	1	0

b.

A	B	C
0	0	0
0	1	1
1	0	1
1	1	1

c.

A	B	C
0	0	1
0	1	0
1	0	0
1	1	0

d.

A	B	C
0	0	1
0	1	0
1	0	0
1	1	1

e.

A	B	C
0	0	0
0	1	0
1	0	0
1	1	1

f.

A	Ā
0	1
1	0

g.

A	B	C
0	0	0
0	1	1
1	0	1
1	1	0

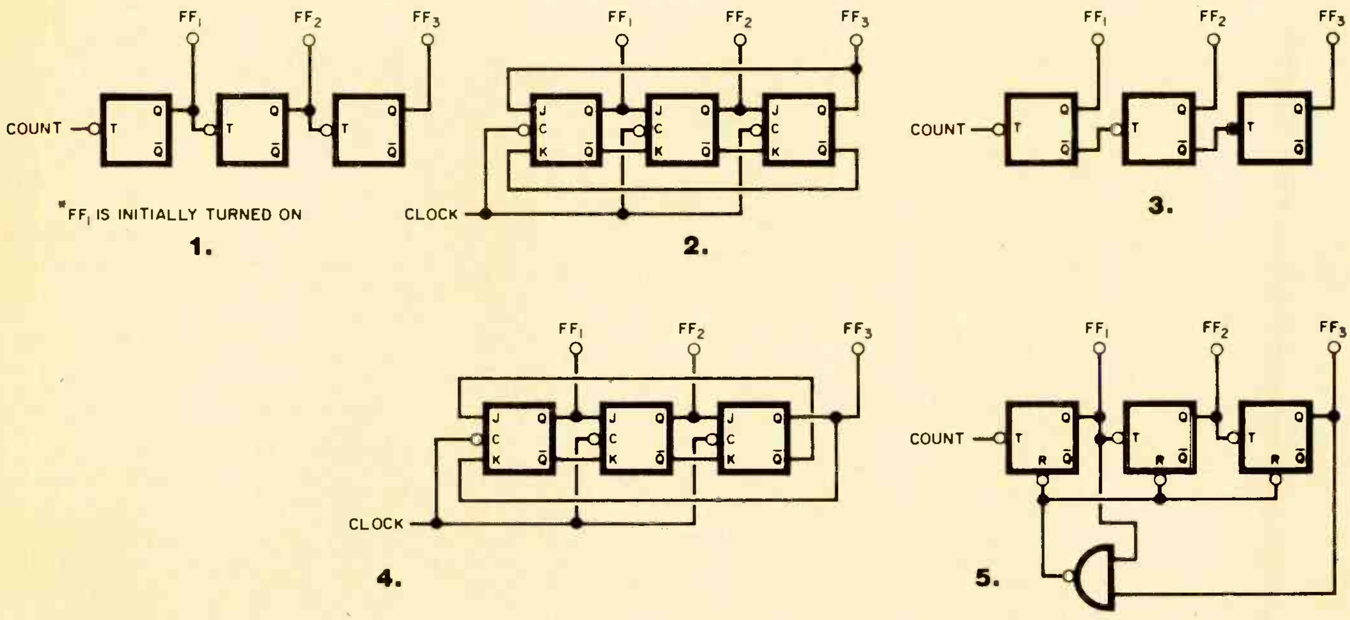
h.

A	B	C
0	0	0
0	1	0
1	0	1
1	1	0

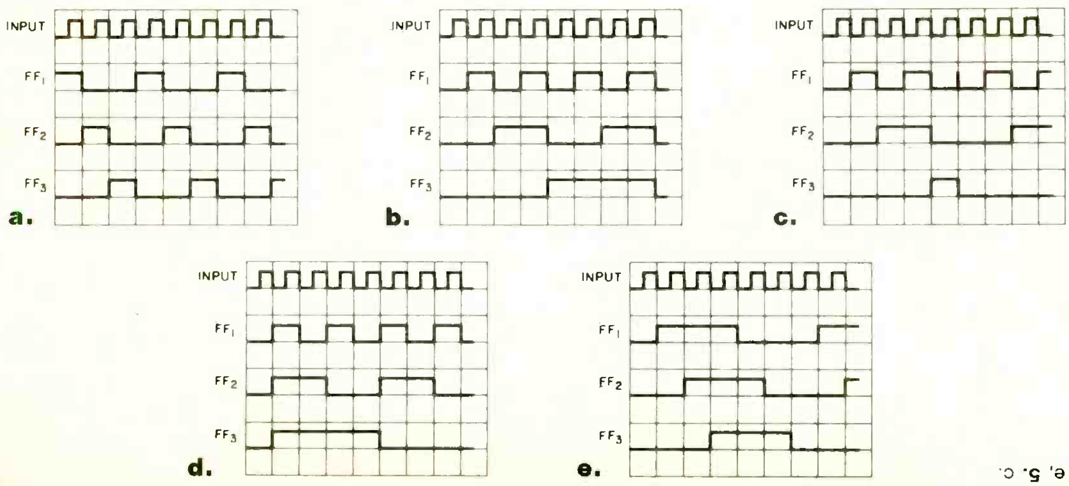
Answers: 1. e, 2. b, 3. a, 4. c, 5. g, 6. d, 7. h, 8. f.

Digital Counter Quiz

Match the correct digital counter to its proper output voltage waveform.



Choices:



Answers: 1. b, 2. a, 3. d, 4. e, 5. c.

COMPUTER BITS

By Carl Warren

New Boards Work—and Play—Hard

YOU'RE probably aware that most microcomputer manufacturers are touting their systems for business applications and, as such, are offering a host of hardware and software products to ease customers into automated bookkeeping and all kinds of other office tasks.

Even the Apple II computer, which isn't really suited for business applications in its basic configuration, is being applied for business with the help of plug-in pc boards. These range from Microsoft's Z80 Softcard to the many 80 by 24 video-enhancement cards.

These options are important to Apple II users since they make accessible the better word-processing packages such as MicroPro's WordStar. Two such cards of particular interest come from Videx, Inc., and Vista Computer Corp.

The Videx card, called the Videoterm and priced at $345, is designed to slip into any slot on the Apple II backplane and provides a crisp 80 by 24-character display, as well as full upper- and lower-case ASCII characters.

Installing the card is simple, and requires no patches to the operating system, Apple DOS, or CP/M. But if you require a 40-character display, you'll need the Soft Video Switch for $29. This allows switching the display between 80 and 40 columns, and handles graphics switches. The Soft Video Switch works well, although we felt this capability should have been part of the Videoterm card.

The only difficulty we experienced with the Videoterm board involved WordStar. Microsoft delivers a version of WordStar for the Apple II that reportedly functions with the Videx card. Unfortunately, such is not the case without a patch supplied by MicroPro. Nor will the card work with standard WordStar, even when changing the keyboard characters with the CONFIGIO program supplied with Softcard.

However, once you get the correct software, everything works well. The display is crisp, quick, and noise-free, with smooth scrolling. Moreover, we could write a BASIC program that made use of *both* screen sizes—dynamically switching while the program ran without causing any screen flutter.

A further enhancement for the Apple II's keyboard and display is the Videx Enhancer II terminal card. This $149 card is worth every cent. It gives your Apple II a true typewriter-style keyboard, and permits use of the SHIFT key. You can even re-map the keyboard to produce custom-character sets, and Videx supplies the necessary software.

The Enhancer II is installed by removing the old logic board under the Apple II keyboard and replacing it with the Enhancer II. You must remove the computer's case, but the Enhancer II's instruction manual is very clear on all aspects of this procedure. In addition, you have to remove some ICs on the Apple II motherboard and replace them with Videx-supplied ICs. This was the only disparity we found with the board. We have suggested that Videx include special sockets that allow attaching cables to an IC, much like Mountain Computer does with its CPS card.

With the Enhancer II in place there were two things we particularly liked: To reset the Apple II, you must now simultaneously hold down the CONTROL and RESET keys, thus preventing unwanted resets. We also appreciated the full-line, type-ahead buffer, which greatly improves throughput.

The Vista Vision-80 card is another exciting bit of hardware that can add features to your Apple II. This $375 card fits into the Apple II backplane (slot 3), must be connected to the video output jacks to handle software display switching, and requires no operating system modifications. In addition, the Vision-80 card works with all software—including standard WordStar—without modification.

The Vision-80 card also comes with built-in communication protocol. This requires that there is a RS-232C serial card in slot 2 of the Apple II backplane. The protocol uses special control codes to send data. This feature, without any supporting software, turns the Apple II into an intelligent terminal capable of communicating with any other computer system.

Although Vision-80 operates well, we did find that when the card was first installed, monitor linearity may require adjustment. If your monitor uses a 75-ohm input, the on-screen display may be dim. We also found that scrolling speed was slow in comparison to the Videx board, and that the cursor wasn't always visible, which is bothersome—especially with WordStar.

While using Vision-80 we did find some fixes, though. To improve the video output, change resistor *R8* from 220 to 100 ohms to remove any slight display tearing. To speed up the scroll, at the expense of causing snow on the screen, lift pin 4 of *U16* and pin 13 of *U18*, tie the pins together, and ground them.

Making the cursor visible requires a little more elaborate modification. To do this, lift pin 8 of *U18* out of its socket. Then, using Wire-Wrap wire and a low-wattage soldering iron, tack a wire from *U19* (pin 1) to *U18* (pin 10). Do the same from *U19* (pin 2) to *U18* (pin 9), and *U19* (pin 3) to *U18* (pin 8). Be sure to leave pin 8 of *U18* out of its socket. When the Vision-80 is set up in this manner, its operation equals that of a Videx board.

Both Vision-80 and Videx are very capable boards, and your selection should be based on your particular needs. If communication is important, the Vision-80 card will fill the bill. On the other hand, numerous software packages have been created to support the Videx board, thus making it a wise choice also.

Computer Whiz. Want to add communications to your CP/M-based system? Then contact Metalogic Corp. about Whiz. This $150 communication package, written in the C language, uses a "Smart Menu," and allows transmission speeds up to 9600 baud.

Although the prime purpose of Whiz is to allow communication between computer systems, the designers have added built-in CP/M commands such as directory, erase, and rename. You can use Whiz to set up a menu of frequently dialed phone numbers that can be called up with a single character entry, and you can use the package with smart or dumb modems.

But that isn't all. Unlike other communications packages that simply turn your computer into an intelligent terminal, Whiz has the ability to speed data-file transmissions by compressing them up to 40%—a 120-bit/s increase.

Whiz supports virtually any protocol and works equally well with programmable and non-programmable baud-rate generators, and can be installed by anyone. The only thing left out of the Whiz Version 1.1 are split-screen operation and the capability for use with other programs. But Metalogic's president, Lou Barnett, assured us that Whiz enhancements are already in the making. Right now they feel that Whiz is state-of-the-art—and we agree. ◊

FOR MORE INFORMATION

To get more information on items mentioned in this column, contact the following manufacturers directly.

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665 Maybell Ave.
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Metalogic Corp.
4325 Miraleste Drive
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Videx, Inc.
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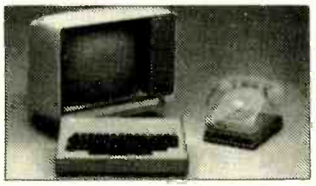

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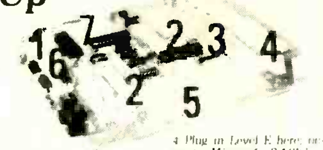

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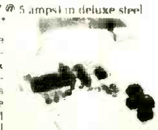

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PROGRAMMER'S NOTEBOOK

Fire That Gun!

By Jim Keogh

PROFESSIONAL systems designers are frequently able to design software packages quickly by using the modular approach to programming. They develop software packages from existing program subroutines. A subroutine is a set of computer instructions which can be used throughout the program by "calling" it. In BASIC, a subroutine is "called" in the program simply by inserting GOSUB, with the line number of the subroutine, wherever the subroutine is needed. At the end of the subroutine, the statement RETURN is used to automatically return the program to the line immediately following the GOSUB statement. Subroutines need only be *keyed* into the program once, usually at the end of the program. (Lines 10,000 and above are good places for storing subroutines.) They can also be *inserted* into the program any number of times using the GOSUB statement each time.

When a programmer designs a new software package, existing subroutines are used with slight modifications to develop the final program.

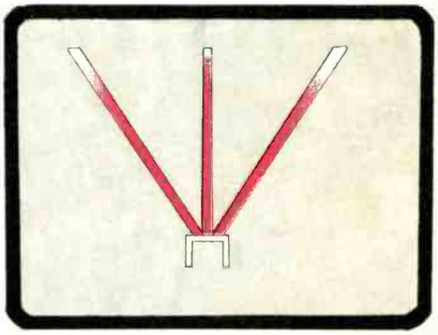
In this column, we will present material that can serve as the basis for your own subroutine file. From the file you can modify subroutines and build your own program. In each column, we will present subroutines and tell you how they operate. By picking apart a subroutine, you will develop a better understanding as to how to modify it to meet your needs.

Subroutines which we will talk about will be written in BASIC. Since it is nearly impossible to write a single program which will run on every microcomputer, we will concentrate on the TRS-80 and the Apple II microcomputers. There are similarities in the BASIC used by other memory-mapped video microcomputers and with little effort you should be able to modify the subroutines presented here to run on your microcomputer. The graphics subroutines, however, cannot be modified to run on serial-port microcomputers unless an "intelligent" terminal and its particular commands are used.

Our first subroutine is one that allows you to fire a shot within the range of a "gun" on your computer screen. Table I is an example of a "gun firing" subroutine which can be used when developing your own microcomputer game.

To use this subroutine, key it into your microcomputer. When you call the subroutine, you will be requested to aim the gun once the gun has been positioned on the screen. INPUT of any number between −1 and +1 will fire the gun. Zero fires it straight ahead. Using −1 will fire a shot to the far left, and using 1 (you need not use the plus sign before the number) will fire a shot to the far right. Use numbers less than 1 and more than −1 (decimals) to fire shots between the gun's horizontal limits.

Let's take a closer look at the subroutine. Starting with line 30, the gun is drawn on the screen. It's not much of a gun, but you can use your artistic talents to improve the gun's looks. You can position the gun at any location on the screen by changing the coordinates of the graphic statement. However, for better results it is important that the horizontal portion of the gun have a center block. Always use an odd number of blocks when drawing this portion of the gun. In the example, five horizontal blocks were lit, making the third block the center. This will become important when we fire the gun.



The gun, when drawn on your screen and firing, should look something like this.

Line 330 is the input statement. It is important that the input remain within the horizontal range of the gun; otherwise an error message may occur.

Now it is time to fire the gun. Note line 370. This coordinate is the center block of the gun. It is from this location that the "bullet" will "leave" the gun. You can see why it is important to have a center block on the horizontal portion of the gun. Otherwise you may be firing the shot from the corner of the gun instead of the center.

An important part of the subroutine is the beginning statement of the loop that displays the shot. The loop starts with line 390. This instruction states that, for the TRS-80, D = 33 to 2 STEP −1, and for Apple II, D = 33 to 10 STEP −1.

The 33 is the horizontal coordinate of the gun. The 2 (10 for Apple II) is the vertical range of the gun. This is the last vertical block which the bullet will "hit." The STEP −1 statement determines the speed of the bullet.

You can easily modify this subroutine and make the 2 (10 for the Apple II) a variable which the player can control (the range) and the speed of the bullet, by changing STEP −1. Here, −1 is slow and −6 is extremely fast. Numbers between −1 and −6 will give the player a corresponding increase in speed.

When you use the subroutine in your program, be sure to remove our many notes contained under the statements REM. They were only used to provide a better understanding of the functions of each statement. Also, line numbers should be changed to conform to your own programs. We used line numbers in our subroutine and even skipped a few line numbers in our Apple II subroutine to make it easier for you to follow our discussion.

If you have a color display terminal, be sure you modify the subroutine to brighten up the action. When you change from a black-and-white screen to a color display, you also may see some graphic changes in our subroutine, depending upon the kind of microcomputer you use.

With some imagination you can modify this subroutine and add targets of all types which the player must shoot. You can also reverse the coordinates and position the gun at the top of the screen—in an "aircraft"—and shoot at ground targets. ◇

TRS-80 SUBROUTINE

```
10 REM CLEAR SCREEN
20 CLS
30 REM DRAWS LEFT SIDE OF GUN. A= NUMBER OF VERTICAL
40 REM SCREEN POSITIONS WHICH SHOULD BE TURNED ON.
50 REM B = THE NUMBER OF HORIZONTAL POSITIONS FROM
60 REM THE LEFT SIDE OF THE SCREEN FROM WHICH THE
70 REM VERTICAL SCREEN POSITIONS SHOULD START.
80 FOR A = 33 TO 35
90 B = 53
100 SET (B, A)
110 NEXT A
120 REM DRAWS TOP OF GUN. A = NUMBER OF HORIZONTAL
130 REM SCREEN POSITIONS WHICH SHOULD BE TURNED ON.
140 REM B = THE NUMBER OF VERTICAL POSITIONS FROM
150 REM THE TOP OF THE SCREEN FROM WHICH THE
160 REM HORIZONTAL SCREEN POSITIONS SHOULD START.
170 FOR A = 53 TO 57
180 B = 33
190 SET (A, B)
200 NEXT A
210 REM DRAWS RIGHT SIDE OF THE GUN. A = THE NUMBER
220 REM OF VERTICAL SCREEN POSITIONS WHICH SHOULD BE
230 REM TURNED ON. B = THE NUMBER OF HORIZONTAL
240 REM POSITIONS FROM THE LEFT SIDE OF THE SCREEN
250 REM FROM WHICH THE VERTICAL SCREEN POSITIONS
260 REM SHOULD START.
270 FOR A = 33 TO 35
280 B = 57
290 SET (B,A)
300 NEXT A
310 REM AIM GUN. INPUT STATEMENT FOR DIRECTION OF GUN.
320 PRINT @ 64, "AIM GUN SELECTION +/- 1"
330 INPUT A
340 REM THIS STATEMENT REMOVES THE INPUT STATEMENT FROM
350 REM THE SCREEN.
360 PRINT @ 64, "                                        "
370 REM FIRE GUN. C = THE CENTER POSITION OF THE GUN.
380 C = 55
390 REM SPEED OF SHOT. D = THE VERTICAL SCREEN POSITION
400 REM OF THE SHOT. 33 = THE VERTICAL STARTING POSITION
410 REM OF THE SHOT. 2 = THE END VERTICAL POSITION OF THE
420 REM SHOT. -1 = THE NUMBER OF VERTICAL POSITIONS FROM
430 REM 33 TO 2 WHICH SHOULD BE TURNED ON.
440 FOR D = 33 TO 2 STEP -1
450 REM C = C + A MEANS THE INPUT QUANTITY (+/-1) IS ADDED
460 REM TO THE VALUE OF C WHICH IS 55, THE CENTER
470 REM HORIZONTAL SCREEN POSITION OF THE GUN. THE RESULT
480 REM WILL GIVE THE NEW STARTING HORIZONTAL SCREEN
490 REM POSITION FROM WHERE THE SHOT IS FIRED.
500 C = C+A
510 REM THE SCREEN POSITION IS TURNED ON.
520 SET (C,D)
530 REM HERE IS THE TIMING LOOP WHICH DETERMINES HOW
540 REM LONG THE SCREEN POSITION IS TURNED ON.
550 FOR T = 1 TO 15
560 NEXT T
570 REM HERE IS WHERE THE SCREEN POSITION IS TURNED OFF.
580 RESET (C,D)
590 REM THIS TELLS THE COMPUTER TO GO TO THE NEXT VERTICAL
600 REM SCREEN POSITION AND TURN IT ON. THE END OF THE
610 REM LOOP.
620 NEXT D
630 REM IF YOU INCLUDE THIS SUBROUTINE AS PART OF YOUR
640 REM PROGRAM, CHANGE LINE 630 TO READ 630 RETURN.
```

APPLE II SUBROUTINE

```
10 REM CLEAR SCREEN
20 CALL -936
30 REM DRAWS LEFT SIDE OF GUN. THE VERTICAL LINE
40 REM IS DRAWN FROM VERTICAL SCREEN POSITION 33
50 REM TO VERTICAL SCREEN POSITION 35. 18 INDICATES
60 REM THE HORIZONTAL SCREEN POSITION FROM WHICH
70 REM THE VERTICAL SCREEN POSITION SHOULD START.
80 VLIN 33, 35 AT 18
120 REM DRAWS THE TOP OF GUN. THE HORIZONTAL LINE
130 REM IS DRAWN FOR THE HORIZONTAL SCREEN POSITION
140 REM 18 TO HORIZONTAL SCREEN POSITION 22.33
150 REM INDICATES THE VERTICAL SCREEN POSITION FROM
160 REM WHICH HORIZONTAL SCREEN POSITION SHOULD START
170 HLIN 18,22 AT 33
210 REM DRAWS THE RIGHT SIDE OF THE GUN. THE VERTICAL
220 REM LINE IS DRAWN FROM VERTICAL SCREEN POSITION 33
230 REM TO VERTICAL SCREEN POSITION 35. 22 INDICATES
240 REM THE HORIZONTAL SCREEN POSITION FROM WHICH
250 REM THE VERTICAL SCREEN POSITION SHOULD START.
270 VLIN 33,35 AT 22
310 REM AIM GUN. INPUT STATEMENT FOR DIRECTION OF GUN.
320 PRINT "AIM GUN SELECT +/-1"
330 INPUT A
370 REM FIRE GUN. C = THE CENTER POSITION OF THE GUN.
380 C = 20
390 REM SPEED OF SHOT. D = THE VERTICAL SCREEN POSITION
400 REM OF THE SHOT. 33 = THE VERTICAL STARTING POSITION
410 REM OF THE SHOT. 10 = THE END VERTICAL POSITION OF
420 REM THE SHOT. -1 = THE NUMBER OF VERTICAL POSITIONS
430 REM FROM 33 TO 10 WHICH SHOULD BE TURNED ON.
440 FOR D = 33 TO 10 STEP -1
450 REM C = C+A MEANS THE INPUT QUANTITY (+/-1) IS ADDED
460 REM TO THE VALUE OF C WHICH IS 20, THE CENTER
470 REM HORIZONTAL SCREEN POSITION OF THE GUN. THE RESULT
480 REM WILL GIVE THE NEW STARTING HORIZONTAL SCREEN
490 REM POSITION FROM WHERE THE SHOT IS FIRED.
500 C = C+A
510 REM THE SCREEN POSITION IS TURNED ON.
520 PLOT C,D
590 REM THIS TELLS THE COMPUTER TO GO TO THE NEXT VERTICAL
600 REM SCREEN POSITION AND TURN IT ON. THE END OF THE
610 REM LOOP.
620 NEXT D
630 REM IF YOU INCLUDE THIS SUBROUTINE AS PART OF YOUR
640 REM PROGRAM, CHANGE LINE 630 TO READ 630 RETURN.
```

COMPUTER SOURCES

By Leslie Solomon
Technical Director

Hardware

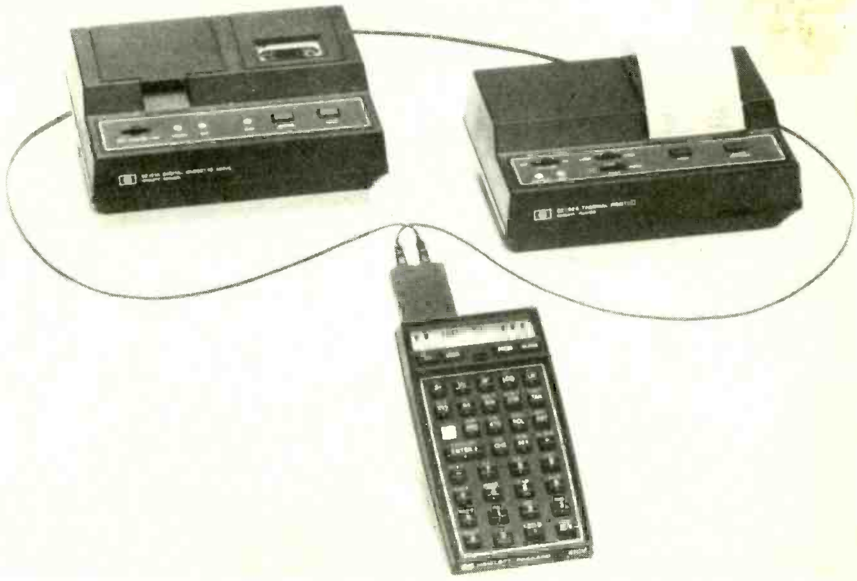
Interface Loop. Digital instruments are the backbone of the modern electronics lab and maintenance shop. And thanks to industry-wide adoption of a standard interface bus, laboratory-type voltmeters, counters, signal generators, and power supplies can be used in concert—under computer control—to program and record specific circuit tests. But now even small, low-cost, battery-powered test systems with relatively low data rates can enjoy the advantages of bus operation thanks to recent developments from Hewlett-Packard.

A couple of years back Hewlett-Packard created an instrument bus, the HP-IB, that later became the IEEE-488 Bus, a standard interface for laboratory instruments. Now, HP has developed a low-cost, low-power interface loop called the HP-IL that enables up to 31 instruments (961 with extended addressing) to work together in a bit-serial "master-slave" configuration.

Data moves around the closed loop in one direction at 5K bytes. Instruments can be up to 100 meters apart using special cable, or just 10 meters with conventional zip cord. Commands from the HP-IL controller (typically a HP-41 Hand-Held Computer) are received and re-transmitted by every device in the loop, but are acted on only by the device specified by the controller.

Talkers and Listeners. Loop information falls into two categories—commands and data. Commands are initiated by the designated controller and are monitored by all devices on the loop. Data is sent by a "talker" and is heard by all the "listeners." To maintain order, all devices on the loop must function in accordance with their assigned roles. Some roles may be temporarily changed by the program to suit a specific operation.

For example, the controller (an HP-41 or some other computer) designates the roles and then controls the loop operation. It can also transfer control to another device, which then becomes "the controller of the moment." A "talker" is a device that sends information to the loop after it has been designated and enabled by the controller (a DMM is a "talker" when it sends some measured value through the loop). A "listener" can only receive data from the loop and then act on that data (a printer, for instance, can only be a listener). A device cannot be a talker and a listener at the same time, but some equipment can assume either role at different



The HP-IL Interface Loop gives the HP-41 mass memory and printing capability with a Cassette Drive and Thermal Printer/Plotter.

A REMARKABLE MAGAZINE

David Ahl, Founder and Publisher of Creative Computing

creative computing

"The beat covered by Creative Computing is one of the most important, explosive and fast-changing."—Alvin Toffler

You might think the term "creative computing" is a contradiction. How can something as precise and logical as electronic computing possibly be creative? We think it can be. Consider the way computers are being used to create special effects in movies—image generation, coloring and computer-driven cameras and props. Or an electronic "sketchpad" for your home computer that adds animation, coloring and shading at your direction. How about a computer simulation of an invasion of killer bees with you trying to find a way of keeping them under control?

Beyond Our Dreams

Computers are not creative per se. But the way in which they are used can be highly creative and imaginative. Five years ago when *Creative Computing* magazine first billed itself as "The number 1 magazine of computer applications and software," we had no idea how far that idea would take us. Today, these applications are becoming so broad, so all-encompassing that the computer field will soon include virtually everything!

In light of this generality, we take "application" to mean whatever can be done with computers, *ought* to be done with computers or *might* be done with computers. That is the meat of *Creative Computing*.

Alvin Toffler, author of *Future Shock* and *The Third Wave* says, "I read *Creative Computing* not only for information about how to make the most of my own equipment but to keep an eye on how the whole field is emerging.

Creative Computing, the company as well as the magazine, is uniquely lighthearted but also seriously interested in all aspects of computing. Ours is the magazine of software, graphics, games and simulations for beginners and relaxing professionals. We try to present the new and important ideas of the field in a way that a 14-year old or a Cobol programmer can understand them. Things like text editing, social simulations, control of household devices, animation and graphics, and communications networks.

Understandable Yet Challenging

As the premier magazine for beginners, it is our solemn responsibility to make what we publish comprehensible to the newcomer. That does not mean easy; our readers like to be challenged. It means providing the reader who has no preparation with every possible means to seize the subject matter and make it his own.

However, we don't want the experts in our audience to be bored. So we try to publish articles of interest to beginners and experts at the same time. Ideally, we would like every piece to have instructional or informative content—and some depth—even when communicated humorously or playfully. Thus, our favorite kind of piece is acessible to the beginner, theoretically non-trivial, interesting on more than one level, and perhaps even humorous.

David Gerrold of *Star Trek* fame says, "*Creative Computing* with its unpretentious, down-to-earth lucidity encourages the computer user to have fun. *Creative Computing* makes it possible for me to learn basic programming skills and use the computer better than any other source.

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times. Even if the HP-IL devices have built-in addresses, the system controller always assigns new addresses to each loop member.

A small HP-IL system might consist of a multimeter (talker) sending data to a printer (listener). A larger system can include many instruments with one designated as the controller. It is possible to have several controllers, each taking charge during certain phases of a complex test. But only one controller can be active at any one time. A priority-interrupt scheme takes care of that.

Since all data goes around the loop and returns to the originating device, error checking is simplified. And instruments may be added or removed from the loop without affecting the overall system performance. Furthermore, unlike the IEEE-488 approach, the HP-IL features a unique power-down mode that allows the battery-powered instruments to be turned off when not needed, thus saving battery power.

Programming the Loop. Software for the loop is simple. For example, the programmer can write a program that requires a printer, without having to know which printer is to be used, what its address is, and where the printer is on the loop. All he does is specify PRINT and the controller will find the printer.

Data is passed around the HP-IL using a three-level code (+volts, zero, −volts) in which information is a function of level transitions only. Each message bit is asynchronous with respect to adjacent bits and no preamble (start) bits are required, as would be the case with two-level codes. The particular code used is relatively insensitive to distortions produced by cable lengths, loads, and variable-speed drivers.

The three-level code defines four types of bits—0, 1, 1S, and 0S. The last two bits are specially encoded versions of ONE and ZERO and are used at the start of each message "frame" for synchronization—no system clock is used. A high (1.5-V) pulse, followed by a low (−1.5-V) pulse defines a logical ONE, while the reverse indicates a logical ZERO.

Nominal pulse width is 1 µs and each bit sequence is followed by a delay of about 2 µs. Thus, a random electrical pulse appearing on the loop cable will be ignored unless it is immediately followed by a pulse of opposite polarity. Since no loop clock is used, devices operating at different speeds can be included in the loop.

A key element of the HP-IL is its use of transformer-isolated drivers and receivers. Transformers can be used since there is no dc component on the loop, just voltage transitions. And, since transformers are passive devices, they require no standby power and make for easy impedance matching within the loop. The use of transformers also means that some instruments can operate with large dc offsets (*e.g.*, a dc multimeter can have its common several hundred volts above earth ground). And transformer isolation permits differential-mode operation: The loop can operate in a noisy electrical environment without extensive cable shielding.

What's on the Bus Now? Instruments currently available for the HP-IL include the HP82162A Printer that uses a thermal print head to form seven columns of 24 characters per line at 70 lines per minute (it contains a 3870 microprocessor with 4K bytes of ROM and 128 bytes of RAM). Another HP-IL member, the HP82161A Digital Cassette Drive, can store up to 131,072 bits on 80 feet of tape recording at 850 bits/inch with biphase level coding. The tape is formatted in two 256-record tracks, each track representing 256 bytes. Files can be named (and recalled by name), and high-speed bidirectional search takes place at 30 inches/second. Also bus-compatible, the five-function HP3468A DMM can resolve up to 1 μV dc and features a 12-character display for output readings and messages generated by the controller or by the DMM. The resolution is user-adjustable from three to five digits. In fact, bus compatability is not a major issue because the HP82166 HP-IL Converter can be built into many other devices, enabling them to join the HP-IL loop.

Communication between the HP Series 80 Computers and the HP 41 Handheld Computer can be made via the HP-IL Interface Card which connects the loop to the HP-85 or HP-83 electronics. The HP 82160 HP-IL Module plugs into any of the four I/O ports of the HP-41 Hand-Held Computer, making it a general-purpose controller.

Future HP-IL products will include an 80-character impact printer, a video (TV/monitor) interface, an HP-IL/RS-232 interface, and an HP-IL/GP-IO interface.

Data Base Access. The RCA VP3501 Videotex Data Terminal is identical to the VP3301 Interactive Data Terminal described in the November, 1981 issue of this magazine, except that this version has a built-in r-f modulator and direct-connect modem. All you need is a TV receiver (or video monitor) and a phone line to immediately access any data/base, or time-sharing system. This makes the VP3501 ideal for the traveller that must maintain contact with a host computer, since the complete VP3501, including its wall-plug power supply can be easily carried within a small suitcase along with the clothes. If the Source, CompuServe, etc., is your thing, this may be the best way to go. $399. The VP3501AC Acoustic Coupler is not a modem, but a low-profile telephone coupler that allows the VP3501 to interface to a conventional telephone where modular versions are not available. No external power is required and the Coupler plugs directly into the VP3501. $59. The VP3501CR Cassette Recorder Interface also plugs into the VP3501 and allows data to be stored on a conventional cassette recorder (not supplied). It also provides a connector so that other external devices can be plugged into the VP3501. No external power is required. $69. **Address:** RCA MicroComputer Products, New Holland Ave., Lancaster, PA 17604 (Tel: 800-233-0094; in PA call 717-393-0446).

OSI CP/M. The PROXY-80 replaces the standard OSI CPU board and disk controller and is compatible with OSI memory and peripheral boards. It allows users to access standard format CP/M. It contains a serial port, true DMA controller, LSI disk controller that supports CP/M single density and optional double density formats, optional real-time clock, and optional parallel printer port. $695. **Address:** Software Federation, 44 E. University Dr., Arlington Hts., IL 60004 (Tel: 312-259-1355).

TRS-80 Hard Disk. The Model LS525 Hard Disk System has a five-megabyte capacity that can be partitioned into one to four partitions at user option using the special hard-disk version of LDOS.

The RCA VP3501 Videotex Data Terminal has r-f modulator and modem.

$1995. Host adaptors for the Model III or Model I is $250. Special hard disk version of LDOS is $160. **Address:** Laredo Systems, 2264 Calle de Luna, Santa Clara, CA 95050 (Tel: 800-538-5137).

Software

ZX-81 Chess. ZXCHESS requires 16K of memory and has seven levels of difficulty. There is a detailed playing board display, and players can change sides or levels during a game. The program allows the computer to recommend a move if desired. $24.95 (plus $1.50 postage and handling). **Address:** Softsync Inc., P.O. Box 480, Murray Hill Stn., New York, NY 10156 (Tel: 212-685-2080).

CP/M Pilot. Nevada PILOT is an implementation of the string-oriented language that meets all PILOT-73 standards. Many features have been added to this CP/M version. These include integrated full screen text editor, and the ability to drive optional equipment such as video tape recorders and voice response units. Requires 32K RAM, one disk drive, and terminal/video display board. $149.95. **Address:** Ellis Computing, 600 41st Ave., San Francisco, CA 94121 (Tel: 415-751-1522).

PET/CBM Games. A number of games for the PET or CBM machines are described in a flyer from Computer-Mat, Box 1664, Lake Havasu, AZ 86403.

Heath/Zenith Spooler. SPOOL-N-GO is a timesharing printer spooler that runs under HDOS allowing it to print text from both disk files and running programs. It occupies less than 3K of RAM and operates with most serial printers. Available for 3.2. Comes on 5" hard or soft sectored HDOS diskette. $29.95 plus $2 postage/handling. **Address:** The Software Toolworks, 14478 Glorietta Drive., Sherman Oaks, CA 91423 (Tel: 213-986-4885).

TRS-80 Morse Code. Code Class is a machine-language program for the TRS-80 Model I or Model III that assumes no prior knowledge of Morse code. It has 11 lessons that gradually improve the user's Morse speed. It also enables practicing receiving and transmitting the code (via an optional interface). Requires 16K and BASIC, Morse key, Macrotronics Ham Interface, and an external audio amplifer. $29 for cassette, $39 for disc. **Address:** Macrotronics, Inc., 1125 Golden State Blvd., Suite G, Turlock, CA 95380 (Tel: 209-667-2888).

Apple Accounting. The Home Accountant requires an Apple II, one disk drive, 48K, Applesoft in ROM, and a 132-column printer. The package offers a 100-budget category and keeps track of up to five checking accounts, cash, and credit cards. Prints checks, balance sheet, and net worth statement. Allows multiple diskettes, fast bank reconciliation, and automatic transfers. It also provides custom search and retrieval, and graphics via bar, line, and trend analysis. $74.95. **Address:** Continental Software, 16724 S. Hawthorne Blvd., Lawndale, CA 90260 (Tel: 213-371-5612).

CP/M Educator. The EC-1120 CP/M Operating System Course requires no previous background in CP/M. Written in an audio-tutorial format, the course includes a 500-page self-instruction text and five audio cassettes. Version 2.2 and earlier versions of CP/M are covered in the 10 units of the course. Among the subjects covered are basic commands, diagnosing causes for errors, using CCP, transient programs, using STAT, CONFIGUR, PIP, ED, XSUB, SUBMIT, and combined commands. A number of exercises are provided, requiring a CP/M capable computer. $99.95. **Address:** Heathkit/Zenith Educational Systems, Dept 350-415, Benton Harbor, MI 49022.

New on the SOURCE. Several new services are to be added to the SOURCE during 1982. These include MAILGRAM, an on-line composition and delivery of Mailgrams with next day service which includes filing and maintaining lists of Mailgram recipients (a forerunner of the U.S. Postal Service E-COM); PARTICIPATE, a sophisticated networking concept; Electronic Encyclopedia, the Academic American Encyclopedia from Arete; Yellow Pages, a listing from major metropolitan areas; Legi-Slate, weekly update on all House and Senate legislation reported out of committee that includes keyword search and brief summary of each item; Media General, a comprehensive report on over 3,100 common stocks; and SourceCable, a consumer information service for cable-TV systems. **Address:** Source Telecomputing Corp., 1616 Anderson Road, McLean, VA 22102 (Tel: 703-821-6660).

Compuserve PE. If you are on Compuserve, pop over to PEM1 and take a look at POPULAR ELECTRONICS' "electronics magazine." It includes an interactive bulletin board, club news, club directory, and lots of other interesting items.

TRS-80 Synthesizer. The Software Synthesizer features white noise, frequency and pulse width modulation, variable duty cycle, white noise superimposed on square wave, and fully variable glissando. It can produce two tones at one time. It has a 300-note buffer, full edit capability, error trapping, and user prompts. It uses the cassette output of the TRS-80. $24.95. **Address:** K&K Computer Peripherals, 4262-9 Crooked Tree, Wyoming, MI 49509. ◇

SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

Reflections on the Pocket Calculator

WHILE visiting a department store recently, I noticed a special sale on Unisonic® 940 pocket calculators. This calculator, about the size of a bar of soap, has a highly visible, 8-digit, electrofluorescent display. It also has a fully addressable memory and both square root and percent keys.

The sale price for this calculator was an incredible $2.97! I bought some for my family and a few extras to be modified into counters and timers.

It's hard to believe how a calculator can be profitably manufactured and retailed for less than three dollars. Perhaps the models I bought were obsolete because of more attractive liquid crystal versions that use much less power. In any event, the $3 calculator is light years away from the first pocket calculators, which cost several hundred dollars about a decade ago.

I remember those early calculators very well. Their high prices kept them beyond the reach of most experimenters and hobbyists until November 1971 when POPULAR ELECTRONICS featured on its cover an 8-digit, 4-function calculator which was available in kit form from MITS, Inc. for the price of "only" $179. A digital calculator for under $200 was a real breakthrough.

Introduced before the availability of microprocessor-like calculator chips, the Model 816 used six LSI chips. MITS eventually introduced a line of single-chip calculators, several of which were featured as construction articles in POPULAR ELECTRONICS. Back then, LEDs were the most popular display medium, and the management at MITS eagerly awaited the day readouts would cost them "only" a dollar per digit in very large production quantities. Today one can buy surplus LED calculator displays for as little as a nickel per digit!

The calculator industry made a giant step forward with the introduction by Hewlett-Packard in 1972 of the first *scientific* calculator, the famous HP-35. For $395, the HP-35 provided keys for trigonometric, exponential, and logarithmic functions, as well as square root, pi, reciprocal, and memory. In short, the HP-35 provided an electronic replacement for the venerable slide rule. Not only was the HP-35 much faster than the slide rule, it was more accurate.

In the decade since the introduction of the HP-35, dozens of scientific calculators have become available for ever decreasing prices. Sharp's EL-5813, for example, is a slim, liquid-crystal display model with more functions than the HP-35, plus 30 steps of programming. Priced at about $35, its inflation corrected cost is only about 5 percent of the original price for the HP-35!

Only a few American manufacturers of scientific calculators have survived the increasing competition of Japanese calculator firms. One is Texas Instruments. Its most advanced scientific calculator is the TI Programmable 59, a programmable model that sports a built-in magnetic card reader and a receptacle that accepts any of a wide range of ROM modules that have been factory loaded with preprogrammed software.

A decade after the HP-35, Hewlett-Packard still makes the most advanced scientific calculator, the HP-41C. The HP-41CV is an identical model with five times the memory.

The HP-41 has an alphanumeric, liquid-crystal display and four receptacles for various kinds of plug-in modules. External peripherals such as a printer, bar-code reader, a mass storage unit, and a versatile interface link can be connected to the HP-41 by means of the receptacles. There's even a miniaturized magnetic card reader that attaches to the top end of the calculator. The HP-41C can accept up to 400 program lines before an external memory cartridge is needed. The HP-41CV can accept 2000 program lines.

All these advanced features notwithstanding, perhaps the most unique aspect of the HP-41 is its remarkable user-definable, alphanumeric keyboard. Briefly, nearly any of its 35 keys and their secondary functions can be reassigned the function of any other key when the calculator is switched to a special USER mode. You can even assign programs you have written to various keys for single-key execution.

Plastic keyboard overlays and self-adhesive labels allow HP-41 owners to custom design their own calculators! Thanks to the alphanumeric display, the calculator can provide visual prompts for information after a key is pressed, thereby negating the need for a special list of program operating instructions.

When my HP-41 is placed in USER mode, it becomes a highly specialized machine that can quickly solve problems in lightwave communications and optical radar. It can also tell me the series resistance required to bias a light-emitting diode at a given current level for a particular forward voltage. Here's the program listing:

```
01 LBL "LEDR"
02 "FORWARD V?"
03 PROMPT
04 ENTER
05 "LED V?"
06 PROMPT
07 -
08 "LED I?"
09 PROMPT
10 /
11 "LED R="
12 ACRL X
13 AVIEW
14 BEEP
15 PSE
16 PSE
17 GTO "LEDR"
18 END
```

This program is assigned to the RTN key on my HP-41. Here's a typical exchange after the new LEDR key (RTN in USER mode) has been pressed:

HP-41: FORWARD V?
USER: 5 (press R/S)
HP-41: LED V? (LED voltage drop)
USER: 1.7 (press R/S)
HP-41: LED I? (desired LED forward current in amperes)
USER: 0.020 (press R/S)
HP-41: (BEEP) LED R = 165.00 (ohms)

After a second or so, the answer is replaced by the FORWARD V? prompt. The program can be adapted for use with a printer by replacing the PSE (pause) statements with a single PRX (print X register) instruction. Many other variations are also possible since editing HP-41 programs is exceptionally easy. The calculator can even be programmed to turn itself off after it has processed a program. The results can be printed, or stored in the machine's continuous memory for later readout.

Is the HP-41 an advanced programmable calculator or a handheld computer? Though the HP-41 doesn't understand BASIC or other higher level languages, it does have many features characteristic of computers. I like to think of it as a hand-held computer with an advanced calculator-style language.

Of course, for those who prefer BASIC, true handheld computers are now available. If it took only a decade for the first scientific calculator to evolve into the handheld computer, think what the next decade might bring. It doesn't take much imagination to envision pocket computers with large-area liquid-crystal displays that show several program lines or graphics. Of course, large amounts of self-contained memory will be a standard feature.

The New Solid-State Relays. SCR and triac circuits billed as solid-state relays have never managed to match the very low contact resistance of conventional electromagnetic relays. However, a new kind of solid-state relay is going to rectify this situation.

The new relays use power FETs in their output stages having an on resistance as low as 0.3 Ω. This ultra-low resistance is made possible by the incorporation of many thousands of identical, parallel-connected FETs onto the surface of a single silicon chip.

A development of Teledyne Relays (12525 Daphne Ave., Hawthorne, CA 90250), the new relays are far more than simple FET switches. They also include a CMOS compatible input Schmitt trigger that increases noise immunity. An optoisolator protects the input from output transients of up to 1,000 V. The relays also incorporate circuitry to eliminate or greatly reduce the noise spikes that are characteristic of conventional SCR and triac relays. This is accomplished by controlling the switching time of the output FET.

The circuits which provide these features are hybridized on a tiny pair of stacked boards and housed in a hermetically sealed, square can that measures only 0.37 x 0.37 x 0.23 inch. An alternate, DIP compatible package option measures 0.5 x 0.9 x 0.2 inch.

Don't expect to rush out and buy one of these new solid-state relays just yet. The cost of one model, the 690-1, is $41 each in lots of 100.

The good news, of course, is that the availabity of low on-resistance, power FETS means budget-minded experimenters, technicians and engineers can design and make their own FET solid-state relays.

High Speed Logic. Emitter-coupled logic (ECL) is considerably faster than standard transistor-transistor logic (TTL). Motorola (Box 20912, Phoenix, AZ 85036) has recently added an even faster line of ICs to its MECL family.

Designated the MECL 10KH series, the new chips provide a 100% improvement in propagation delay over the standard MECL family, with no increase in power consumption.

The gate propagation delay for the MECL 10KH series is only one nanosecond. The improvement in rise and fall times over the standard MECL 10K line is shown clearly in scope photographs reproduced on the data sheets for the new chips. For example, here are the rise and fall times for the NOR outputs of the 10K and 10KH versions of Motorola's MECL triple line receiver:

	MC10K116	MC10KH116
Rise Time	1.86	1.12
Fall Time	1.74	1.08

(Times shown are in nanoseconds.)

Other chips in this new family include the MC10KH104 quad two-input AND gate, the MC10KH107 triple two-input Exclusive OR/NOR gate, the MC10KH109 dual four-five input OR/NOR gate and the MC10KH131 dual D Master-Slave flip-flop.

Because of their ultra-fast switching times, ECL chips require special attention to lead dress. For some basic operating tips about how to use ECL chips, see "Experimenter's Corner" in the October, 1981 issue of this magazine.◇

EXPERIMENTER'S CORNER

By Forrest M. Mims

A Single-Channel Infrared Remote-Control System

NEAR-INFRARED radiation is well suited for use as a carrier of trigger signals in miniature remote-control applications. No governmental rules or regulations apply to remote-control systems triggered by radiation from near-infrared emitting diodes. Such systems are less susceptible to false signals than similar systems using ultrasonic sound. Furthermore, infrared transmitters can be very compact in size.

However, a 100-mW radio remote-control system does have some advantages. For instance, it can broadcast through obstacles such as foliage, haze, and walls; and its omnidirectional range may easily exceed a city block. Though near-infrared cannot penetrate such obstacles, the use of small lenses at the transmitter and receiver can extend the range of the system to many hundreds of feet. In some applications the pointing problems associated with the narrow beam of such a system are a distinct disadvantage. In applications requiring a high degree of security, however, a narrow beam can be a major asset.

In most cases, radio edges out near-infrared long-range remote-control systems. Infrared, however, can be the clear winner in applications where the distance is under a few tens of feet. Typical applications include remote-controlled garage door openers, TV sets, toys, lamps, and various other devices and appliances.

Single-Channel Remote Control Systems. There are several approaches to single-channel remote control. The most common is the analog of the momentary-contact, push-button switch. The controlled device is actuated only when the transmitted signal is being received. When the transmitted signal is absent, the controlled device is no longer actuated.

Another, less common approach resembles the mechanical push on/push off switch. In this method the controlled device is actuated when a signal, however brief, is received. It remains actuated until another signal pulse is received.

For the purpose of this column, let's designate the first remote-control method Actuated when Pushed or AP for short. We'll call the second method Push On/Push Off or simply PO/PO.

Figure 1 illustrates in block diagram form how both these methods can be implemented. Note that both systems can use the same tone-modulated transmitter. Also note the receivers for both methods share a common detection-preamplification-tone decoding front end.

A simple power amplifier that drives a relay, lamp, or other device completes the receiver that uses the AP approach. The PO/PO receiver requirements are more complex since false signals from inadvertent mutiple input signals must be ignored. This problem is analogous to the well-known contact bounce phenomenon that accompanies the opening and closing of most mechanical switches.

Referring again to Fig. 1, the output from the tone decoder is fed into a one-shot multivibrator that effectively stretches the incoming tone burst from the transmitter into a logic pulse having a duration of several seconds. This pulse sets the flip-flop.

During its timing cycle, the one-shot ignores subsequent input signals from the transmitter. When the timing cycle is complete, the one shot will trigger on the next arriving pulse and, in turn, reset the flip-flop. The set-reset cycle of the flip-flop provides the desired PO/PO action.

Tone-Modulated Transmitters. Figure 2 shows a simple tone-modulated, near-infrared transmitter suitable for short-range, remote-control applications. When *S1* is pressed, *LED1* emits a train of pulses at a frequency determined by *R1*'s setting.

Resistor *R3* limits the current through LED1. Its resistance can be reduced for more current per pulse, hence higher infrared output, as long as the LED's peak current rating is not exceeded. If the LED's forward voltage is 1.5 V, a value typical of some gallium-arsenide devices, then the peak current is given by

$$I = (V_{in} - 1.5) / (R3 + R_{DS})$$

where V_{in} is the power supply voltage and R_{DS} is the drain-source *on* resistance of *Q1*.

The R_{DS} of the VN10KM specified in Fig. 2 is about 5 ohms. Therefore, the peak current through LED1 in Fig 2 is (9-1.5)/(100+5) or 71 mA. This is *well* within the safe operating range for pulsed operation of most near-infrared LEDs. Many LEDs can be driven to a couple of amperes by microsecond pulses as long as a high duty cycle is avoided to prevent excessive heating.

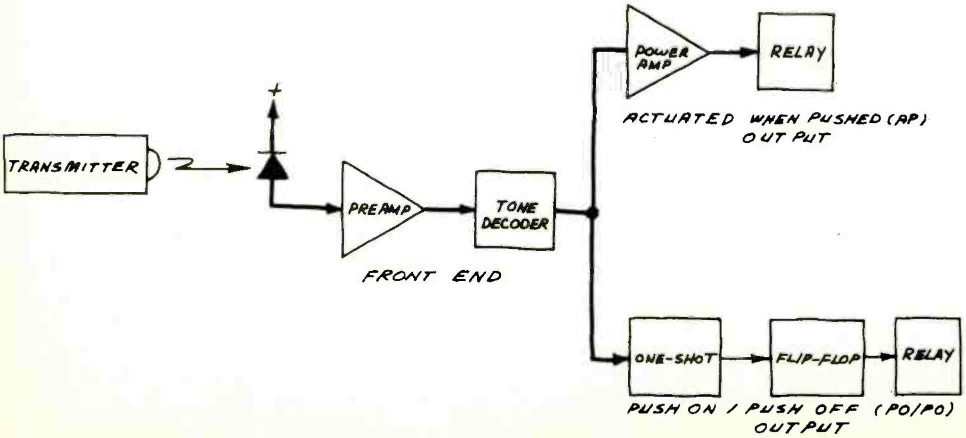

Fig. 1. Block diagram of a single-channel remote-control system.

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Incidentally, a CMOS 7555 timer can be substituted for the 555. Similarly, a 2N2222 or similar npn driver transistor can be substituted directly for the VN10KM power FET. Connect the base to pin 3 of the 555, the collector to *R3* and the emitter to the anode of *LED1*.

Figure 3 shows an alternative transmitter you may wish to construct. (Regular readers of this column may recall this circuit from previous columns.) It's exceptionally efficient and will easily deliver 1.1-A pulses to the LED. It may not be as reliable, however, and it may consume excessive current. For additional details, refer to the "Project of the Month" in the July 1979 issue of POPULAR ELECTRONICS.

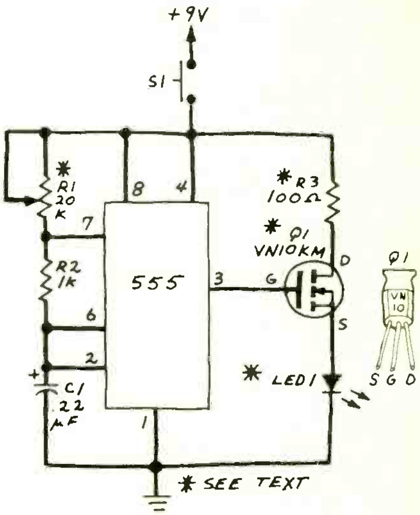


Fig. 2. Infrared remote-control transmitter.

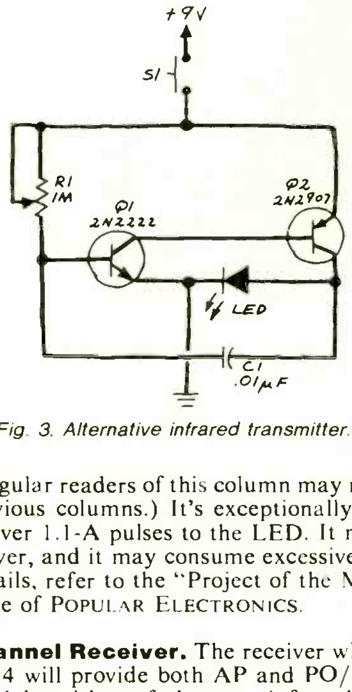


Fig. 3. Alternative infrared transmitter.

A Single-Channel Receiver. The receiver whose circuit is shown in Fig. 4 will provide both AP and PO/PO operation when triggered by either of the near-infrared transmitters described above. The circuit is reasonably sensitive and will not trigger in the presence of line-powered, hence 60-Hz modulated, incandescent and fluorescent lamps.

For example, a tungsten desk lamp placed within a few millimeters of the circuit's photodiode failed to trigger the circuit. Also, the full flash from a Vivitar 283 photographic strobe unit placed 15 cm from the photodiode also failed to initiate a false trigger. However, flashing the strobe closer to the photodiode did cause a false trigger.

In operation, near-infrared from the transmitter is detected by reverse-biased photodiode *D1*. The resultant photocurrent is then amplified by an LM308 op-amp connected as a high-gain, current-to-voltage converter. The amplified signal is coupled via *C3* into a 567 tone decoder tuned to a center frequency of about 3 kHz.

When the 567 receives an in-band signal, pin 8 goes low.

This turns on *LED1* and provides an AP output signal that can be used to drive a small relay or turn on a transistor. In Fig. 4, however, the signal from pin 8 is used to trigger a CMOS 4528 one-shot multivibrator. The 4528 then issues an output pulse that turns on *LED2* and sets the 4027 flip-flop. The flip-flop's Q output then turns on *LED3* and *Q1*, which, in turn, pulls in relay *K1*.

The time delay provided by the 4528 is determined by *R6* and *C7*, either or both of which may be increased to further stretch the incoming tone burst into a longer logic pulse. The values in Fig. 4 give a timing interval of a few seconds.

To preclude triggering on switching transitions and other noise generated within the circuit, it is essential to include capacitors *C8* and *C9*. Both should be placed as close as possible to the 567 power supply pins. If false triggering occurs or if the circuit appears to operate erratically, it may be necessary to install additional 0.1-μF decoupling capacitors directly across the power supply pins of the LM308 and the two CMOS logic chips. Incidentally, be sure to ground all unused inputs of both CMOS chips. Both chips are dual versions, and floating inputs to the unused side may cause excessive current consumption, overheating, and erratic circuit operation.

The LM308 is ideally suited for this circuit. In a pinch you can substitute a 741 or other op amp, but for best results use an LM308. If you have to get it from a mail order company, you might want to buy a few extras. Use them to make low-noise, high-gain amplifiers having a high input impedance.

For best results, avoid substituting a phototransistor for *D1*. While phototransistors will work very well in subdued light, they quickly saturate in the presence of even moderate light levels.

I used a Texas Instruments TIL413 photodiode for *D1*. This low-cost photodiode, which is available from Radio Shack is equivalent in quality to photodiodes that cost considerably more. It incorporates a built-in epoxy lens designed to filter out visible radiation while transmitting near-infrared.

Testing the System. Proper operation of the receiver requires that the tone frequency of the transmitter match closely the center frequency of the receiver's 567 tone decoder. The values shown in Fig. 4 give a center frequency of about 3 kHz. If this frequency is acceptable in your application, *slowly* tune the transmitter while pointing its LED toward the receiver's photodiode.

Indicator *LED1* will flicker as you tune the transmitter through the 567's center frequency. When this occurs, carefully "tweak" the transmitter's tone frequency to give a bright, steady glow from *LED1*. Then move the transmitter LED away until *LED1 just* stops glowing. Again "tweak" the transmitter's tone frequency until *LED1* glows. This optimizes the tuning for the receiver.

The circuit should now operate as follows:

1. Initially, *LED2* glows to indicate the receiver is ready to receive a signal. *LED1* and *LED3* are off.
2. *LED1* glows when a signal is present *and* being received.
3. *LED2* turns off immediately after *LED1* turns on. Note that even the slightest flicker from *LED1* is sufficient to insure that *LED2* will be extinguished.
4. *LED3* switches on or off to indicate the status of the relay. When *LED3* is glowing, the relay is pulled in.
5. *LED2* glows again after the time delay is complete. The receiver is now ready to receive another signal.

Note that if the transmitter is pointed at *D1* for an interval longer than the time delay of the one-shot, *LED2* will turn back on to indicate the receiver is ready to receive another command. If the transmitter is still sending infrared signals to *D1* and is then moved away or turned off, the receiver will be triggered a second time. The flip-flop will then be reset, and the device just actuated will be deactuated. In other words, for true push-on/push-off operation, the transmitter should be operated for only a moment *or* used to sweep a flash of infrared pulses across *D1*.

For more information on advertised products, equipment tested, etc., circle appropriate number on postpaid Free Information Card.

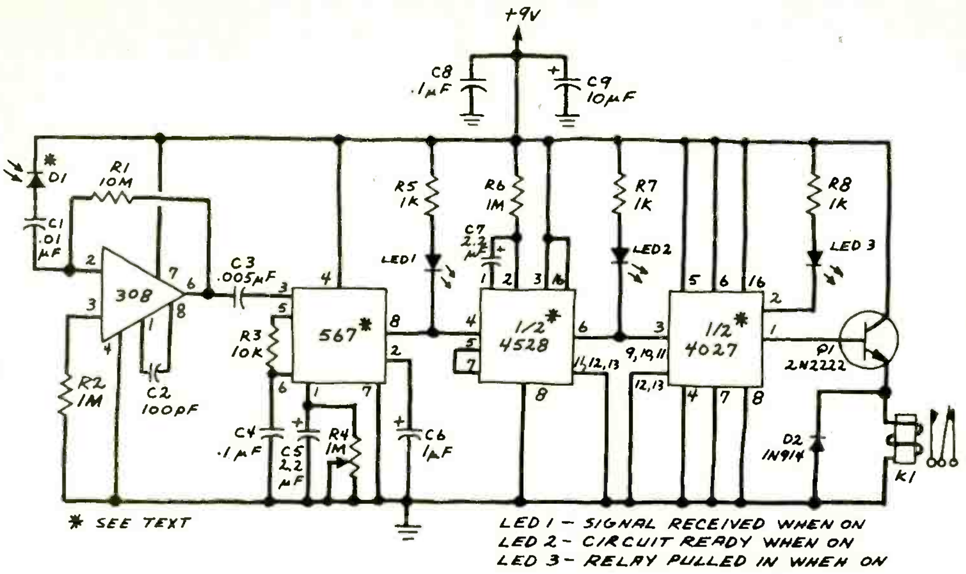


Fig. 4. Complete schematic for an infrared remote-control receiver.

If the circuit appears unreliable, the problem may be associated with properly pointing the transmitter at the receiver. For example, since the 567 requires a minimum number of pulses to acquire lock, a very brief sweep of the transmitter beam across the receiver's photodiode may *not* trigger the circuit, particularly at longer ranges. For this reason it's a good idea to stay with the 3-kHz operating frequency of the system by using the parts values given in Fig. 4.

Low battery voltage and temperature changes can also cause problems. Weak batteries, for instance, may alter the frequency of the transmitter and the center frequency of the receiver. This problem can be alleviated by making sure fresh batteries are used (alkaline batteries will provide good service). Alternately, you can design a line-powered supply or use a voltage regulator chip.

Construction Tips. *Before* building a permanent version, be sure to assemble a test version of the circuit on a solderless breadboard. This way you can test and evaluate its operation and correct any bugs. This step is important since properly tuning and operating the system can be a little tricky.

Be sure to consult the 567 data sheet/application note before attempting to make major changes in the receiver's detection frequency. For instance, the 567 may require a second or more to respond to very-low frequency signals. The data sheet/application note clearly explains this and other operating idiosyncrasies of the 567.

My system gave a range of more than eight feet without external lenses. Doubling the diameter of the photodiode's collection surface will double the range. Narrowing the beam of the transmitter with a suitable lens will give an even greater improvement in performance.

A range of hundreds of feet should be possible with patience and careful attention to detail. But make sure the system works well in the breadboard stage *before* trying such an ambitious range test. A light shield such as a hollow tube lined with black paper or coated with flat black paint might be helpful when the receiver is used in the presence of bright sunlight. Place the tube over *D1* and avoid pointing it at brightly illuminated objects and clouds. An infrared filter can also be used.

Applications. I have used this system to turn the sound of a television off when loud commercials interrupt news programs. The receiver and an external speaker box are connected to the TV's earphone jack by a short cable. This automatically disconnects the TV's internal speaker. The relay in the receiver then switches the external speaker on or off.

I plan to use this or a similar system to remotely control a toy car and a camera. You can probably think of many other applications. In any case, be sure to follow appropriate safety procedures should you use the receiver to actuate line-powered devices. You should avoid using this system in any application which might endanger people or property. For example, using it to control a garage door would require the inclusion of appropriate limit switches and other safety precautions to prevent accidents resultant from erratic operation.

Also, bear in mind the limitations of any remote control system. For example, if this system is used to control a toy boat and the boat exceeds the reception range of the system, you will have a problem. If AP operation is used, the boat will simply ignore the transmitter; if PO/PO operation is used, the boat will continue to follow the last command it received. ◇

NEW LITERATURE

Photo-Voltaic Products Catalog

Photo-voltaic cells and panels are the main feature of the new "Solar Wonderbook" mail-order catalog from Energy Sciences Company, a subsidiary of Solarex Corp. The catalog concentrates on equipment for building practical solar electric systems, e.g., for wilderness homes, farms, and supplemental household electric power. Other sections feature science education kits and books on energy topics. Cost is $3. **Address:** Energy Sciences, 832 Rockville Pike, Rockville, MD 20852.

Earth-Station Products

Blonder-Tongue Laboratories, Inc. is offering a new brochure which describes and illustrates the B-T line of TVRO Earth Station products. Five basic systems, each applicable to a specific geographic area, are detailed along with a reference map to assist a potential user in his product selection. **Address:** Blonder-Tongue Labs, Inc., One Jake Brown Road, Old Bridge, NJ 08857.

Shure Catalog

Shure Brothers, Inc. has released a new Microphone and Circuitry Products Catalog, said to be their most comprehensive yet. The catalog features a selection guide that offers suggestions for product applications; as well as a new indexing format that cross-references similar products and provides technical specs for them. The catalog is 72 pages long, and describes over 150 microphones and accessories for amateur and professional use. **Address:** Shure Brothers, Inc., 222 Hartrey Ave., Evanston, IL 60204.

Computer Graphics Brochure

Digital Engineering, Inc., a company involved in upgrading standard alphanumerics terminals to full graphics and color-graphics, has issued a new brochure describing its organization and products. Entitled "Digital Engineering—A Product Perspective", the publication provides a six-page overview of Retro-Graphics enhancements for terminals without graphics. **Address:** Digital Engineering, Inc., 630 Bercut Drive, Sacramento, CA 95814.

Projection-TV Manual

A new 16-page manual, titled "How to Build a Giant Screen Television System," is available from Projectapix. The manual provides instructions for building projection TV systems from four to seven feet (measured diagonally). It is assumed you already own a 10" to 17" TV, and have some familiarity with the electronics appropriate to TV repair. A copy of the manual is available for $1. **Address:** Projectapix, Ltd., 300 W. 53 St., New York, NY 10019.

ELECTRONICS LIBRARY

Computer Peripherals for Minicomputers, Microcomputers, and Personal Computers

by C. Louis Hohenstein

Peripherals transfer information in and out of the computer. This book describes those commonly encountered, what each one does, where it should be used, and how it works. For example, printers (impact, optical, thermal, etc.); CRT displays and their ancillary equipment, such as cursors and light pens; graphics plotters; keyboards: position digitizers (joysticks, track balls, and image digitizers); optical readers; modems for synchronous and asynchronous transmission; and memory peripherals (magnetic tape and disk, punched cards and tape, semiconductor memory, and bubbles). Attention is given to the data processing concept that applies to each peripheral, e.g., FM coding and magnetic disks. Also discussed are the more exotic peripherals, such as plasma displays, speech synthesizers, and optical readouts. The language of the book is nontechnical, and the topics covered are relevant even to the user of a personal microcomputer. The illustrations, also, are copious and good.

Published by McGraw-Hill, 1271 Avenue of the Americas, N.Y., N.Y. 10020. Hard cover. 312 pages. $19.50.

How to Tune the Secret Shortwave Spectrum

by Harry L. Helms

Clandestine broadcasters are stations whose programs are intended for reception by a certain region or segment of the world's population. They are distinguished from ordinary broadcasters by any or all of three factors: they are extralegal in some respects; they are political creations; and there is some element of deception in their operation. In one of the most interesting books on DXing I have run across, Harry Helms describes the range of clandestine radio stations—from those operated by anticommunist guerrillas in Southeast Asia, to Soviet manned-spaceflight communications, to high school r-f bootleggers in Minnesota. And there's more: Basques who seem to be transmitting from northern Spain, but whose transmitter is actually in Venezuela; strange coded messages originating in South Dakota, whose purpose is unknown but presumed to have something to do with the Minuteman missile fields; spy rings in Croatia; you-name-it. If you want to check some of this stuff out on your own set, the author gives lots of frequencies and times to choose from, plus suggestions about the equipment you'll need.

Published by TAB Books, Inc., Blue Ridge Summit, PA 17214. Soft Cover. 182 pages. $6.95

Experiments in Artificial Intelligence for Small Computers

by John Krutch

Artificial Intelligence (AI) is usually associated with big main-frame computers and exotic programming that only a few academics can understand. Here is a book that explores the possibilities for using your home computer to develop some simple programs in AI. There is not much theoretical discussion, but the author has provided complete programs in BASIC for such applications as checkers, geometric analogies (like the kind found in IQ tests: a is to b, as c is to . . .), and simple syllogisms. (Socrates is a man. A man is mortal. Socrates is mortal.) Also discussed are more abstractly verbal programs such as those for generating verse and prose; as well as natural language dialog between computer and user. The book is short, but thorough in the areas it covers.

Published by Howard W. Sams Co., 4300 W. 62nd St., Indianapolis, IN 46268. Soft cover. 110 pages. $8.95.

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.)

RCA series RC-19 receiving tube. Need manual. Frank Gasnik, R. 1, Box 294, Sebring, FL 33870.

Holden Electronics r-f power amplifier. Need any information available and schematic. Ral Stallsworth, 3506 Moffat, Toledo, OH 43616.

Lafayette Model LA 524 4-channel amplifier. Need service manual and schematic. E. Eustache, 13 N. Shekin St., Mt. Vernon, NY 10550.

Dumont Model 324 oscillograph. Need owner's manual and schematics. A.R. MacHattie, Rd. 4, Box 26, Pine Avenue, Scotia, NY 12302.

Seeburg Model HFA 3-56 power amplifier and **Morley** Model EV0-1 stereo echo volume pedal. Need schematics. E.A. Bathgate, P-3908, Box 200, Camp Hill, PA 17011.

Heath Model 0P1 oscilloscope. Need power transformer. Gerald R. Perry, 141 Susan Dr., New Port Richey, FL 33553.

Precise Development Corp., Model No. 116 tube tester. Need schematic and roll charts. George M. Collins, Box 212, Noblesville, IN 46060.

Philco Model 28 and **Sparton** Model 1271 receivers. Need schematic diagrams and service data. John Roland, Box 64, Downieville, CA 95936.

BLJ Model 300 linear amplifier. Need schematic and any other information available. Jack Fernandes, 17 Germantown Rd., Danbury, CT 06810.

Singer Models RF10, and SPA 10 spectrum analyzer. Need schematic. J. Dieringer, 1517 S. Highland Ave., Los Angeles, CA 90019.

Hickok Model 670 oscilloscope. Need schematic and manual. Gayne L. Jones, 10071 N.E. South Beach Dr., Bainbridge Island, WA 98110.

Packard-Bell Model 5M AM radio, **RCA** Model 8BX6 AM radio, and **Knight Kit** Model 620-A multimeter. Need schematics. David J. Hamm, 502 Winston Circle, Selma, NC 27576.

Superior Instruments Co., Model 8Z0 rapid tube tester. Need operating instructions and tube charts. Aubrey Alexander, 6120 Benjestown Rd., Millington, TN 38053.

Sears Serial #873B2111 solid-state 8-track AM/FM phonograph and **General Electric** 82324 recorder. Stan Giaczas, RT. I, Box 586, HTI, Waupaca, WI 54981.

Hammarlund HQ 160 receiver. Need schematic and operating manual. John Bowles, Rt. 1, Box 147, Coffeen, IL 62017.

Bell Sound Systems Model 2200C high fidelity tube amplifier. Need any information available. Brian Harwell, 216½ E. 10th, Apt. 4, Okmulgee, OK 74447.

Concord Model 800 video tape recorder. Need service manual. Frank V. Larkin, 9 Bainbridge St., Islip, NY 11751.

Heathkit Model IO-14 oscilloscope. Need # HV-173 gas filled corona discharge tube or substitute for scope modification. R. N. Baughman, 572 Strumbly Dr., Highland Hts., OH 44143.

Kenwood KS3000 stereo receiver. Need schematic. Clyde Goodman, Hamlet's Gap, Hindsbury Rd., St. Michael, Bridgetown, Barbados.

Century Electronics Model FC2 tube tester. Need instructions. John E. Jones, Box 236, Charlestown, IN 47111.

Hallicrafters Model S-85 receiver. Need alignment information and manual. L. W. Gregg, 65 Holiday Lane, RR. 2, Riverton, IL 62561.

Hickok Model RF0-5 oscilloscope. Need manual and technical information. Kenneth Miller, 10027 Calvin St., Pittsburgh, PA 15235.

Midland Model 11-500 receiver. Need 5X4, 6U7G and 6K7G tubes. Bill Gilbert, WDX2RVW, 26 Terrill Lane, Kings Park, NY 11754.

Sencore Inc., Model FE 16 meter. Need high voltage probe 39A19. **RCA** Model WO91B oscilloscope. Need manual and schematic. J.P. Wilson, 528-532 First National Bank Bldg., Springfield, OH 45502.

Fingerhut Serial #04878 DAG Cariole AM/FM 8-track stereo. Need schematic. Namon H. Smith, 29706 Ailanthus Dr., Flat Rock, MI 48134.

Heathkit Model BR-2 receiver. Need schematic. Archer RS1755 Cat. No. 276-1755 MOS/LSI integrated circuit digital clock/calendar. Need schematic and parts list. Richard Lim, 805 North Third St., Montebello, CA 90640.

Packard Bell Model 5MC2P dual-trace oscilloscope. Need owner's manual and schematic. D. Tavares, 22926 Ward St., Torrance, CA 90505.

Delta Data System Model 5000 (also called Telterm) terminal. Need wiring diagram. Also **Pendar** No. 721017 keyboard. Need diagram. Aurelien Boisvert, 4830 Des Pervenches, Orsainville, Quebec, Canada G1G1R7.

Navy Model TS-239 oscilloscope. Need operating and service information. Tim Rutemeyer, 6513-B Still Meadows Ln., Harrison, TN 37341.

Sherwood Model S-8900A receiver. Need schematic and parts list. Robert Weirich, 5151 N. 87th, Milwaukee, WI 53225.

G.A.S. Thalia II preamplifier. Need schematic and service manual. S. Hult, 887 Raymond Ave., St. Paul, MN 55114.

Hallicrafters Model S40 and **Hammarlund** Model HQ129X communication receivers. Need operation manuals. Bob Langton, 6 Sussex Pl., Deer Park, NY 11729.

Concord Model 880 tape recorder. Need motor and speed selector knob. A.A. Gawlik, 810 Laurann Ave., Tallmadge, OH 44278.

Hammarlund Model SP 600 JX communications receiver. Need manual. Howard Hartzell, Jr., RD #2, Box 489, Mifflinburg, PA 17844.

General Precision Laboratory Model PD-500 television camera, serial #2150. Need schematic. R. Newman, Jr., 11441 Heather St., Coon Rapids, MN 55433.

Rogers Model HG88 MKII amplifier. Need schematic and owner's manual. Brian O'Malley, 5687 Miles Ave #9, Oakland, CA 94618.

Majestic Model 90-B radio receiver. Need schematic, parts or any information available. Patrick W. Gallagher, #1 Grippen Hill Rd., Vestal, NY 13850.

General Electric Model M113AVY B/W TV. Need schematic. Vince Tomalonis, Box 136, Painter, VA 23420.

Crosley Model 169 radio. Need schematic and wiring diagram. W. Giles, 6519 Marsh Ave., Huntsville, AL 35806.

Standard Radio Model SRTV-3 TV. Need service manual, schematic, parts list and owner's manual. W. Ganz, Box 1882, Rockville, MD 20850.

Hallicrafters Model SX25 communications receiver. Need schematic, parts list, diagram and service manual. John Eroh, 1728-C First Ct., Ft. Gordon, GA 30905.

Hallicrafters Model HCM 261 CB transceiver. Need service manual and schematic. D. E. Horn, 466 Bostwick Ave., Janesville, WI 53545.

Fisher Model 800T receiver, Model X202 control amplifier and **Sprague** Model TO-4 analyzer. Need manuals and schematics. J. R. Hetherington, 2820 So. Main, Soquel, CA 95073.

PROJECT OF THE MONTH

By Forrest M. Mims

An Ultra-Simple VMOS Timer

ONE of the challenges of good circuit design is to accomplish the task at hand with as few components as possible. VMOS FETs are often ideally suited for simplifying circuits since they are much easier to use than conventional bipolar transistors.

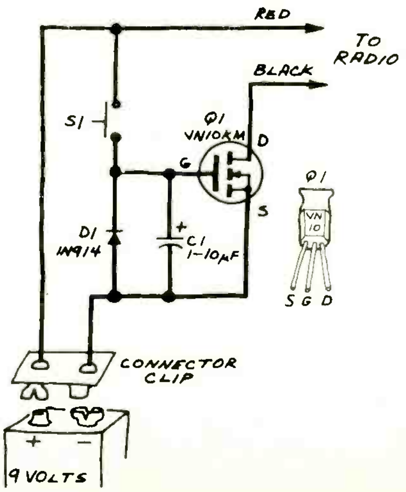
Istvan Mohos of Bergenfield, NJ, has submitted an exceptionally simple VMOS circuit which has several practical applications. Istvan writes, "A friend asked me to build a timer into his transistor radio. He kept falling asleep with the radio on and draining the 9-V battery overnight."

Istvan solved his friend's problem with the simple circuit shown in Fig. 1. He explains, "Pressing the miniature pushbutton switch (Radio Shack number 275-1571) charges the 1.5-μF tantalum capacitor to the supply voltage. The capacitor supplies hole charges to the gate of *Q1*, turning it fully on."

When *Q1* is on, the 9-V battery is connected to the radio through *Q1*. The timing cycle begins as *C1* is slowly discharged through reverse-biased diode *D1*. Why use a diode when a very high resistance resistor would work as well? Istvan explains he used the diode " . . . in place of a 200-300 megohm resistor I wasn't going to find anyway."

Eventually, the charge on *C1* is too small to keep *Q1* fully on. As the charge continues to leak through *D1*, *Q1* is gradually turned fully off. The timing cycle can be reinitiated by again pressing *S1*.

Istvan tried various values for *C1*. "A value of 1.5 μF gave a timing period of 70 minutes," he writes. "During the last few minutes the FET operates in its linear region, slowly pinches off the current to the radio and provides a built-in fade. Both the Radio Shack VN10KM and VN67AF VMOS FETs worked well, but if the radio has a large supply bypass capacitor, the higher power VN67AF is the one to use to avoid troubles with excessive capacitive loading. My friend says he has never slept better."



I've breadboarded Istvan's circuit and can report it works just as he describes it. The circuit is so small it's easy to see how Istvan was able to install it inside his friend's radio.

While experimenting with the circuit, several modifications came to mind. The most obvious is to increase the drive capability of the VMOS FET by inserting a small relay in place of the transistor radio. This would permit the construction of a simple automatic shut-off switch for lamps and appliances. Connect the circuit to your car's headlights, for example, and they will provide light during the several minutes or so it takes you to get to your front door. They then turn off automatically.

The circuit can control low-wattage, low-voltage lamps directly. An interesting aspect of direct control is the gradual dimming of the lamp shortly before it is extinguished. In this role it is important to observe the maximum power ratings for *Q1*.

If you experiment with Istvan's circuit, you may wish to try leaving out *D1* altogether. The natural leakage of the capacitor will still provide timing operation. Depending upon such factors as humidity and the type of board the components are mounted upon, the use of the diode may provide a more consistent timing cycle.

Be sure to experiment with various kinds of capacitors, also. Though tantalums are well suited for this application, even ceramic and other higher leakage capacitors will provide surprisingly long timing periods.

Finally, for precision timing purposes, don't overlook timing chips and binary divider chains designed specifically for that purpose. Coupled with crystal-controlled oscillators, these circuits can provide exceptionally precise timing cycles of weeks, months and even years. Of course, they cost more money, use lots of parts and won't fit inside a transistor radio like Istvan's simple circuit. ◊

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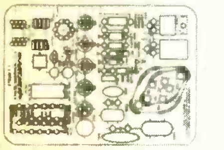

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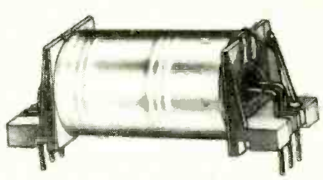

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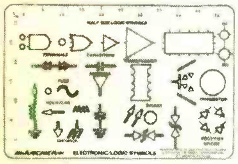

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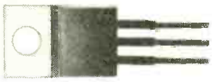

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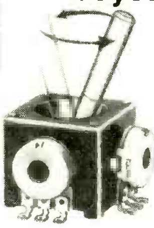

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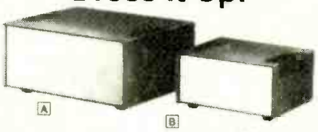

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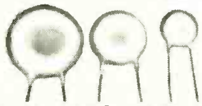

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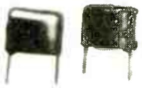

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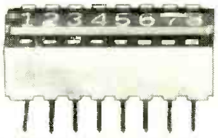

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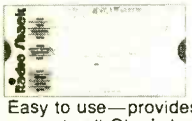

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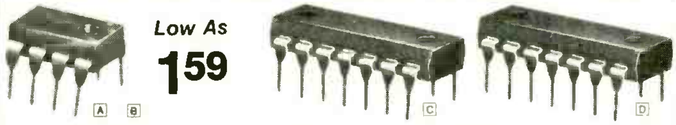

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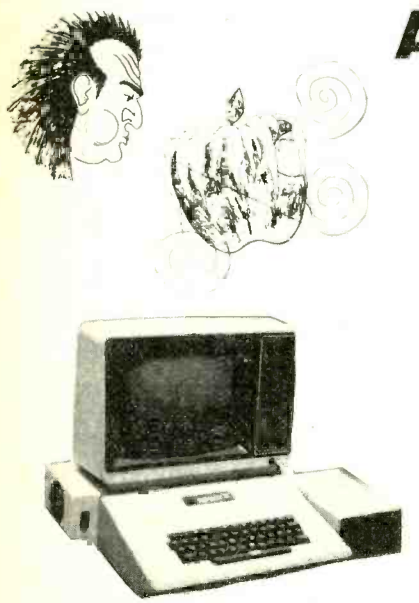

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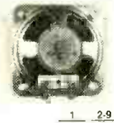
2¼" Round — 8 Ohm
.25 Watt (4" Leads)
Size: 2¼" x ¾"



Part# SF-25016 — 1: 1.39, 2-9: 1.25
2½" Square — 16 Ohm
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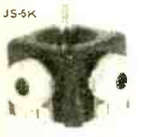
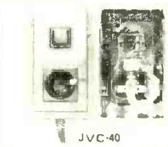

JS-5K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FEATURES
- Adjustable regulated power supplies, pos. and neg. 1.2VDC to 15VDC
- Power Output (each supply): 5VDC @ 500mA, 10VDC @ 750mA, 12VDC @ 500mA, and 15VDC @ 175mA.
- Two, 3-terminal adj. IC regulators with thermal overload protection.
-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

JE215 Adj. Dual Power Supply Kit (as shown) .. $24.95
(Picture not shown but similar in construction to above)
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2650	MPU	16.95
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MM5013N	1024-Bit Dynamic/Accumulator	1.95
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21L02	1024x1 Static	1.95
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MM5262	2Kx1 Dynamic	.49
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2732 (Intel) TI	32K EPROM	17.95
2758	8K EPROM (450ns) (Single +5V)	7.49
2764Q	64K EPROM (Hitachi HN462764)	49.95
5203	2048 PROM	14.95
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MCM66740P	128x9x7 Math Symbol & Pictures	13.50
MCM66750P	128x9x7 Alpha. Control Char. Gen.	13.50

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

SPECIAL FUNCTION

DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
DS0026CN	Dual MOS Clock Driver (5MZ)	1.95
INS1771N-1	Floppy Disc Controller	24.95
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MM58174N	Microprocessor Compatible Clock	11.95
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COP470N	12-Seg. VAC Fluor. Driver (20-pin Pkg.)	3.25

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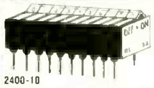
MM57499N	96/144 Key Serial Keyboard Encoder	8.95


2400-10

EECO Rocker DIP Switch — "Mini-Dip™" 2400 Series
THE MOST UNIQUE DIP SWITCH AVAILABLE!

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

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

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GB180 100 pieces Robot/Slot Car Gears, Shafts, Wheels, Motors $9.95

CAPACITORS

Part No	Description	Price
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GB102	60 each Electrolytics	4.00
GB103	40 each Tantalum (tubular & dipped)	4.00
GB176	40 each Dipped Micas .10pf 1000pf (5-100-500V)	4.00

INTEGRATED CIRCUITS

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GB148	30 each Exar - marked (XR320, 1310, 4136, etc.)	4.00
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GB159	6 pcs. Negative Voltage Regulators (TO-3 case) (7905, 06, 12, 15, 18, 24, etc.) Linear marked	4.00
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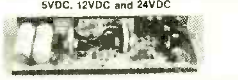

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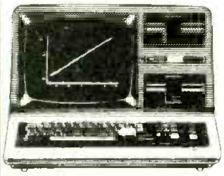

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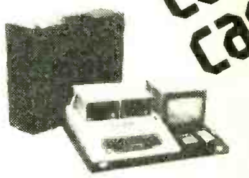

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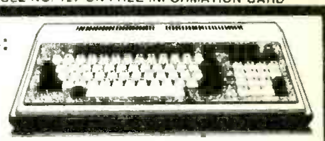

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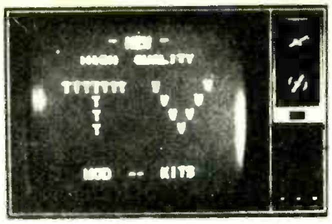

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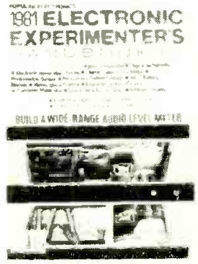

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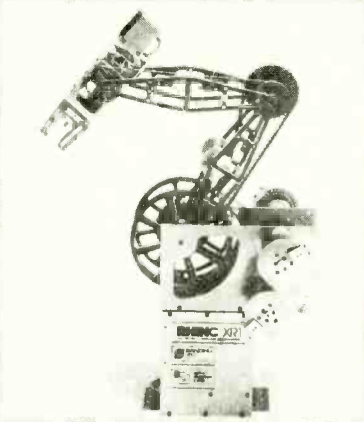
ELECTRONICS WORLD®

Personal Electronics News

LCDs BREAK SIZE BARRIER thanks to a patented manufacturing technique developed by a Norwegian firm, Norsk LCD A/S, a consortium of Dyno Industries and Hansen Vakumroer. Until now, the biggest LCDs on the market measured 3 x 12 cm. The new cells are 30 x 30 cm. Applications include vehicle instrument panels, information display boards, destination panels on buses, etc. According to Norsk, there is no theoretical limit to the size of an LCD; a contract has already been secured to supply a railway station indicator panel that measures three square meters.

DP CAREERS FOR THE HANDICAPPED was the subject of a day-long workshop at a three-day symposium sponsored by Commodore Business Machines. Several hundred severely handicapped persons from throughout the United States travelled to Baltimore to hear from more than 40 experts about career opportunities in the world of computers and data processing.



A TRAINING ROBOT, called the Rhino XR-1, is being marketed by Sandhu Machine Design, Inc., Champaign, IL. The device is said to offer manipulative abilities similar to those of industrial robots, but is less expensive because it does not need to provide industrial-strength lifting and gripping force. Rhino is completely open and observable; it's meant to be handled and studied. In addition, all of its components can be taken apart and reassembled by the user. The unit stands 32" tall and sells for $2400. Like industrial robots, Rhino must be linked to a host computer to become operational.

ELECTRONIC SHOPPING is now offered by THE SOURCE, a database service for home computers. Called Comp-U-Star, the system is said to allow shoppers to select from over 30,000 name-brand items, and order them directly over a personal computer, data terminal, or communicating word processor. Nearly 200 manufacturers are reported to be participating in Comp-U-Star, offering such items as cameras, appliances, stereos, and televisions. Subscribers can use the service to comparison shop. The cost of doing the shopping varies with the time of day. A typical search-and-order is said to take three to eight minutes; and prices for using Comp-U-Star are structured like phone rates: lower for off-hours. Per-minute charge for the service on weekends and evenings is 25¢; weekdays, 50¢; after midnight, 17¢.

STEREO SOUND FROM VIDEOCASSETTES is now available from MCA. Gene Giaquinto, President of MCA's videocassette division, made the announcement that all future MCA releases that are capable of stereo sound will be released in stereo (as well as in mono). The new policy covers not only concerts and musical programs, but also movies with stereo sound tracks.

COMPUTER SUMMER CAMPS sponsored by Atari for 10 to 18 year-olds will be initiated this summer. Each camp session will last four weeks, under the supervision of a staff recruited and trained by Atari. Camp sessions will begin at the end of this month or in early July, and will be conducted on school and university campuses in the northeast, southeast, midwest, and west. Formal instruction will last for two hours each day, with all of the computers and software available to campers during their free time. There will be one computer for every two campers, and one instructor for every five or six campers, said a company spokesman. Hardware will consist of Atari 400 and 800 Home Computers.

SATURN V

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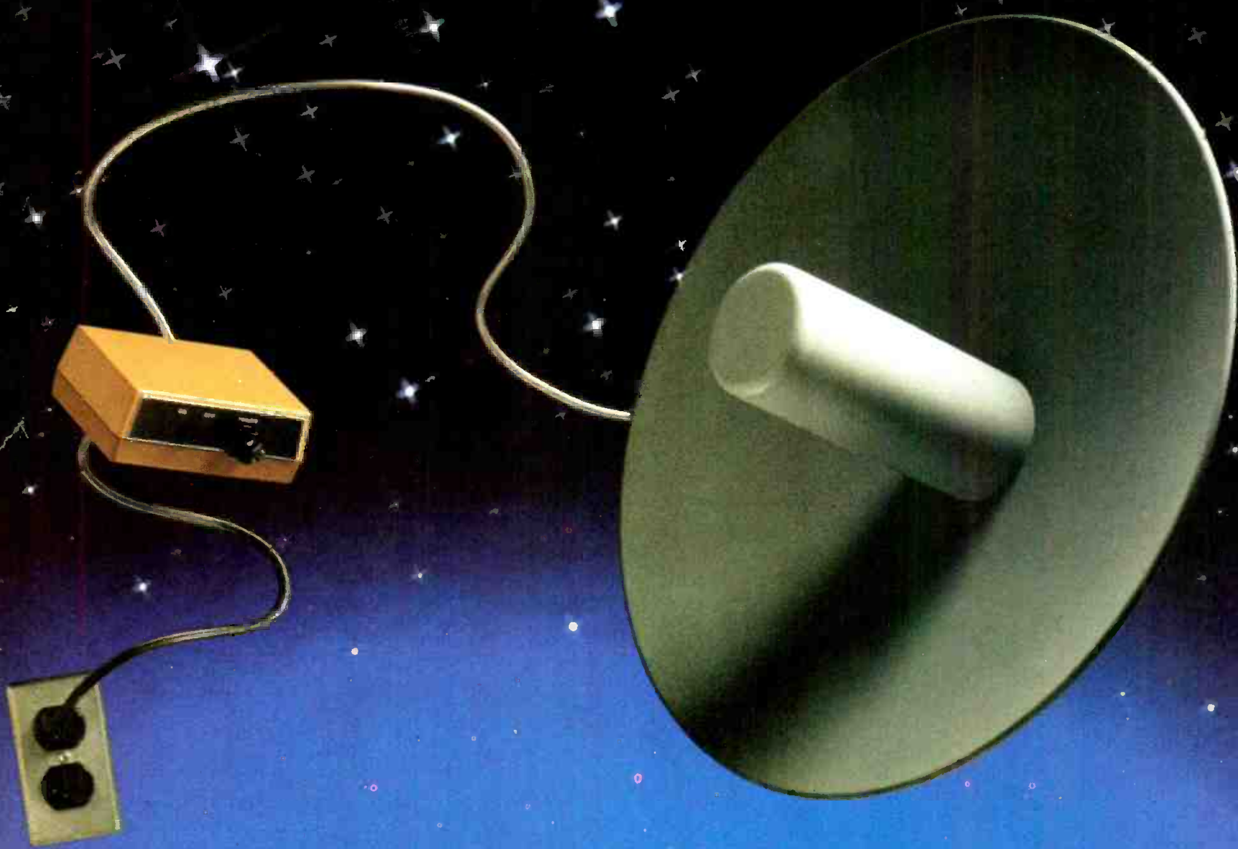

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