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MAY 1982/$1

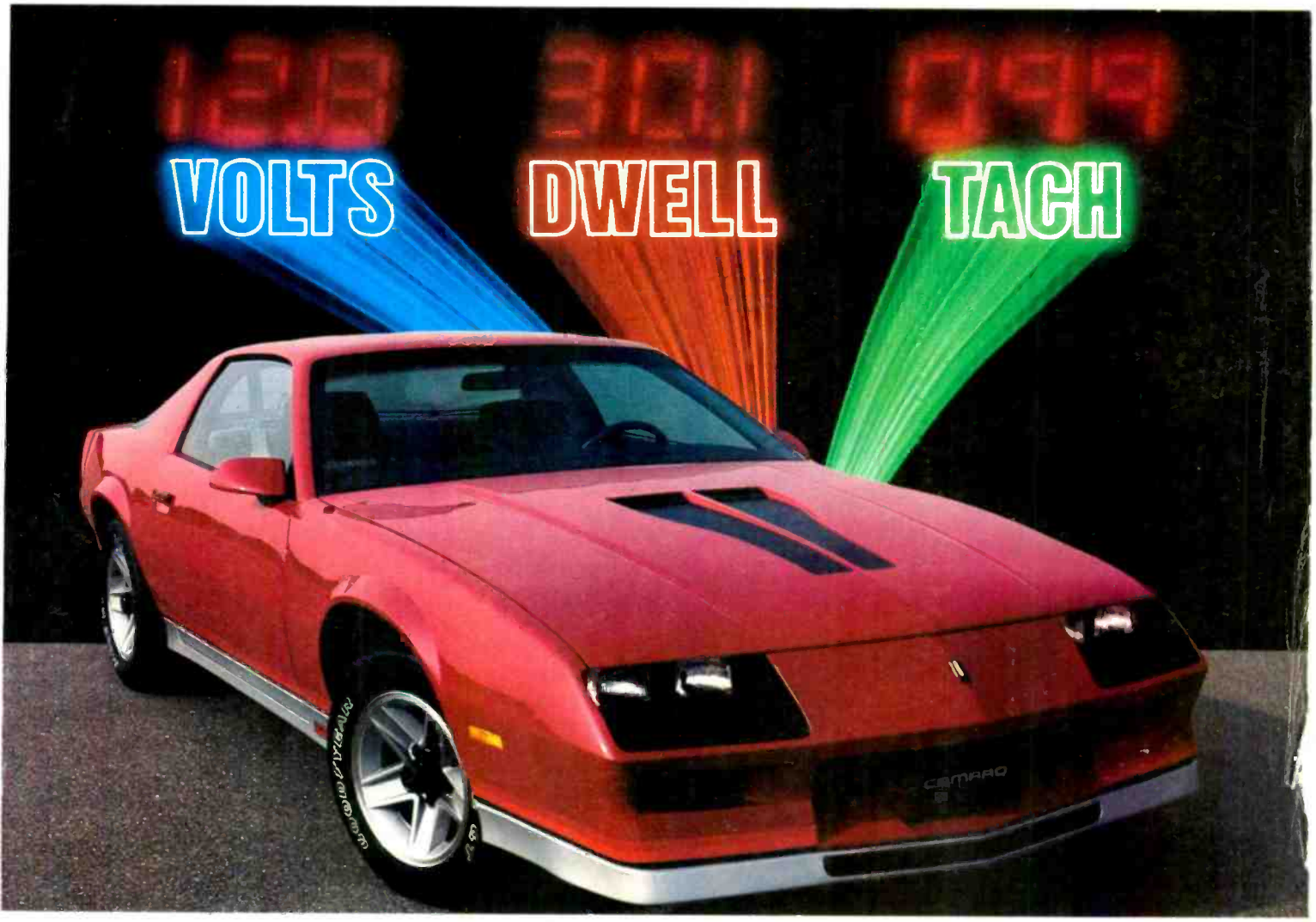
THE ELECTRONIC WORLD

Microcomputers: Which One Is Right for You?

Experimenting with Fiber Optics

Audio-Actuated Camera Flash

Easy Car Tuneup with a Digital Meter



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Tested in this Issue:

Radio Shack TRS-80 Model III Computer
Acoustic Research AR48s Speaker
Sylvania 13" Color TV Receiver

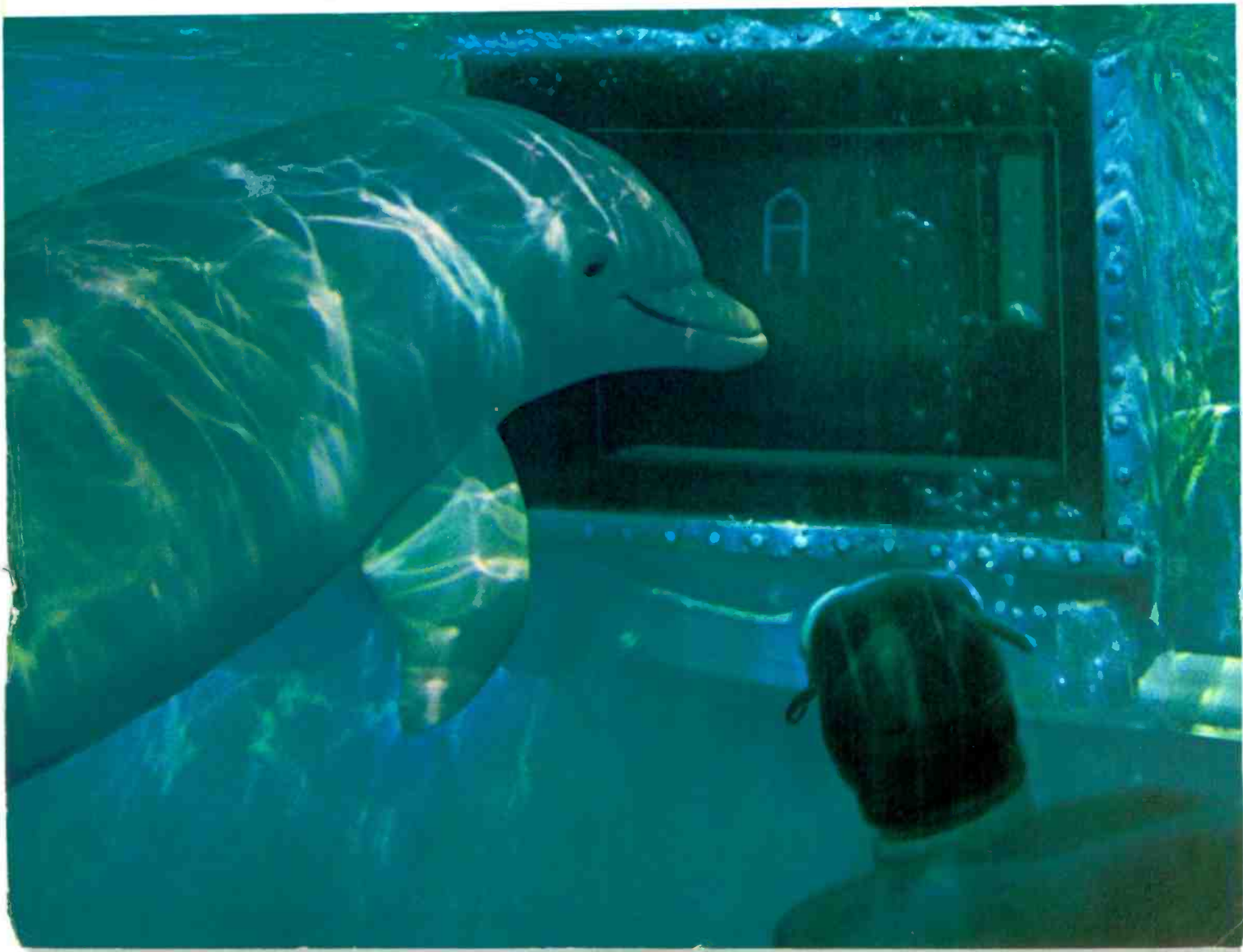
Make waves with an Apple.

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

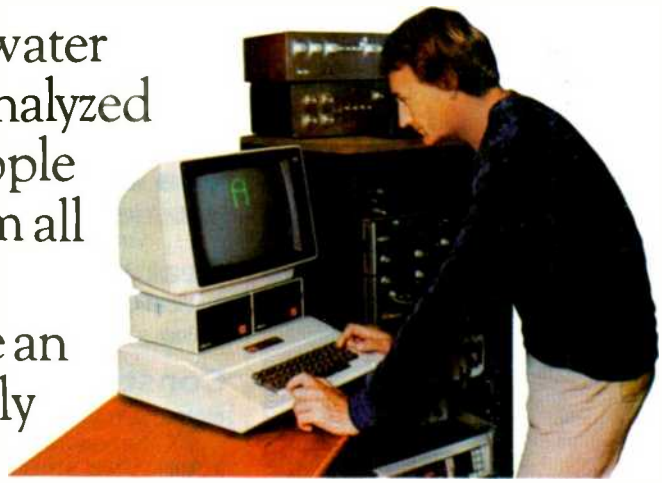
Dolphins vocalize at 2,000-40,000 Hz (compared with 300-3,000 Hz for humans) and "converse" 10-15 times faster than their bipedal brethren.

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

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



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



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

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

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

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The Human/Dolphin Foundation is a non-profit research organization. For more information, write Dr. John Lilly, P.O. Box 4172, Malibu, CA 90265.
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MAY 1982 VOLUME 20, NUMBER 5

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WORLD'S LARGEST-SELLING ELECTRONICS MAGAZINE

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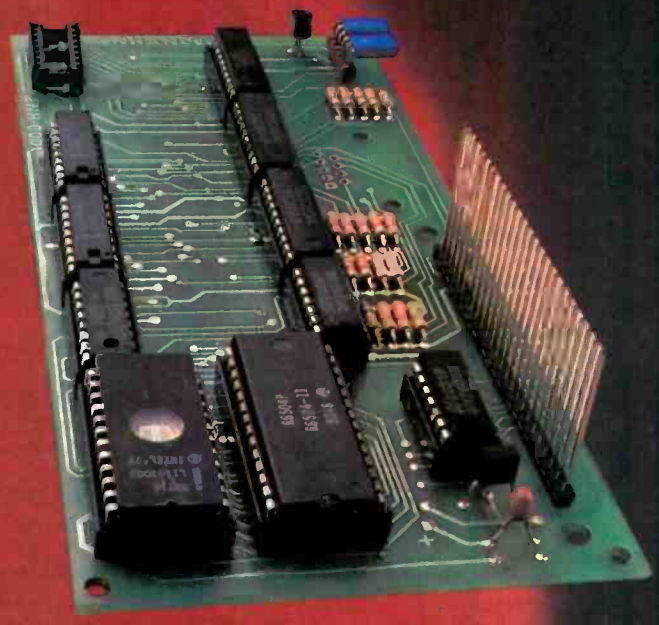
Introducing the Enhancer][: a new Standard which is improving the relationship between Humans and Apples. The Enhancer][can help your Apple][‘s keyboard become more sociable by remembering words or phrases which can be entered into the Apple by the mere touch of a key. Life can become even easier because the Enhancer][can remember what you typed while your Apple was busy talking to your disc (or doing other things). Naturally, it knows the difference between upper and lower case letters and what shift keys are supposed to do. It even knows to auto repeat any key held down. The Enhancer][replaces the encoder board making installation simple.

Suggested retail price: $149.00.



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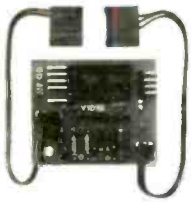
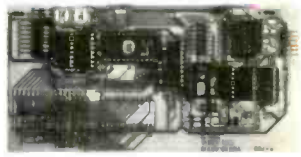


The Soft Video Switch is an automatic version of the popular Switchplate. It knows whether it should display 40 or 80 columns or Apple graphics. It does the tedious work of switching video-out signals so you don’t have to. The Soft Video Switch can be controlled by software. Any Videoterm with Firmware 2.0 or greater may be used with the Soft Video Switch. The single wire shift mod is also supported. Package price is $35.00.

■ KEYBOARD AND DISPLAY ENHANCER



The original Keyboard and Display Enhancer is still available for Revision 0-6 Apples (on which the new Enhancer][will not fit). These Apples have memory select sockets at chip locations D1, E1 & F1. The Keyboard and Display Enhancer allows entry and display of upper & lower case letters with fully functional shift keys. It does NOT have user definable keys nor a type ahead buffer. The price is $129.00.

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- Top & Bottom Scrolling
- Pascal Vidpatch
- Graphics Template

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- Inverse
- German
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- Line Drawing Graphics (Expanded)
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- French
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Dvorak EPROM (Enhancer) $29.00
Lower Case Chip $29.00

CIRCLE 64

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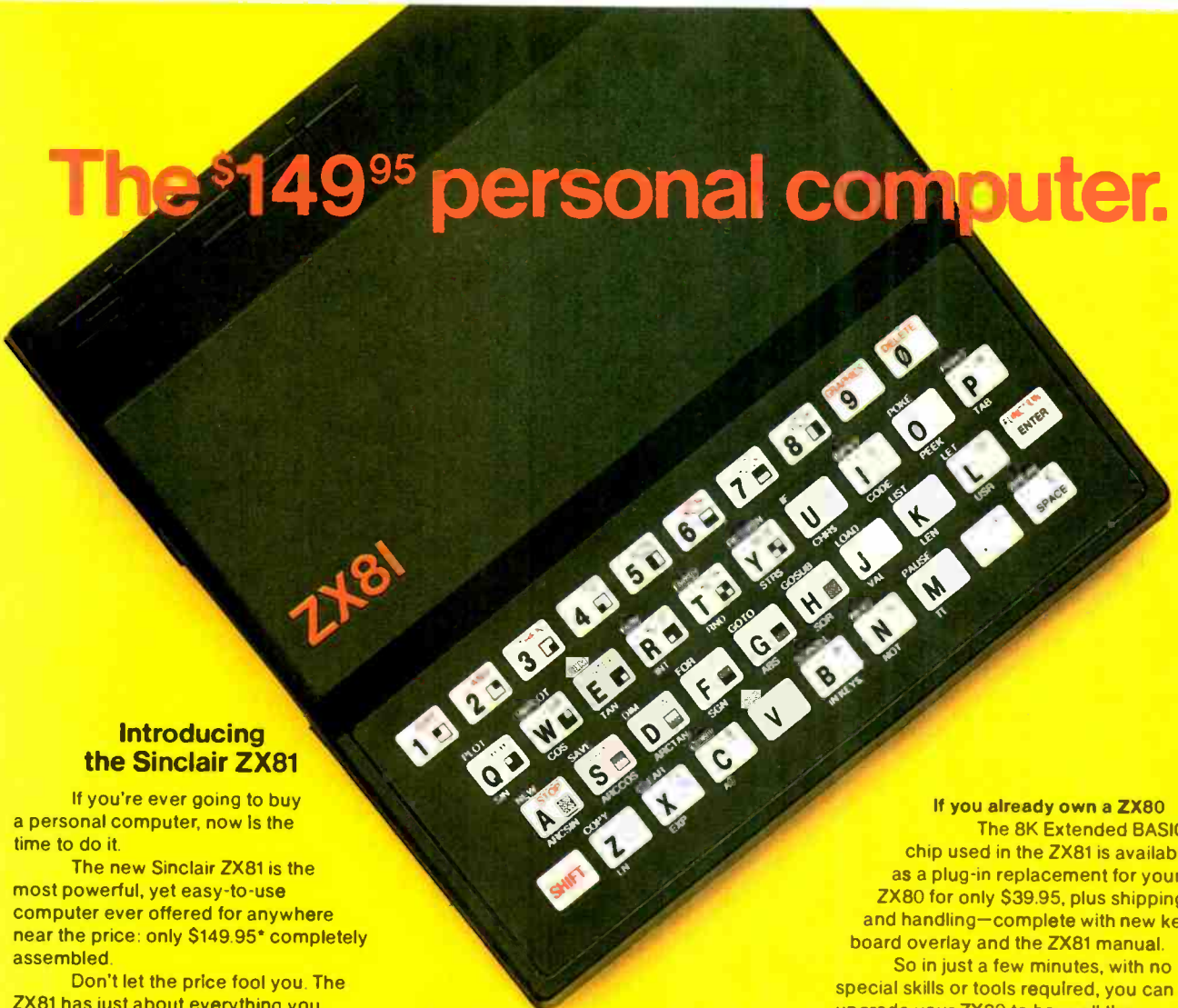

Introducing the Sinclair ZX81

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

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

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

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Just look at what you get:

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

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

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

If you already own a ZX80

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

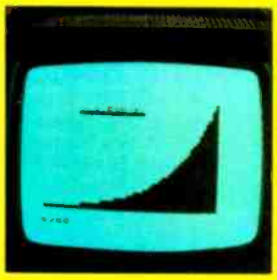
So in just a few minutes, with no special skills or tools required, you can upgrade your ZX80 to have all the powerful features of the ZX81. (You'll have everything except continuous display, but you can still use the PAUSE and SCROLL commands to get moving graphics.)

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

Warranty and Service Program**

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

**Does not apply to ZX81 kits.



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

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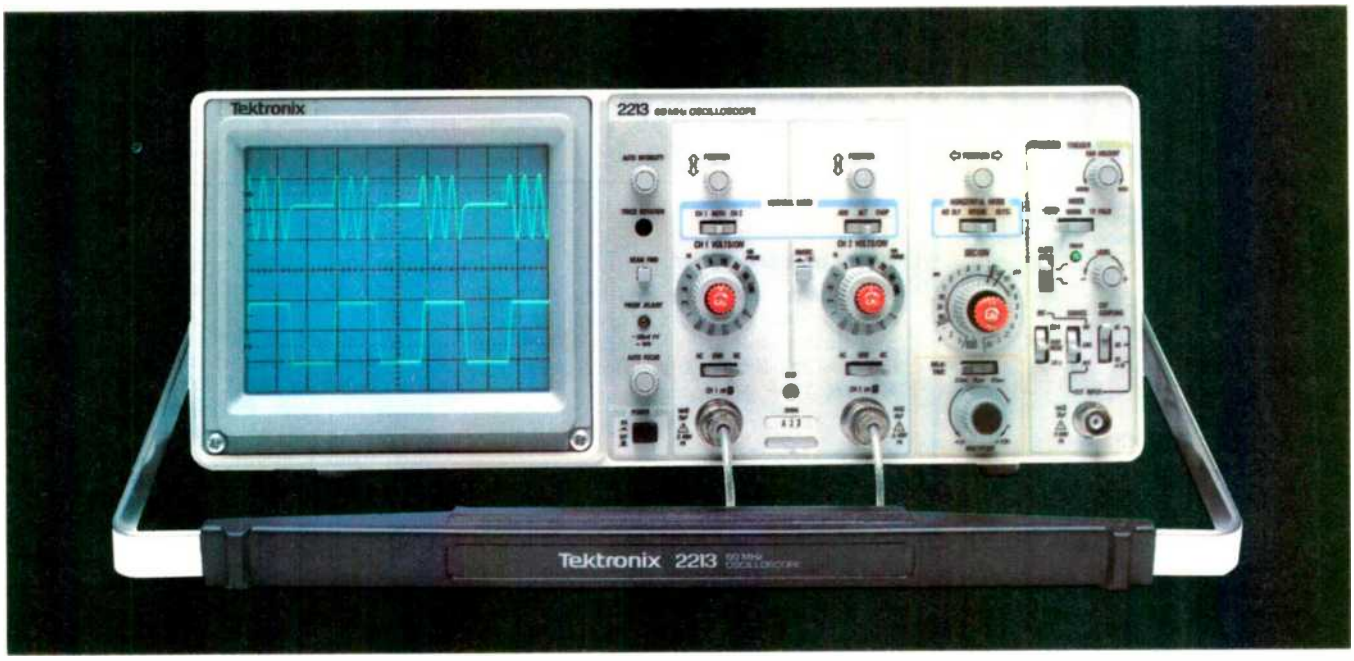

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LETTERS

Wrong Wow and Flutter

In the review of the Realistic SCT-32 cassette deck, the figure given for wow and flutter should have been 0.06% not 0.6%.—*M. Winston, Radio Shack, Ft. Worth, TX.*

Bass Boost and Distortion

Re "Electronic Bass Boost for Woofers" (November 1981), distortion is proportional to how far the diaphragm moves. Including greater motion by "equalizing" or whatever other means must inevitably create an increase in modulation distortion.

Harmonic distortion in loudspeakers, even up to several percent, may be ignored because the frequencies generated are harmonically related to the input frequencies. But modulation distortion, even in amounts of a fraction of a percent, causes objectionable effects.

Certain reviews deny the audibility and even the existence of modulation distortion, although both frequency-modulation distortion and amplitude-modulation distortion have been measured and demonstrated to be audibly perceived. For those who are deaf to distortion, bass boost is the way to go.—*Paul W. Klipsch, Klipsch and Associates, Hope, AK.*

Author's reply: Distortion is only indirectly related to diaphragm excursion. A driver's range of linear (undistorted) motion may be limited by its suspension, by voice coil overhang, and by the nonlinearity of air under compression in the speaker enclosure. Larger drivers do not automatically guarantee lower distortion. Small drivers will often exhibit less transient, harmonic, and intermodulation distortion than larger drivers that have less cone motion due to imperfect piston motion of larger diaphragms. Intermodulation is normally present in music, but can be aggravated by cone breakup in larger diaphragms.

Equalization does not necessarily increase cone motion at a given cutoff frequency (for drivers of the same size) where one driver is equalized and the other is not. It can be demonstrated that equalization masks some forms of distortion. Any modulation distortion produced by bass boost is present only during the presence of deep bass in program material. My listening tests have shown this condition to be preferable to a lack of bass reproduction. For example, the lowest note on a piano is 27.5 Hz. If your speakers can't reproduce that note, pianos just won't sound real. (Even when bass keys aren't struck, their strings resonate, adding to richness of sound.)

This is not to imply that my speakers now equal a pair three times as large with twice as many drivers, costing ten times as much. But distortion becomes noticeable only at sound levels far louder than what I would care to listen to.

Speaker design is very much a series of compromises, of trade-offs between different parameters. Bass equalization is certainly worthy of consideration for high-fidelity applications where healthy bass response is desired from reasonable-size speakers—even though the price is a greater power requirement. It is not necessary to accept high levels of distortion as a trade-off.—*Richard Kaufman, New York, NY.*

CP/M Users Address

In the January 1982 issue (p 30) the address for the CP/M Users Group, from which Computer Languages for CP/M use are available, should be 1651 Third Ave., New York, NY 10028.—*Stan Veit, New York, NY.*

Tax Tips

Your editorial "The IRS Cometh" (December 1981) is well-taken. I hope your readers will see it and heed its advice because it can save them some money.—*W. R. Ham, Jr., Milton, WV.*

Making PC Boards

In building projects from your magazine, I have developed a process for making pc boards that, I think, is simple and does not require any special photographic equipment. First, make a copy of the foil pattern on a photo-copying machine. Use a machine that produces clean white areas and a solid black trace. Second, make a negative on high-contrast film by direct-contact printing. The exposure is made with the photocopy face down against the emulsion on the film. Experiment with exposure times to get the best contrast. Finally, make the pc board from the negative, using negative photo-sensitive resist. To improve this process even more, it would be helpful if you printed the patterns with nothing on the reverse side so the photocopy step could be omitted and the negative made by direct-copy printing through the page.—*Kenrick Chin, Hamilton, Ontario, Canada.*

Introducing incredible tuning accuracy at an incredibly affordable price: The Command Series RF-3100 31-band AM/FM/SW receiver.* No other shortwave receiver brings in PLL quartz synthesized tuning and all-band digital readout for as low a price.† The tuner tracks and "locks" onto your signal, and the 5-digit display shows exactly what frequency you're on.

There are other ways the RF-3100 commands the airways: It can travel the full length of the shortwave band (that's 1.6 to 30 MHz). It eliminates interference when stations overlap by narrowing the broadcast band. It improves reception in strong signal areas with RF Gain Control. And the RF-3100 catches Morse communications accurately with BFO Pitch Control.

RF-6300 8-band AM/FM/SW*

Want to bring in your favorite programs without lifting a finger? Then consider the Panasonic RF-6300 8-band AM/FM/SW* receiver (1.6 to 30 MHz) has microcomputerized preset pushbutton tuning, for programming 12 different broadcasts, or the same broadcast 12 days in a row. Automatically. It even has a quartz alarm clock that turns the radio on and off to play your favorite broadcasts.

The Command Series RF-3100 and RF-6300. Two more ways to roam the globe at the speed of sound. Only from Panasonic.

*Shortwave reception will vary with antenna, weather conditions, operator's geographic location and other factors. An outside antenna may be required for maximum shortwave reception.

†Based on a comparison of suggested retail prices.

This Panasonic Command Series™ shortwave receiver brings the state of the art closer to the state of your pocketbook.

With PLL Quartz Synthesized Tuning and Digital Frequency Readout.

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just slightly ahead of our time.

CIRCLE NO. 35 ON FREE INFORMATION CARD

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.

MOSFET-Output AM/FM Receiver

Cybernet's Kyocera Model R-451 is a 45-W/ch receiver rated at a frequency response from 20-20,000 Hz with a THD of 0.015%. Weighted S/N is 80 dB for

phono and 95 dB for other amplifier functions. The amplifier section uses a MOSFET output that is said to extend the power bandwidth to the higher frequencies. The FM tuner features linear i-f filters and a quartz PLL to give an S/N of 80 dB in mono and 74 dB in stereo. A fluoroscan digital read-out displays station frequencies; automatic or manual tuning allows one to program up to seven AM and seven FM stations (14 in all). Bass and treble tone controls provide sound shaping at ± 10 dB (100 Hz for bass and 10 KHz for treble). Also included is a subsonic filter of 12 dB/octave, and a high-frequency filter of 6 dB/octave. The system has two tape inputs with dubbing facilities. Function controls are soft-touch. $570.

CIRCLE NO. 87 ON FREE INFORMATION CARD

Flat 2-inch TV Receiver

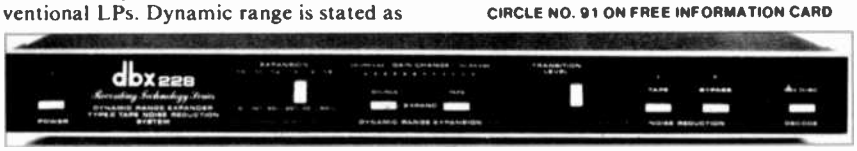
Sony's FD-200 (FD for Flat Display) is an ultra-thin, 2-in. screen, black-and-white TV that can be operated in the palm of one's hand. According to Sony, the small size is made possible by positioning the electron gun parallel to instead of behind the phosphor screen. Also by using a miniturized flyback transformer, a very thin deflection yoke, and extensive use of ICs in the power supply circuit. The unit features electronic tuning, and a sound-only switch—permitting the picture to be turned off while only the TV sound is heard. An ear-receiver (MDR-E3) is supplied for private listening; and the unit will also accommodate Walkman-type headphones. Power consumption is 1.8 W when video operates. There are four possible power sources: four AA batteries, an optional rechargeable BP-82 battery, household power (a power adapter is supplied), and a car battery (an external antenna jack accommodates a car antenna). Dimensions : 3½"W x 3¾"H x 1¼"D; weight is 1.2 lb. $240.

CIRCLE NO. 89 ON FREE INFORMATION CARD

NR/Dynamic Range System

dbx, Inc. has integrated its noise reduction system with dynamic range expansion circuitry. According to dbx, the new Model 228 Tape Noise Reduction/Dynamic Range Expansion System is suitable for use with two-head recorders, and can provide full monitoring capability with three-head recorders. The unit is reported to offer noise reduction of 30 dB for tapes recorded on dbx equipment; 20 dB for FM broadcasts, pre-recorded tapes, and conventional LPs. Dynamic range is stated as 110 dB; and a dynamic range increase of 50% for commercially recorded music and FM broadcasts. Frequency response is given as 20-20,000 Hz ±1.0 dB for the expander section; 40-20,000 Hz ±0.5 dB for the noise reduction section. Expander section THD: 0.1% at 1.0 expansion; noise reduction THD: 0.1% from 100 to 20,000 Hz. IM distortion is 0.2%. Standard 19" rack mounts are supplied; wood sides available at additional cost. $500.

CIRCLE NO. 91 ON FREE INFORMATION CARD



Inductive-coupled Modem

The MFJ-1230 Originate/Answer Modem resembles an acoustic modem, and functions the same way; but it uses an inductive-coupling technique for receiving. This technique is reported to give a more reliable data transfer by eliminating room noise and vibration errors. Bell 103-compatible, the MFJ-1230 can operate at up to 300 baud, in half- and full-duplex modes, and has a six-pole active-bandpass filter to handle weak signals. It provides TTL and CMOS inputs and outputs, as well as RS-232 compatibility—covering the interfaces of almost all computers. Also, input/output ports for a cassette recorder let you save data for reloading or retransmission. A carrier-detect LED indicates when a signal has adequate strength for data recognition; there is no audio tone during a no-connect condition. The unit uses 110 V ac, or two internal 9-V batteries. $130.

CIRCLE NO. 88 ON FREE INFORMATION CARD

Portable Mike Mixer

The Shure Brothers compact M267 microphone mixer has four inputs that are

switchable to provide simplex power for condenser microphones. Featuring balanced, transformer-coupled line- and microphone-level outputs, specifications for the M267 are: frequency response 30 to 20,000 Hz ±2 dB; total harmonic distortion, less than 0.35%; intermodulation distortion less than 0.5%; and maximum out-

Why use their flexible discs:

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Product Description	Part #	CE quant. 100 price per disc ($)
8" SSSD IBM Compatible (128 B/S, 26 Sectors)	3062	2.09
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8" SSDD IBM Compatible (128 B/S, 26 Sectors)	3090	2.74
8" DSDD Soft Sector (Unformatted)	3102	3.34
8" DSDD Soft Sector (128 B/S, 26 Sectors)	3115	3.34
8" DSDD Soft Sector (256 B/S, 26 Sectors)	3103	3.34
8" DSDD Soft Sector (512 B/S, 15 Sectors)	3114	3.34
8" DSDD Soft Sector (1024 B/S, 8 Sectors)	3104	3.34
8" DSDD Burroughs B-80 Comp., 32 Hard Sector	3092	3.34
8" DSDD Shugart Compatible, 32 Hard Sector	3181	3.34
5¼" SSSD Soft Sector (Unformatted)	3401	1.94
5¼" SSDD Soft Sector w/Hub Ring	3481	2.34
5¼" SSDD 10 Hard Sector w/Hub Ring	3483	2.34
5¼" SSDD 16 Hard Sector w/Hub Ring	3485	2.34
5¼" DSDD Soft Sector w/Hub Ring	3491	3.09
5¼" DSDD 10 Hard Sector w/Hub Ring	3493	3.09
5¼" DSDD 16 Hard Sector w/Hub Ring	3495	3.09

SSSD = Single Sided Single Density; SSDD = Single Sided Double Density
DSDD = Double Sided Double Density

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Quality
Memorex means quality products that you can depend on. Quality control at Memorex means starting with the best materials available. Continual surveillance throughout the entire manufacturing process. The benefit of Memorex's years of experience in magnetic media production, resulting, for instance, in proprietary coating formulations. The most sophisticated testing procedures you'll find anywhere in the business

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Each and every Memorex Flexible Disc is certified to be 100 percent error free. *Each* track of *each* flexible disc is tested, individually, to Memorex's stringent standards of excellence. They test signal amplitude, resolution, low-pass modulation, overwrite, missing pulse error and extra pulse error. They are torque-tested, and competitively tested on drives available from almost every major drive manufacturer in the industry including drives that Memorex manufacturers. Rigid quality audits are built into every step of the manmanufacturing process and stringent testing result in a standard of excellence that assures you, our customer, of a quality product designed for increased data reliability and consistent top performance

Customer-Oriented Packaging
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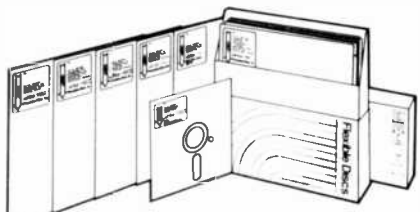

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CIRCLE NO. 1 ON FREE INFORMATION CARD

put hum/noise, −53 dBV (master control up, input controls down). Each of the M267's four balanced microphone inputs has its own volume control, low-cut filter switch, and line/mic switch. The master volume control sets the overall program output level (+18 dBm maximum). A switchable, fast-attack limiter cuts output overload distortion during loud program segments without affecting normal program levels. In addition to its illuminated VU meter, the mixer has an LED peak indicator that indicates limiter operation. An automatic muting circuit eliminates audible "clicks" and "thumps" during turn-on and turn-off, and the headphone jack doubles as a separate unbalanced line feed. A built-in 1000-Hz tone oscillator (front-panel switchable) permits line test and level checks. The unit is powered by 120-V ac, an integral battery pack, or any external 30-V dc source. $395

CIRCLE NO. 92 ON FREE INFORMATION CARD

Dot Matrix Printer

Developed by Star Micronics, Inc., the Model DP-8480 is an 80-column dot matrix impact printer that features: bi-directional printing with a logic-seeking carriage control; 96-character ASCII, alpha/numeric, and non-Roman alphabet fonts; block graphics capacity; standard parallel interface with optional EIA RS-232C, IEEE-488, and 20 mA interfaces; software-selectable character pitches—10, 12, or 16.7 CPI, with a maximum yield of 132 characters per line; replaceable printing head with a life expectancy given as 100 million characters; and a built-in self-test mode. Dimensions are: 15.3"W x 12.2"D x 4.9"H. Paper width is 8" to 10" for sprocket-fed paper with the optional tractor-feed assembly. $575; $590 with tractor-feed.

CIRCLE NO. 95 ON FREE INFORMATION CARD

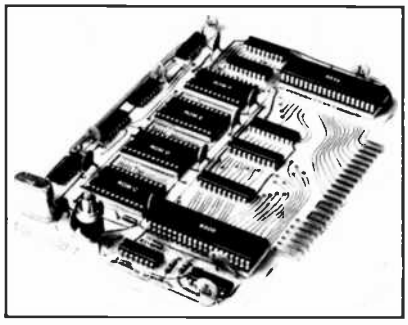
Logic Trainer

The Broder Logic Trainer Model 100 is said to reduce the time required for a student to learn how gates and flip-flops function in circuits. The Trainer covers the following subjects: switch circuits, Venn diagrams, binary and BCD counting, relay logic, diodes, bipolar transistors, and nonlinear FETs. The student solves digital circuit problems by manipulating any of eight external switches; no wire or component manipulation is necessary. The Model 100 uses PMOS LSI circuitry, with an LCD. A 9-V battery is included. $169.

CIRCLE NO. 93 ON FREE INFORMATION CARD

Microcomputer Board

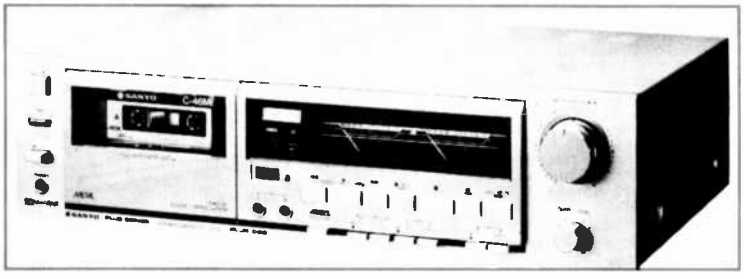
Commodore Semiconductor has introduced the MMS 6508/1 Micromodule for



control applications that require only a moderate amount of program storage and read/write memory. Employing a 6508 microprocessor and the new 6525 Tri-port Interface chip, the board is compatible with the 6525 processor, and four 8-bit I/O ports. Sockets are provided for up to 16 K bytes of ROM or EPROM; and there are 1280 bytes of RAM. The edge connector is optimized for direct control rather than system expansion—consisting of the I/O ports, four pins for +5-V dc input power, four ground pins, a RESET line, and two clock phases (01 and 02) for use in peripheral synchronization. The I/O ports may be configured as either 32 I/O lines, or as 24 I/O lines with two handshake lines and five priority interrupts. $99.

CIRCLE NO. 96 ON FREE INFORMATION CARD

Cassette Deck with Super-D Noise Reduction



Sanyo's Plus 90 cassette deck is said to be capable of providing a dynamic range of 110 dB, with a signal-to-noise ratio of 100 dB with metal tape. In addition to Super-D noise reduction (which is used in conjunction with Dolby B/C NR), the Plus 90 offers the following: soft-touch, IC-controlled transport; 15-program Automatic Music-Select System (AMSS) which scans the tape at high speed (forward and reverse) and automatically plays the next recorded selection; a mute control for inserting the blank tape gaps necessary for AMSS operation; LED function indicators for AMSS and tape selection (normal, CrO_2, and and metal), separate input and output level controls, left/right mic input jacks, headphone jack, digital tape counter, wide-range peak VU meters, and defeatable FM multiplex filter. Frequency response is given as 30-19,000 Hz ±3 dB; wow and flutter is 0.5%. The Plus 90 uses a two-motor drive. $380.

CIRCLE NO. 94 ON FREE INFORMATION CARD

Low Voltage Soldering Irons

The "Soldr-Mite" from Wall Lenk is a miniature soldering tool that is claimed to

heat quickly (25 to 50s) from a potential of 6 V. Available in six models, from 4.5

Pocket Concert Plus

NOW WITH FM STEREO

JUST $69.50

DAK was in trouble. Our Pocket Concert cassette players were selling like crazy. Orders were coming from everywhere. We were able to get 24,000 players, but it wasn't enough. We stopped advertising but the orders still kept coming.

We were in a jam. We had angry cutomers everywhere. We couldn't find a new player good enough to satisfy our customers, or for that matter ourselves. After all, we had promised a player that could equal the sound of the Sony Walkman.

Well, money talks. Not only did we find a great replacement, but we've even got one with an FM module. It's smaller, lighter and the sound is fabulous. Because of DAK's massive buying ability, (an opening order of 10,000 players), we were able to bargain such a low price that we can offer the new Pocket Concert–Plus FM to you for just 50 cents more than our original cassette-only player.

Don't be confused–– This is no cheap $69 retail player. For example, Pacific Stereo, the gigantic California chain, sold this fine unit in their 'Super Sale' ad of December 20, 1981 for more than 140% of our low discount price. This is a state of the art, musical component you'll enjoy for years.

EXTRA HOME BONUS––Here's a cable system that lets you plug the Pocket Concert Plus into any 'aux' inputs in your home stereo, so you can copy cassettes by playing them on the Pocket Concert Plus and recording them on your main deck, or just listen through your main system. The sound is great. Just add $4 ($1 P&H) for the cable. Ord. No. 9200.

It's uncanny. You can sit, walk, ski or mow the lawn. And think of it, you can do it all in an environment controlled totally by YOU.

You can be doing the most mundane task, but your mind may be soaring thousands of miles away. It's no fluke that Sony has sold hundreds of thousands of their Walkman Cassette Players.

The power of music has been used for centuries to rouse the troups and relax the kings. But, only now with the new 1½ oz. Samarium Cobalt headphones are you able to get such a kaleidoscope of sound that the outside world seems to literally disappear.

And, the effect is so total that there are even laws to stop you from wearing these remarkable players while you ride a bike or drive a car.

WHAT SOUND

The sound is easily equal to a several thousand dollar home stereo system. Yet, the new Pocket Concert Plus with both cassette and FM stereo weighs only 12½ oz. and is so small you'll hardly know that you're wearing it.

The Pocket Concert Plus goes where you go with a protective leatherette case that easily hangs on your belt or rides comfortably in your pocket. It also has an adjustable shoulder strap.

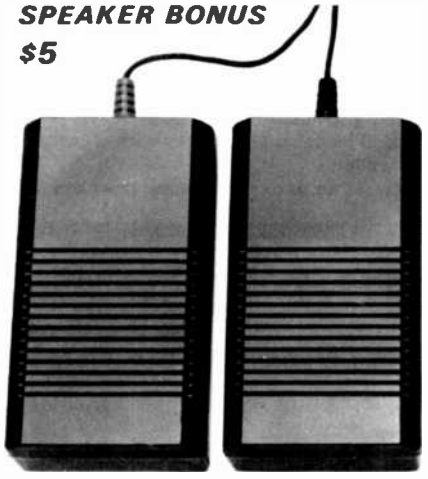
So, whether you're into long walks, sitting in airplanes or washing your car, you'll enjoy the unbelievably rich stereo sound of the Pocket Concert Plus.

ENGINEERED FOR STRESS

Most fine stereo equipment is designed to be lovingly placed on a shelf and then never moved. Obviously, this isn't a practical way to listen when you're walking your dog or jogging.

The Pocket Concert Plus is specifically designed for rough treatment. Many other machines are really redesigned dictation recorders. The Pocket Concert Plus is designed to provide superb stable stereo music while you're on the move.

SPEAKER BONUS $5



Wow. Now personal stereo for one can be stereo music for all. The same mylar diaphragm technology that makes possible the fabulous feather-weight headphones now makes possible these great monitor speakers.

These speakers are less than 4" tall, and come complete with a connecting cable. They are so efficient that they require no additional amplification and plug in just like the headphones.

For serious listening you will still use your headphones, but for casual listening of portable radio quality, you'll be amazed at the volume level and sound quality of these new feather-weight speakers. With your order for the Pocket Concert Plus only, just add $5 plus ($1 Post. & Handling) for your pair of bonus speakers. Order Number 9334.

MUSIC AT YOUR COMMAND

You won't be 'roughing it' when you leave home. You can play all your cassettes since there is an equalization switch for Metal/Chrome or standard.

The sound is crisp and clean with a wide frequency response. It's operated by 3AA batteries, not included. There are convenient lock-in fast forward and rewind buttons, plus cue and review.

You can listen to the outside world by pushing the Mute–FM/Tape switch without taking off the feather-light stereophones. Dual volume controls autostop and a LED operation indicator round out the convenience features.

PLUS FM STEREO

Just pop in the FM stereo module instead of a cassette and you'll be tuning in your favorite FM stereo stations.

The FM module automatically direct-couples with the cassette deck so it works off the deck's power. It feeds the FM signal directly to the amplifier, not through the head for great fidelity.

The headphone cable is used as the antenna for FM reception that is equal to the 'FM only' units on the market.

The Pocket Concert Plus utilizes superb electronics and an all new state of the art tape transport for stability. It is manufactured by Unipacific and backed by a standard limited factory warranty.

TRY THE POCKET CONCERT PLUS RISK FREE

Take your Pocket Concert Plus as you commute or on walks. Enjoy breathtaking stereo music wherever you are.

If for any reason you aren't 100% satisfied, simply return it in its original box within 30 days for a courteous refund.

To order your Pocket Concert Plus including the FM module, risk free with your credit card, call our toll free hotline, or send your check for just **$69.50.** Plus $2.50 postage and handling. Order Number 9303. If you wish the optional home cable and/or speaker bonuses, see above for their price and order numbers. Calif. residents please add 6% sales tax.

You'll be in control of your own environment and enjoying your favorite cassette and FM stereo music with the great sound of the Pocket Concert Plus.

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2114L	8/17.95
6116 2K x 8 CMOS RAM 200nS	12.95
2708 EPROM	3.49
2716 EPROM	5.49
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2764 EPROM	34.95
Z6132 4K x 8 Quasi-Static RAM	24.95

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1771	24 50	6845	18 49	DAC-0800	3 99
1791	34 95	6850	4 49	INS8250	14 90
21L02	1 49	8085A	8 95	MM58167	8 75
2112	2 39	8212	2 75	TMS9900	29 95
2516	5 49	8214	3 95	TR16028	2 49
2532	12 99	8216	2 75	SC-01	55 00
2651	12 95	8224	3 29	Z80A-CPU	7 95
4044L-2	2 49	8226	2 79	Z80ACTC	7 49
6502	8 99	8228	4 49	Z80ADart	19 95
6800	6 99	8251	6 95	Z80APIO	7 49
6802	11 95	8255	6 49	Z80ASIO	17 95
6809	19 95	AY5-1013A	4 95	Z8603	74 95
6821	4 95	AY5-2376	14 95	Z8671	29 95

1 Amp TO-220 Voltage Regulators

PART #	1-24	25-99	100-499
7805 (LM340T-5)	.85	.75	.65
7812 (LM340T-12)	.85	.75	.65
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7818 (LM340T-18)	.85	.75	.65

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8038	3 95	LM393	97	MC3302	90
LF351	75	LM733	99	MC1458	59
LF353	1 29	LM741-8	35	MC1514	1 39
LF357	1 39	LM741-14	35	NE555	45
LM301	45	LM747	77	NE556	98
LM307	49	LM748	49	NE565	1 25
LM311	95	LM1310	2 49	NE5534	2 35
LM318	1 75	LM1458	69	NE5538	2 25
LM324	90	LM1800	2 49	SSM2010	7 50
LM339	79	LM1818	3 49	SSM2020	7 50
LM358	90	LM1889	2 99	SSM2030	7 50
LM377	2 49	LM2900	69	SSM2040	7 50
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Talking Pocket Calculator

Incorporating voice-synthesis technology, Sharp Electronics has introduced the Model EL-620 pocket-size calculator. It is said to deliver a clear "voice" announcement of whatever numeral has been depressed on the keyboard, as well as indicating which arithmetic operation has been selected. The answer, expressed in the proper units (hundred, thousand, million) is also announced. Other keyed entries are announced by a musical beep tone for verification. The EL-620 operates from three mercury batteries or an optional ac adapter. The 8-digit LCD model accommodates the four arithmetic functions, percent, square root, and a 4-key memory. Dimensions are: 3"W x 5½"H x ½"D. The calculator comes with a carrying wallet.

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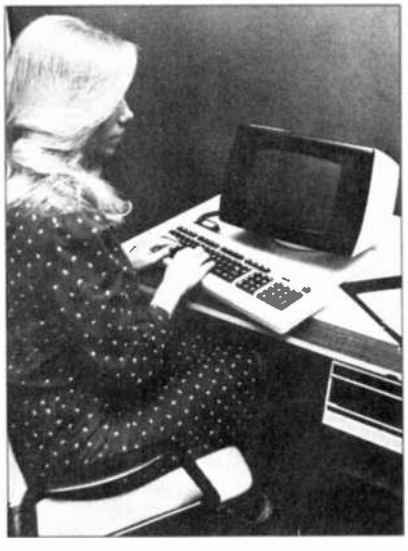

Altos Computer Systems has introduced its first video terminal, the Altos I. It has a detached keyboard with a tiltable, rotating, green-phosphor display. The typewriter-style board (105 keys) is connected to the display via a 6-ft. cable. It can format 24 lines with 80 characters per row, with two additional lines for messages and function key identification. Eight program keys plus a function key provide up to 96 codes; 14 keys include the numbers 0-9, period, comma, minus, and enter/tab. Functional command, editing, and cursor keys allow editing options as well as "send" and "print." The display is also capable of line drawing and horizontal/vertical split screen with independent scrolling. The Altos I uses 15 transmission baud rates from 50 to 9600 cps via a standard RS-232C interface. The printer port allows data transfers at the same rates. $995.

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Beckman DMM

The new Tech™ 320B portable digital multimeter from Beckman Instruments has both visual and audible indication of continuity. That is, the meter will alert the user with a single "beep" tone when continuity is detected. Continuity is indicated visually by the appearance of an ohms omega in the corner of the LCD. The 320B has 29 ranges, with overload protection: voltage is protected to 1,500 V dc/1,000 V ac; resistance is protected to 500 V; current ranges are protected with a 2-A/250-V fuse, and are rated up to 20 A for 30 s. Resistance measurements are said to be sensitive enough to operate in-circuit (without turning on the diodes or semiconductors of the circuit being tested). A separate semiconductor test function provides a 0-2-V, 2-mA constant test current. Basic accuracy is given as 0.1%. $189.

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The Laser Rod is a tunable-tip CB antenna with 500 W of power. It can light up with a parallel array of replaceable bulbs (red, blue, green, amber, or clear), adding, it is claimed, to the visibility and bodaciousness of your rig. Available in 2′ and 3′ lengths, it transmits or receives with the lights on or off. Options include a switch and bracket, extra conductor wire, and cigarette lighter plug. $28 for the two-footer; $30 for the three.

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ENTERTAINMENT ELECTRONICS

By Len Feldman

Listening Locations Equalized Digitally

WHILE everyone is busy predicting the "marriage" of audio and video, there has been little mention of a more obvious combining of technologies: audio and computers. To date, the incorporation of computer technology into audio gear has been almost crude, in terms of the microcomputer's true potential. Various memorizing functions (pre-setting of favorite stations on a frequency-synthesizing tuner), and timing functions (pre-programming of a video cassette recorder) have constituted the chief uses of microprocessors in audio/video applications.

If Acoustic Research, the well-known speaker system manufacturer, has its way, all of that is about to change. In last month's column I touched briefly upon AR's Adaptive Digital Signal Processor (ADSP), a "smart digital audio component" that can recognize and automatically correct frequency response errors in a sound reproduction system. According to AR's director of research, Bob Berkovitz, the ADSP is especially effective in correcting loudspeaker shortcomings and errors related to non-ideal room acoustics.

The ADSP derives its "intelligence" from a novel computer program developed at AR. The program employs mathematical techniques which have, until now, been used primarily for speech synthesis and economic modeling. The millions of calculations required to execute the program are performed by a new 16-bit NMOS microcomputer chip produced by Texas Instruments, who worked on the project with the AR research team.

While first impressions of the ADSP suggest a glorified graphic or parametric equalizer, it is actually quite different from any analog equalizer. For example, it has no fixed-frequency characteristics, such as a definite number of bands, center frequencies, or filter bandwidths. The ADSP operates in a *time* domain, dividing the program into thousands of fragments per second, through digital sampling. It then adds error correction to each fragment and finally reassembles them back into recognizable analog music signals. But for all the complexity of its computer program, the ADSP is as easy to use as some of the self-analyzing analog equalizer systems now available.

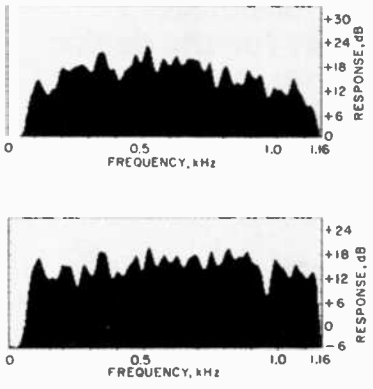
To activate the ADSP while listening to music, you simply press a button on a small hand-held module which also houses a tiny microphone. The music is then temporarily interrupted and the computer in the ADSP converts a series of numbers in its memory into a test signal which sounds a bit like white noise. This test signal is heard briefly from each of the two loudspeakers and is picked up by the hand-held microphone. The signal is then converted into a series of several thousand numbers which are stored in memory. These numbers are analyzed by the ADSP's computer for a mathematical order that indicates regular patterns. Patterns discovered in this way are then used by the computer to design a correction filter.

During this complex process (some of which AR left intentionally vague since full patent protection is still being obtained), numbers in another part of the ADSP's memory converge to a code that is a mirror image of the sonic errors produced by the loudspeaker/room-acoustics combination. The ADSP adds these "opposite errors" to the music signal. Now when music is played through the sound system and into the room, the two sets of errors cancel. The sound reaching the listener (at the position where the microphone module was originally held) is thus a more faithful reproduction of the original music. Because ADSP has no preset filter bands or adjustments, it can synthesize as many digital filters as are needed—normally a far greater number than the usual eight or ten bands associated with analog graphic equalizers. Typically, the ADSP will be called upon to provide extremely narrow filters, with more than fifty peaks and dips in a 1000-Hz bandwidth.

However, ADSP works only in the frequency region below 1 kHz. This represents about five out of ten octaves of the audio spectrum. But AR's research people maintain that errors in system response *above* 1 kHz in a typical listening room are affected more by a turn of the listener's head than by room acoustics. Flat response above that midpoint, they claim, is largely a matter of the manufacturer's choosing the correct combination of midrange and tweeter drivers when designing the speakers. Failing this, correction above 1 kHz is most easily accomplished using ordinary tone controls, since sharp peaks and valleys caused by room resonances are not commonly found in these upper frequency ranges.

The ADSP is not available yet, but AR hopes to have a first version of the device at retail outlets by mid-1982. The projected price should be under $2000. ◇

HOW THE ADSP HANDLES ROOM REFLECTIONS



Effect before and after (top and bottom) of ADSP on a typical speaker.

The ADSP hardware, as presently configured, consists of Texas Instruments' TMS-9995 NMOS microprocessor and more than 100 integrated circuits driven by AR's proprietary software program. Unlike analog devices that may use microprocessors (and are often referred to as computer-operated components), the ADSP is entirely software-dependent.

To give an idea of how the system actually works, consider a good audiophile speaker in a typical listening room. The speaker, if measured in an anechoic chamber, would have yielded a uniform response to below 50 Hz. Yet, when measured in the listening room, the response is far from smooth (shown at top). After the application of the ADSP filter, however, a much flatter curve was obtained (shown at bottom). The important point to observe here is that the *degree* of detail provided by the ADSP correction is far greater than that provided by any analog equalizer available for home or professional use.

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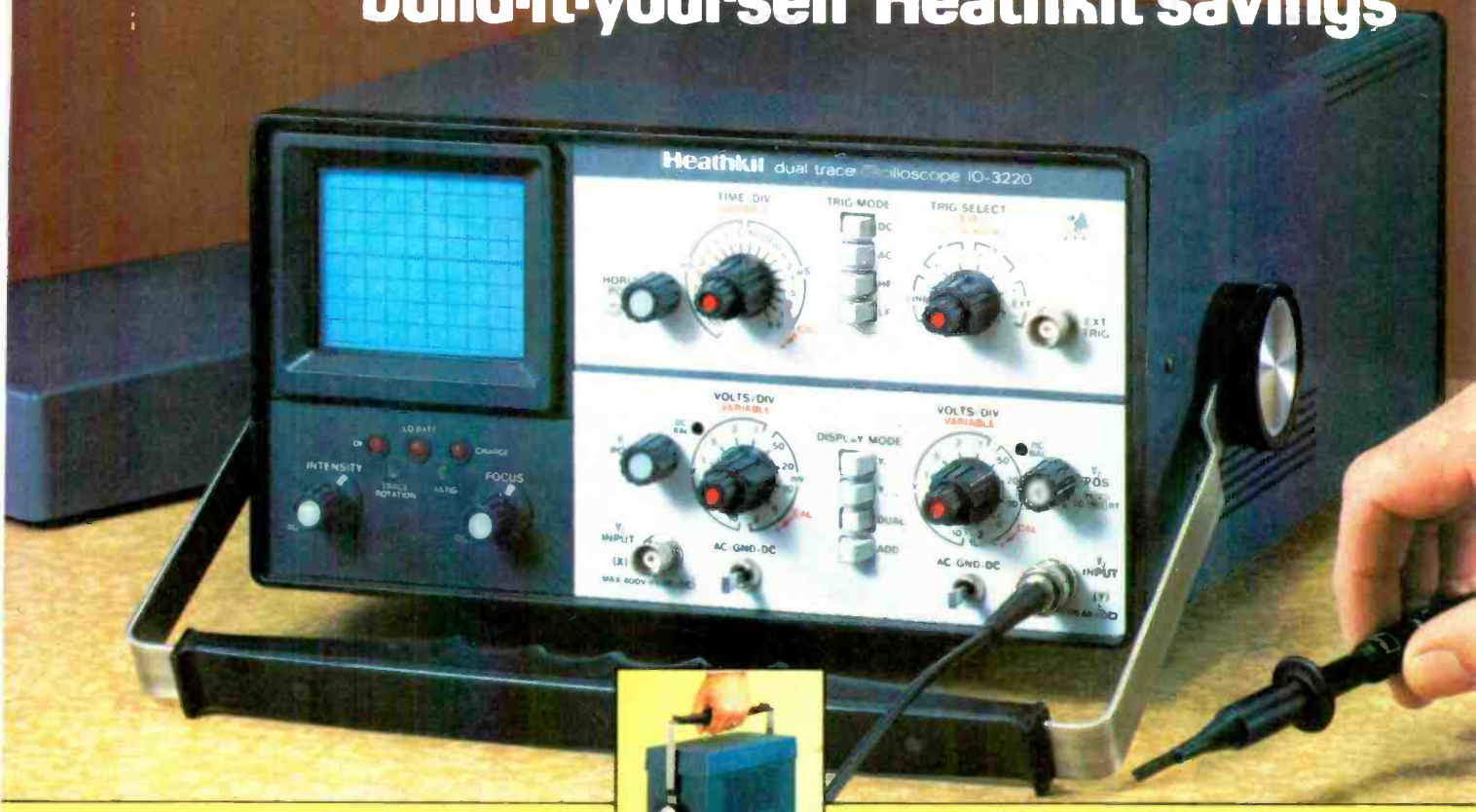

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Audio Product of the Month

CHOSEN BY THE EDITORS OF POPULAR ELECTRONICS

Acoustic Research AR48s Three-Way Speaker System

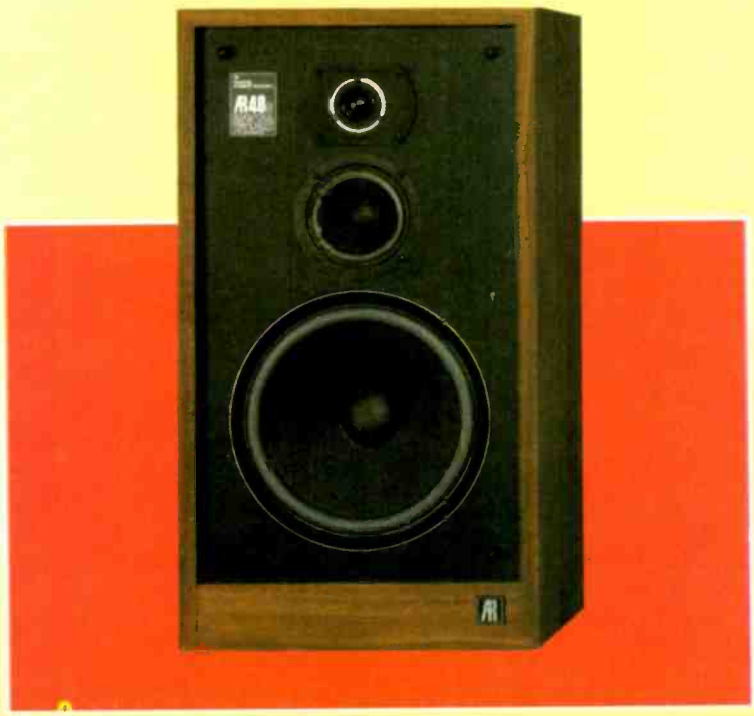
THE AR48s is one of the largest "bookshelf" speaker systems currently available from Acoustic Research. It is a three-way system, employing a 10-in. acoustic suspension woofer in a 1.32-liter sealed enclosure, a newly designed four-in. midrange cone driver in a sealed enclosure, and a one-in. dome high-frequency radiator. The crossover frequencies are 400 and 2500 Hz, and rated 3-dB bandwidth is 45 to 24,000 Hz.

Nominally a 6-ohm system, the AR48s has a rated minimum impedance of 4.8 ohms. The cabinet, covered with walnut-grain vinyl veneer, measures 25" x 14" x 10¾" and has a dark brown cloth grille retained by plastic snaps. The speaker system weighs 38 lb. Suggested retail price is $210.

General Description. Although the AR48s is not too different from its predecessors, it is novel in at least two areas: the new 4-in. midrange driver and the computer-designed crossover network described below.

The midrange (roughly 300 to 3000 Hz) is the most critical part of the audio spectrum for natural reproduction of the human voice. AR designed its 4-in. driver to cover this entire band, avoiding aberrations that could otherwise result from a crossover between drivers.

To obtain a smooth, uncolored output from a driver, it is necessary to suppress any resonant modes in its cone. These modes can introduce dips and peaks toward the higher end of the speaker's operating range that the crossover network cannot remove without sacrificing the driver's high-frequency response.



AR cones, in general, are designed to be mechanically "lossy," and thus absorb internal reflections that could roughen their response. This is one reason for their continuing use of the paper cone (instead of plastic and metallic cone materials). They treat the paper cone with proprietary damping liquids that, once absorbed, deaden acoustic transmission.

A different method is used in the new AR 4-in. driver. Its cone is made of a fibrous material that is inherently lossy throughout its entire thickness and requires no additional treatment to achieve the desired low "Q." According to AR, this gives the small cone more consistent performance than would be possible with treated paper. To the touch, the AR midrange driver cone has a felt-like texture and consistency.

The AR48s crossover network has an unusual design. Its 12-dB-per-octave rolloff would normally call for four inductors and four capacitors, but by using a series configuration for the two lower frequency speakers and a parallel network for the tweeter, the two 3.8-mH coils needed for the 400-Hz crossover are replaced by a single 2.3-mH inductor. And since air-core windings are used, the savings in copper for the smaller inductor are appreciable.

The AR48s has been designed to give its flattest overall response with either of two room placements: against a wall at approximately ear height, and on the floor next to the wall. However, placing the speaker on a stand (or a foot or two from the wall) will permit cancellations from floor or wall reflections to degrade bass performance.

For an acoustic suspension speaker system, the AR48s is moderately efficient. Its rated voltage sensitivity is 88 dB Sound Pressure Level (SPL) at 1 meter on axis with 2.83 V applied. The recommended range of amplifier power is 15 to 100 W per channel. Acoustic Research defines very specific high-

power limitations: the AR48s can handle 100 W of continuous power, with the amplifier being driven into clipping no more than 10% of the time on normal speech and music in noncommercial applications (no public address or disco service). Since the AR48s's frequency response has been optimized by careful design of the drivers and crossover network, no user-accessible balance controls are provided. The input connectors are insulated spring clips with holes that accept stripped wires.

Laboratory Measurements. The room response of two AR48s's was measured with the speakers against a wall (about 28 inches above the floor), and the microphone on the axis of one and about 30 degrees off the axis of the other. The averaged response was almost perfectly flat, with small fluctuations that are characteristic of a "live room" measurement. The left and right speaker curves did not diverge appreciably until the test frequency exceeded 10,000 Hz, indicating very good tweeter dispersion characteristics.

The bass response was measured with close microphone spacing to eliminate room interactions and give a true anechoic response. Speaker output was maximum at 80 Hz, falling off gradually at higher frequencies and at 12 dB per octave at lower frequencies. Combining the bass and room response to create a composite frequency characteristic resulted in an impressively uniform curve that varied only ±2.5 dB from 45 to 20,000 Hz. Using our analysis program with an Apple II computer, we were able to measure the anechoic frequency response of the AR48s from 180 to 17,000 Hz (these frequency limits are set by the measurement system, not the speaker). There were fairly narrow response dips at 3500 and 6500 Hz, and a peak of about 3 dB at 16,000 Hz, but the overall response (on axis) was within ±3 dB from 180 to 17,000 Hz.

The bass distortion, also measured with close microphone spacing, was very low. At a 2.83-V (nominal 2-W) drive level the distortion was less than 0.5% everywhere down to 60 Hz, 1% at 50 Hz, and 3.6% at 40 Hz. A 10-dB level increase (nominal 10 W) made little difference. Distortion was about 1% everywhere down to 60 Hz, 2.5% at 50 Hz, and 5.6% at 40 Hz.

The AR48s's impedance was slightly lower than rated, reaching a minimum of 3.5 ohms from 700 to 900 Hz. Over the remaining audio range it was typically 4.5 to 9 ohms, with a maximum of 15 ohms at 56 Hz. Voltage sensitivity was exactly as rated, 88 dB SPL at 1 meter when driven by 2.83 V of random noise in the octave centered at 1 kHz.

User Comment. The AR48s shares a basic quality of all AR speakers: deep, clean, effortless bass. In fact, bass was essentially equivalent to AR's former top-of-the-line AR3a. The smoothness and range of the higher frequencies are more in line with what we have come to expect from good-quality speakers, and the overall sound quality was consistent with the measured performance. In other words, the sound of the AR48s was excellent in every respect.

We also listened to several other speakers, both bookshelf and floor-standing types, priced well above and below the AR48s. And with respect to cleanness and natural sound balance, the AR48s certainly held its own. It has a slight tendency toward warmth, depending on the program material (the AR48's bass response is somewhat better than that of most speakers in its price range), but above all the sound is smooth and not at all tiring.

The current AR product line includes both floor-standing and bookshelf speakers. A purchasing decision should probably be made on the basis of individual installation requirements. Although the AR48s is one of the larger "bookshelf" speakers, it is not too big or heavy for wall mounting (don't use a standard bookshelf, however, since it won't be deep enough). The AR tradition of honest value and accurate specifications is certainly evident in this fine, up-to-date product.—*Julian D. Hirsch*

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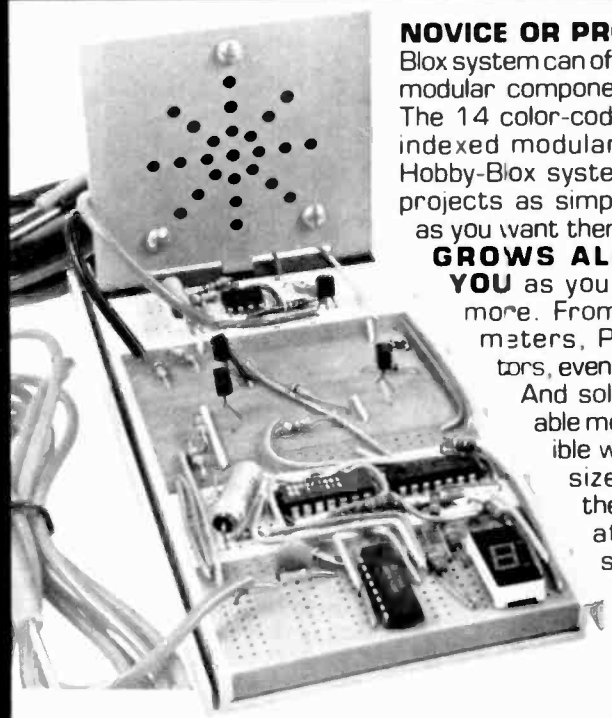

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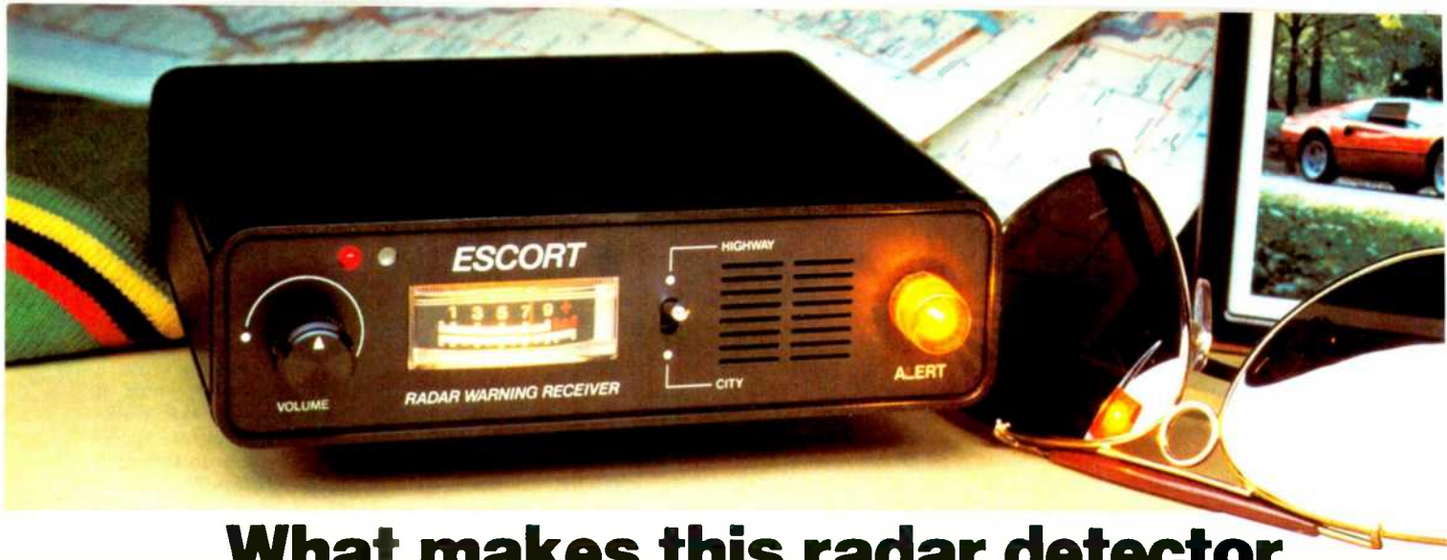

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Popular Electronics Tests

Sylvania 13" Color TV Receiver

THE Model CAA118WR is Sylvania's recent contribution to the expanding market for 13-in. receivers, which often serve as second color-TV sets. It features a new chassis (Model E31-02) with automatically regulated black-and-white and color levels, automatic fine tuning (aft), automatic gain control (agc), ambient light compensation, and a new horizontal/vertical countdown IC that eliminates manual picture-hold controls. Its infrared remote control has both direct-address and channel-scan, while the 105-channel tuner accepts uhf, vhf, and CATV inputs. Rear-panel controls allow the user to adjust sharpness, picture, color, and tint. The Chroma-Line picture tube is of the dark-faceplate variety. Dimensions are 13½" H × 19½" W × 15"D; weight is 27 lb. Suggested retail: $480.

General Description. The main chassis consists of a single board for the signal-processing and deflection circuits. It is colored blue with easy-to-read white lettering for component and test-point identification. The chassis may be unplugged from the deflection yoke, cathode-ray tube (CRT), and tuner—permitting easy service of its well-laid-out components. (Most ICs are in sockets.) The dc voltages are plainly marked, and component positions are legibly shown on the pc board's bottom.

The set's power supply input has both line and choke transient protection and a 4-A ac fuse. A bridge-type rectifier and large filter capacitors supply fullwave dc rectification and filtering to a three-transistor, single silicon-controlled rectifier (SCR) circuit that regulates the main 112-V dc power bus. A phase detector and zener-clamped error amplifier sense any voltage changes and furnish the necessary correction to the SCR driver—controlling SCR conduction time. Anode potential for this SCR is derived from the flyback transformer at the horizontal scanning frequency.

There is also automatic shutdown (in the event of excess high voltage) in the horizontal oscillator startup circuit. This circuit consists of two zener diodes and an SCR. When the flyback transformer's 220-V output varies enough to cause gate turn-on, the SCR shuts down the horizontal oscillator, taking out both raster and sound.

The receiver's preamplifier has a surface acoustic-wave filter input to reject adjacent-channel and CB interference. Also, the fullwave video detector permits a maximum bandpass output. Unfortunately, there is no comb filter, so even with a highly effective auto/manual sharpness control, just 3 MHz of video is delivered to the CRT.

Integrated Circuits. All six of the TV chassis's ICs are interesting, but two are of particular significance. (Sylvania's project engineering manager, George Kent, was kind enough to help. . . .)

The *IC700* chip (Fig. 1) eliminates the need for vertical and horizontal hold controls. It receives separate horizontal and vertical sync via ac coupling to the horizontal automatic phase detector and vertical timing counter, respectively. A 503.5-kHz voltage-controlled oscillator (vco) and ceramic resonator determine the clock rate for this proprietary IC. The 503.5 kHz is first divided by 16 and then by 2 to establish the horizontal sweep rate of 15,734.375 Hz.

The vco frequency accuracy is derived from a standard automatic phase control (apc) that compares horizontal timing from the receiver with broadcast horizontal timing pulses from the sync separator. If there is no phase-match, the apc generates a dc voltage. This dc, delivered to the horizontal driver, corrects the receiver's horizontal timing output. The horizontal apc also controls the first chroma amplifier and color killer with a gated pulse burst to the *IC600*'s internal keyer.

The *IC900* chip (Fig. 2), the automatic video-chroma processor, corrects black-and-white level variations, has an automatic color-level detector, automatic peak-detector, and an automatic black-level control. *(Cont'd on p. 28)*

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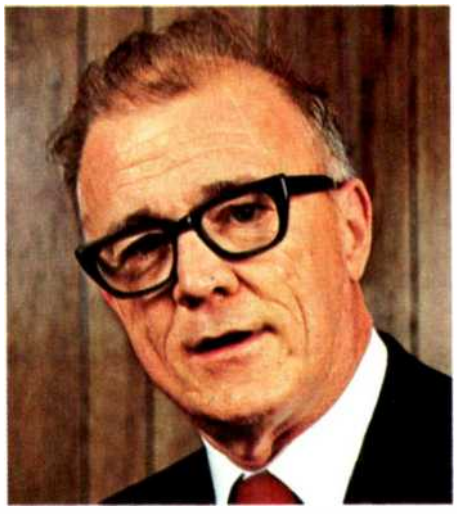

John E. Cunningham

Special Projects Director
Cleveland Institute of Electronics

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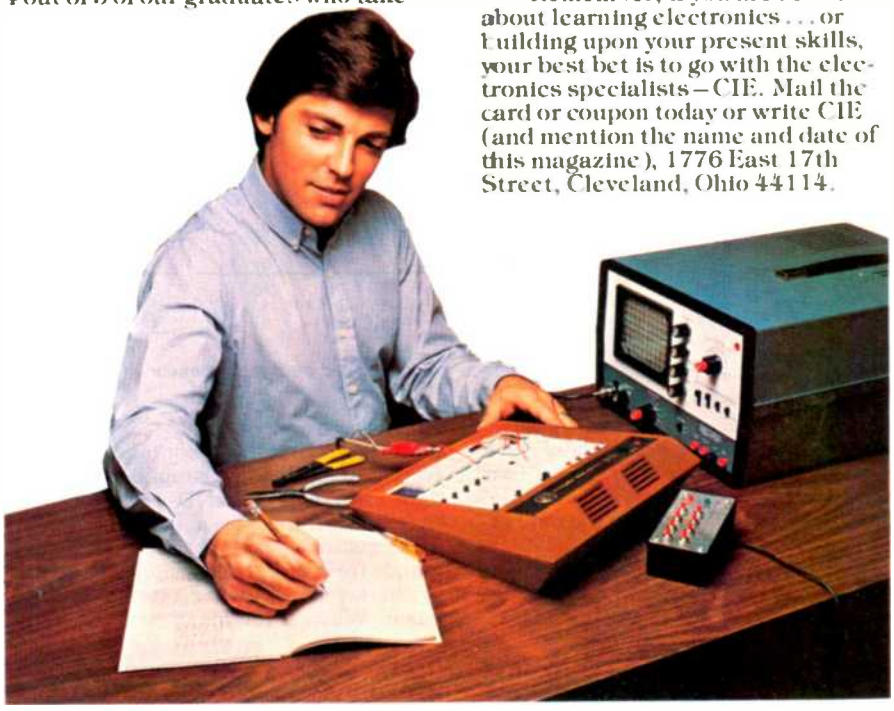

Pattern shown on oscilloscope screen is simulated.

PE-62

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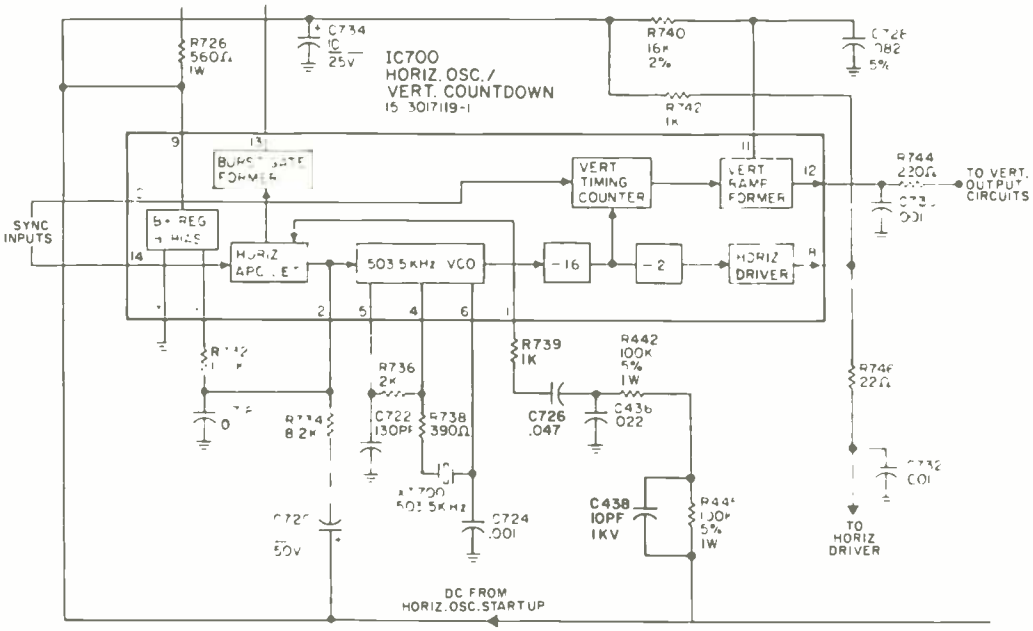


Fig. 1. Digital sync eliminates manual controls for vertical and horizontal holds.

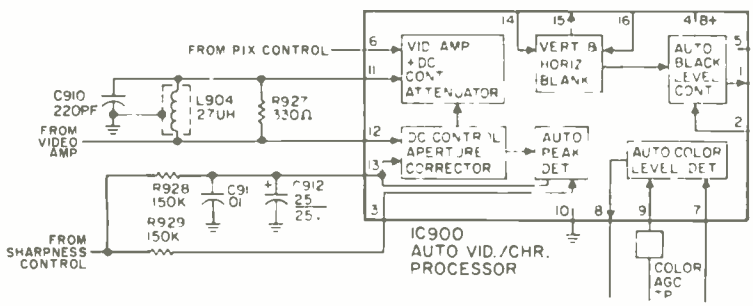


Fig. 2. Both color and luminance are controlled by this processor.

(Continued from page 23)

The *IC900* also contains a dc aperture corrector that receives composite video from the second video amplifier (not shown) and is, in turn, controlled by the automatic peak detector and the manual sharpness control.

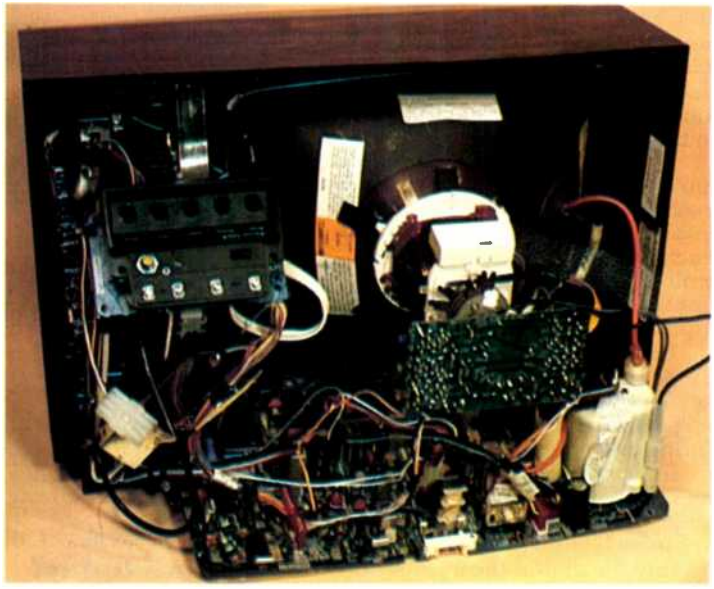
Common components *C910*, *L904*, and *R927* form a short, unterminated delay line. Delayed and non-delayed video are matrixed to produce aperture correction, equalizing preshoot and overshoot characteristics to give faster rise and fall times for video transitions.

The automatic level detector is actually a feedback arrangement from the color amplifier. Having a color-level threshold control and an agc circuit to monitor chroma gain, it holds chroma level constant in response to the manual adjustment of the "color" control.

Both the horizontal and vertical blanking pulses are joined in the *IC900*, forming a pedestal for the video output and black level. In this way, blanking pedestal heights are controlled to maintain a black-level clamp for overall picture stability. The Vertical Interval Test and Reference Signals transmitted during vertical blanking intervals remain unblanked, and can be seen in the video output. During active line periods, video is sampled outside the *IC900* and reintroduced into the picture as a black reference signal.

Remote Control. The receiver's remote-control section contains an infrared detector and amplifiers and a data set/reset NAND-gate flip-flop that is controlled by a microprocessor. This microprocessor carries out commands from either the remote keyboard or the keyboard on the receiver's front panel. When a command is received, it selects the channel via an IC frequency synthesizer and a shift register and then generates the channel number on an LED display. The same register also provides 64-step up/down volume adjustment through a control buffer. A synthesizer compares tuner frequencies with the output of a crystal-controlled oscillator. A dc difference voltage is then routed to aft, which makes the necessary fine-tuning correction.

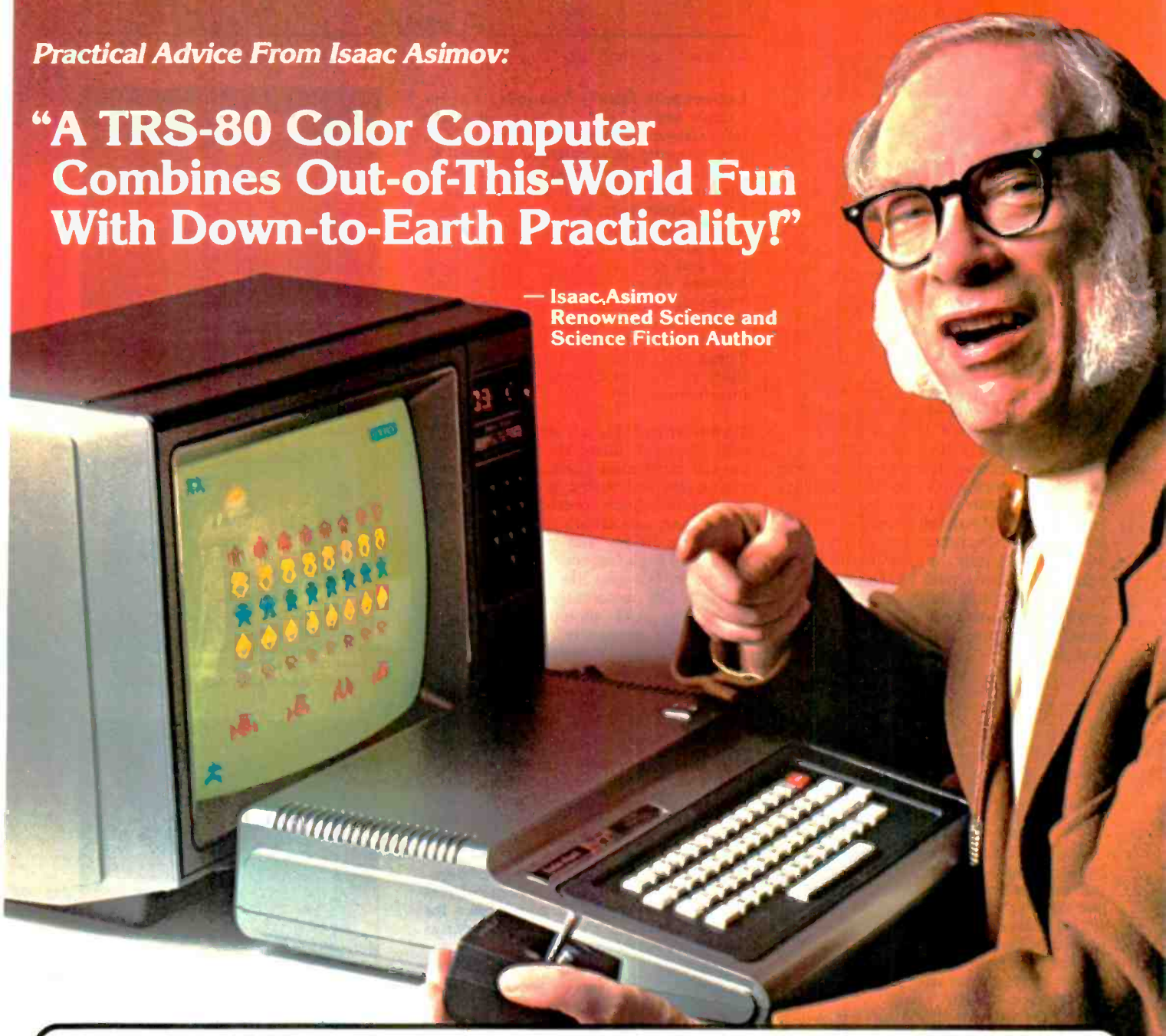
The remote keyboard has column and row identification, a clock generator, program controller with parallel-to-serial conversion, and pulse amplifiers for three infrared diodes and their driver. In practical terms, this means that the keyboard can handle channel-select (direct-address and scan), on/off, and volume up/down. You can also program access to a second channel (other than the one you're watching) onto the receiver, and the remote keyboard will call it up anytime you want a quick look.



Practical Advice From Isaac Asimov:

"A TRS-80 Color Computer Combines Out-of-This-World Fun With Down-to-Earth Practicality!"

— Isaac Asimov
Renowned Science and Science Fiction Author



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CIRCLE NO. 33 ON FREE INFORMATION CARD

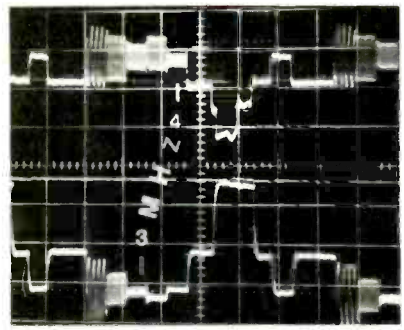
Laboratory Measurements. As previously stated, only 3 MHz of video information is delivered to the CRT. The intensity of luminance is 7000°K, producing a sharp, bold picture. (Note that degrees Kelvin in this instance is not a temperature, but a scale of brightness—7000°K being at the high end of the scale for a CRT.) The regulation of high and low voltages is good—ranging between 96 and 100% in all instances. Video signal-to-noise ratio is 42 dB, and dc restoration is a quite adequate 88%. Convergence ranks with the finest: 99%. Tuner sensitivity is satisfactory, and there is very good protection from CB interference.

Comments. This is a well-built chassis that uses the latest of Sylvania's advanced integrated circuits. These chips are augmented with a surface acoustic-wave input filter, overload protection, and a sharpness circuit that senses weak signal conditions and compensates by rolling off high frequencies and masking the noise. We also like the Perma-Tint feature for automatically "holding" fleshtones. And should you need to adjust this manually, the rear-panel controls are easy to reach.

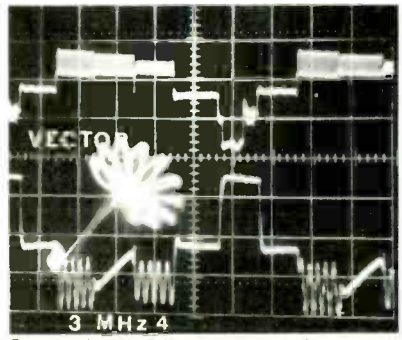
The versatile remote-control keyboard, however, is large and a bit unwieldy, with a left-handed scan button position and a "zero" key in the middle. Its quick-view position to glimpse a second programmed channel is a plus. It would be nice if Sylvania would add a 4-MHz comb filter to the set. Overall, though, the receiver offers good video color and a steady picture that's remarkably crisp for 3 MHz of luminance bandwidth. In practical terms, therefore, the smallness of the screen reduces the need for a 4-MHz comb filter for standard picture viewing, with savings passed on to the consumer.

—*Stan Prentiss*

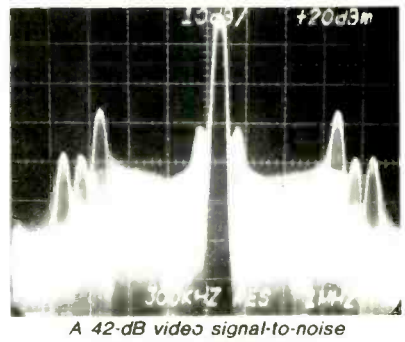
CIRCLE NO. 103 ON FREE INFORMATION CARD



Multiburst test shows 4 MHz at video detector, 3 MHz at CRT.



Swept chroma measurements show good vector and little rolloff at 4.08 MHz.



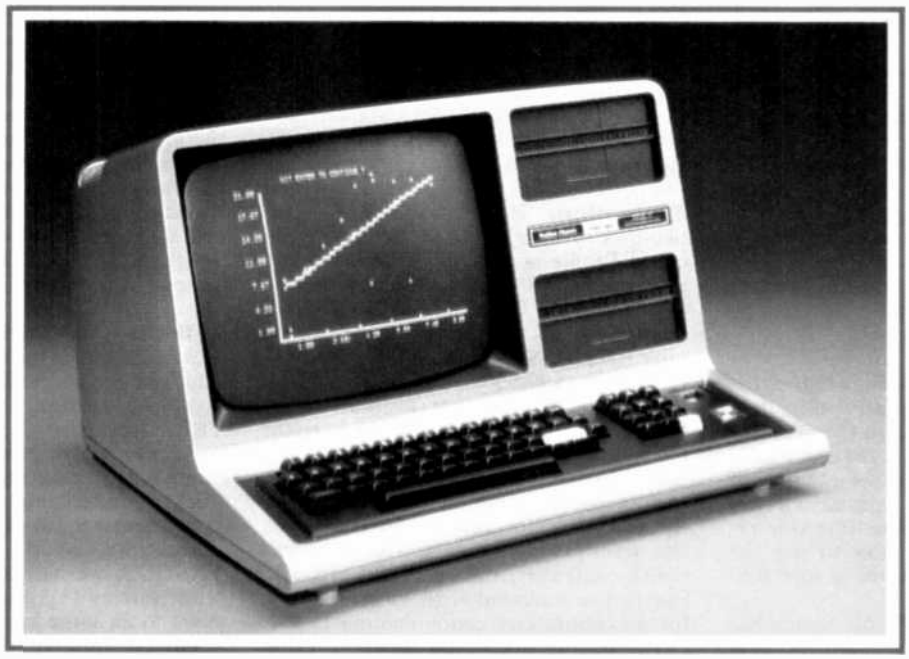
A 42-dB video signal-to-noise ratio rates with the best.

SYLVANIA MODEL CAA118WR 13" COLOR TV RECEIVER LABORATORY DATA

Parameter	Measurement
Tuner/receiver sensitivity (before snow):	vhf (Ch. 6): −5.5 dBmV uhf (Ch. 30): −3 dBmv
Voltage regulation w/signal input:	Low voltage: 24-V supply—100% 112-V supply—98.8% High voltage: 26-kV supply—96%
Video S/N at CRT:	42 dB
Luminance bandpass at CRT:	3 MHz
Luminance bandpass at video detector:	4 MHz
Dc restoration:	88%
Agc swing from saturation to cutoff:	62.5 dB (min.)
CRT color temperature:	7000°K
Horizontal overscan:	12%
Convergence:	99%
Power requirements (signal applied):	95 W (avg.)

Note: Instruments used in these measurements are: Tektronix 7L5, 7L12 spectrum analyzers; Telequipment D66, D67A oscilloscopes; Sadelco FS-30 VU f/s meter; Winegard DX-300 amplifier; Data Precision 245, 258, 1750 multimeters; B&K-Precision 1250 and 3020 NTSC and sweep/function generators; Sencore VA48 (modified), CG169 video & color bar generators and PR58 variable power supply; Tektronix C-5A, Minolta XD-11 cameras; and Gossen Luna-Pro light meter.

Popular Electronics Tests



Radio Shack TRS-80 Model III Desktop Computer

THE Radio Shack TRS-80 Model III offers more capability than the older Model I, yet Model III users can enjoy all the older machine's programming options since the units are software-compatible. Also, the Model III's self-contained packaging eliminates the unsightly external cabling required for the Model I.

The basic Model III features a high-resolution 12-in. black-and-white video monitor that can display 64 characters per line (the full display height is 16 lines) from a selection of 96 text characters, 64 graphics characters, and 160 "special" characters. Also, there is a 65-key board which includes a 12-key numeric pad, a cassette port (cassette recorder optional) capable of handling 250 baud with Level I BASIC, a parallel printer interface, a buffered bus for external expansion, and provisions for adding two internal and two external double-density 5¼" disk drives and an RS-232 port. A Z80 CPU operating at 2.03 MHz, 4K bytes of RAM internally expandable to 48K bytes, and 4K bytes of ROM expandable to 14K bytes are the principal electronic features.

Level I BASIC, stored in the 4K-byte ROM, features most standard BASIC commands, a screen display of 16 lines of 64 upper-case characters, 48 x 128 video graphics, a 250-baud cassette I/O rate, floating-point arithmetic, six-digit numeric accuracy, single-dimension arrays, limited string variables, command abbreviations, and simplified error codes. It also includes such printer commands as LLIST and LPRINT.

The optional Model III BASIC is stored in 14K bytes of ROM and requires 16K bytes of RAM to store variables. Execution time is about 30% faster than Level I and more features are available—repeating keys, a screen format of 16 lines of either 32 or 64 upper/lower-case characters, auto-scrolling, and a screen print command. The cassette baud rate is user-selectable (500 or 1500 baud), and you get multi-dimensional arrays, definable cursor, comprehensive string variable handling, automatic line numbering, extensive editing commands, TRACE/PEEK/POKE for machine-language routines, initialization of the optional RS-232 port, 23 error codes, and a special graphics set. Accuracy is 16 digits, and there is compressed storage for video display text. Program lines and string variables may contain up to 255 characters.

The Model III can control four double-density disk drives, each having 40 tracks of eighteen 256-byte sectors. The first drive (installed within the system) contains TRSDOS and Disk BASIC and allows 131K bytes of user space. Each of the other three drives provide 175K bytes. (Certain system information must be stored on every diskette.) Two disk drives can be installed within the Model III's cabinet, while two more can be externally mounted.

The unadorned Model III with 4K-byte Level I BASIC is priced at $699, the 16K-byte Model III BASIC system is tagged at $999 (more RAM can be added in 16K-byte increments at $99 each), and the RS-232 Serial Interface costs $99. The first internally mounted disk drive—including TRSDOS and Disk BASIC—is $849, and a second internally mounted drive is $399. Each external disk drive costs $499.

Several Model III configurations are also available—from a "starter" system to a full-blown business package—along with a considerable variety of software.

Expansion. It is very easy to expand or add peripherals to the Model III. If you want to add extra RAM or disks, the necessary items are available at your local Radio Shack store. However, be aware that the warranty is broken once *you* open the case.

For peripherals like printers, external disk drives, or a modem, the Model III

provides easy access via plug-in connectors underneath the unit. The parallel printer port, for example, uses a 40-pin, Centronics-compatible edge connector, and the RS-232C port uses a recessed DB-25. The external disk-drive connector, located behind the printer port, can cause problems if you make any wrong connections. However, sufficient documentation is available to show what goes where.

Besides standard peripheral connectors, there is an expansion connector for adding new items as they become available. If you're inventive, you can expand the Model III with designs of your own. However, don't approach this capriciously since you need a pretty good understanding of digital electronics and interfacing techniques to avoid damage to the computer.

Documentation. One of the highlights of the Model III is the quality of its documentation. Packaged with the machine is *Getting Started with BASIC*, a handy little book that covers the ins and outs of setting up the system, and easing you into ROM BASIC. By the time you finish reading, you know how to use the computer and have become a fair BASIC programmer.

For the disk system, Radio Shack has provided in-depth discussions of how disk BASIC works, with excellent examples to familiarize you with the operating system.

Something that we found unusual in the Model III documentation is the explanation of where everything is located in the ROM monitor. Exact locations are shown and various examples explain how all the functions are used.

The TRSDOS-operating system isn't CP/M, but it is very capable. And unlike CP/M, where you have to specify a drive that the desired file exists on, all you have to do is call TRSDOS. Then it looks for the name file on the available drives. This useful function makes this version of TRSDOS stack up well against other operating systems.

Radio Shack uses an unusual method of setting up its disk drives. Each disk has 40 tracks and each track is divided into 18 sectors of 256 bytes each. Nine sectors taken together is called a *gran* and equals 2304 bytes. When you save a program or data file, the system allocates one gran. If more disk space is required, the system assigns another full gran. On the Model III an initialized diskette with no data will have 80 grans.

In operation, a logical record is 255 bytes (one sector) long, and is the amount TRSDOS buffers during a read/write operation.

The disk system isn't the only thing intriguing about the Model III. Besides offering the normal display characteristics of upper/lower case and character graphics, Radio Shack has included 96 special characters that you can employ to enhance games or special applications programs. Character codes 192 to 255 are switched to by entering PRINT CHR$ (21) in BASIC. What you'll get are numeric functions like pi.

The Model III supports an upper/lower-case alphabet. Unfortunately, TRSDOS doesn't understand lower-case characters, and when used with the operating system, they produce an error message. Therefore, you must enter the lower-case mode by pressing the SHIFT key, holding down 0, and locking. Some application programs, such as Profile, won't recognize the lower-case characters, however, and thus take away some program flexibility.

Evaluation. Besides the 32K-byte, two-disk system hardware, we also evaluated Profile, a disk-based information package ($79.95), Scripsit wordprocessing ($99.95), COBOL ($199 and an additional 16K bytes of memory), Compiler BASIC ($149), and Macro Editor/assembler ($99.95).

The first part of our evaluation involved taking the cover off the system. (We don't recommend this, nor does Radio Shack.) We found a well laid-out arrangement. The logic boards are easily accessible for repair and consist of the main processor board with memory, a disk controller, and an I/O board. All boards are mounted with ½-in. spacing for maximum convection cooling.

All boards are wired together using flat cable that snaps into connectors on the boards. In earlier models, these cables were merely slipped in and could wiggle loose during transportation. We learned that the snap-in hardware was added to prevent this situation.

To see how well convection cooling worked, we put back the cover and placed a smoke source under the computer. This "smoke test" determines how well the unit dissipates heat. We found that the smoke moved through the TRS-80 III's top and sides in a smooth flow, indicating that care was taken in designing the computer's thermal characteristics.

Next we checked for RFI and EMI problems. Although the TRS-80 III meets the necessary FCC requirements, we discovered interference in the channel 2 (54-60 MHz) and channel 4 (66-72 MHz) range. This was true even with the cover replaced and tight connection made to a copper ground pole on the chassis. Interference was most severe during disk I/O, and least bothersome during a steady screen display with no memory or disk access taking place.

In order to evaluate the overall operation in terms of environmental extremes, we placed the system in a hot box and raised the ambient temperature to 120 degrees F. This temperature was maintained for 48 hours while multiple reads and writes were made to the disk system, using a finite number of data.

In this test, we write 1000 capital A's and 1000 lower-case a's to disk, read them back, kill the file, and start over. All the characters read were printed out. On inspection of the test data we found no loss on the read data.

Our next test is one that we consider the most severe. We set the hot box to room temperature (approximately 65 degrees F) and kept it filled with dirty air—tobacco smoke pumped in from a pipe-like flask. We ran the same read/write test, looking for soft errors caused by particulants on the media. After 100 cycles of the test, one soft error was produced, and after opening the case, we found a film of smoke particulants.

The only physical attribute we observed that was questionable was that the top drive cover goes under the lip of the system case, making it slightly difficult to flip down. At first we thought the two closing pins in the front could puncture a diskette, but we found that this is not the case unless the diskette is sticking out of the drive.

Software Scenario. Once we were satisfied that the hardware was solid, we attacked the software. Since this was a disk-based system, we first looked at TRSDOS.

As previously mentioned, this is a well thought-out operating system that's continually undergoing enchancements. In fact, this strength is its only weakness. Before we could begin looking at TRSDOS, we had to upgrade it to the latest version (1.3), using the Patch program to fix some known bugs. This took about 10 minutes and then everything worked correctly.

On powerup, the disk operating system looks for a disk in the lower drive (drive 0), and if there is no disk there, it goes to the upper drive (drive 1). If there is no disk there either, push SHIFT and BREAK at the same time to bring up cassette BASIC. Should you have a system disk in either drive, TRSDOS signs on with the copyright and version notice, and asks for the date. You can't bypass this, but are forced to enter the information. Next you're asked for time (which you can bypass). We recommend putting in the time since you'll possibly want to use it in an application program. The Model III's timekeeping utility is quite accurate—we found it lost only 10 seconds in 48 hours of operation.

One of the most important operation system commands is LIB for library. This will generate a list of all the commands available under TRSDOS including:

APPEND	ATTRIB	AUTO	BACKUP
BUILD	CLEAR	CLOCK	CLS
COPY	CREATE	DATE	DEBUG
DIR	DO	DUAL	DUMP
ERROR	FORMS	FORMAT	FREE
HELP	KILL	LIB	LIST
LOAD	MASTER	PATCH	PAUSE

The next most important command is, HELP. If you don't know how to use a particular command, and don't want to look in the manual, simply enter HELP and the command you want information on The Model III will respond with an explanation on how to use that particular command.

The DO command is unique and allows turnkey system operation. What you do is first BUILD a file, then DO it.

For example, entering BUILD TEST will cause a file called TEST to be created, and you'll be asked what TEST is supposed to do. In this case, the following dialog was used in our TEST DO file:

BASIC: loads BASIC
return: answers memory question
return: answers file question
RUN "EXERCISE/BAS": run a file.

Entering DO TEST causes BASIC to be loaded, the setup questions to be answered, and the file called EXERCISE/BAS to load and run. We used this method while in the test mode.

The command DUAL allows whatever is on screen to go to the printer at the same time. This command will stay in effect no matter what program is running, a feature that control-P in CP/M doesn't always allow.

Although TRSDOS will search all the disks on the system for a file, you have the option, by using MASTER, of setting up any drive to be the MASTER (0 drive). This option can become important, especially if you're doing a special application that requires switching diskettes, but it may be of more concern later on if you add hard-disk memory.

Since many reviewers are hung up on how fast BASIC works on a machine, we did the obligatory speed test. We employed 10 GOSUB 10 for our speed determination. The reason is that, when run, BASIC will push everything on to its stack to get to the subroutine (in this case it pushes all memory). For cassette BASIC we counted 10 seconds, the same for disk interpreter BASIC, and 3 seconds for compiler BASIC. This time is contingent on the amount of contiguous RAM. We found it to be acceptable for a system operating at 2 MHz.

For a more thorough test, we used Profile, a data-handling system designed for building data structures such as mailing lists. Using Profile, we built a list with the following attributes for a total of 67 characters (bytes):

Name: 20 characters
Address: 25 characters
City: 15 characters
State: 2 characters
Zip: 5 characters

We then built a datafile holding 100 records, and accessed them one at a time. Worst-case access time was 4.3 seconds for the 100th record. File sorting took a little too long—6 minutes—but we blame this on Profile, which isn't designed for high-speed ordering (it uses a bubble-sort algorhythm). We then printed the list. This took 7 minutes—not bad considering overall system throughput.

Although we did no time trials with COBOL, we brought it up without difficulty and, with reference to the manuals Radio Shack provides, had no problem getting into it.

Even though this version of COBOL is designed for interactivity of a microcomputer, we feel that a 5.25-in. disk isn't sufficient to provide all the functional features you need. A better environment is a hard disk where one has sufficient storage and rapid throughput not possible on a floppy-based system.

Scripsit, Radio Shack's word-processing system, uses a screen format that allows use of special characters—like the symbol for marking the start of a paragraph. Since the TRS-80 III keyboard doesn't have a CONTROL or ESCAPE key, Scripsit comes with stick-on labels to identify the operation of certain keys that will be redefined. The "at" (@) key, for example, is redefined as the CONTROL key, yet another key is redefined as the "at" (@) key.

We found this very confusing. Even though the keyboard layout doesn't handle the needed keys, we think Radio Shack should have elected to shift the keypad for use with Scripsit rather than scattering the function keys around the main keyboard.

Besides the confusion of new definitions, we learned that if you failed to enter the lower-case mode in TRSDOS, there was no convenient way to do so in Scripsit. This may be an oversight that can easily be corrected in a future update to Scripsit.

The Scripsit word processor works differently than others on the market, and only allows you to work on files that fit in existing memory. It operates by filling the available workspace with holes (spaces) and having you fill them in. This technique was used in early word-processing systems and isn't very efficient since you have to take care that no holes are left at the end of a file.

Scripsit comes with a manual and an audio cassette course that tells you how to best use the system. You can become very proficient after spending about an hour-and-a-half listening to the tapes.

Conclusions. The TRS-80 Model III is a highly functional microcomputer system ideally suited for data entry and engineering use. In addition, the system is flexible enough to be implemented easily in a networking environment.

Like many sophisticated personal computers, the Model III can be expanded for business applications. And like most, it is not ideally suited for this purpose, though it could serve well in a very-small-business environment. Some obvious drawbacks for business include the need to redefine some keys for Scripsit, limited disk-storage capacity, and ungainly lower-case implementation with some software.

As a high-quality personal computer with compromised business-use utility, however, the TRS-80 Model III deserves overall high marks for performance, general ease-of-use, and relative compactness. The storehouse of cassette and disk software that can be used with the III is enormous, of course. Coupled with the national support given by Radio Shack, and its expandability from a lowcost "starter" system to a modest desk-top business machine, the III should have wide appeal.

—Carl Warren

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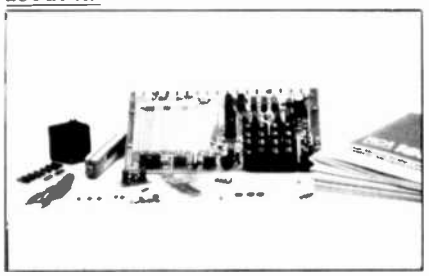

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COMPUTER BITS

By Carl Warren

Latest Micros Offer Power and Graphics

THE microcomputer race is running at even a faster pace than it was just a few months ago. Already, a number of manufacturers are responding to IBM by offering 16-bit power, while others are enhancing 8-bit designs with graphics functionality or lowering of costs. The most notable entry in the last few months is the Model 16 from Tandy/Radio Shack.

Introduced this past January, the Model 16 is a "downward-compatible" machine to the Model II. Employing both the 16/32-bit Motorola 68000 and a Zilog 8-bit Z80A microprocessor, the system supports up to 512K bytes of user memory and is software compatible to the Model II. Besides serving as the "engine" in the 8-bit mode, the Z80 assumes the additional task of handling I/O duties, screen refresh, and general system housekeeping.

The Model 16 has a starter price of $4999 for 128K bytes of memory, a single 1.25M-byte Tandon 8-in. drive, and one parallel and two serial RS-232C ports, one of which is capable of bisynchronous operation with IBM and other mainframes. A hard-disk port can be added to permit up to four 8.4-megabyte drives. Provisions have been made to use the ARCNET local network, which can support any combination of 255 Model II and Model 16 computers. Adding memory is done in 128K increments with the first add-on costing $499 for the 128K RAM chip set. Adding the final 256K costs an additional $1200, $699 for the board with 128K and $499 for the final 128K RAM set. An additional drive is priced at $799 for a full system price of $7495. Adding the 8.4M-byte hard-disk system brings the price to $9993.

For those applications that require graphics display, Radio Shack has the high-resolution graphics board for $499. The board which is designed to fit on the backplane of either the Model 16 or Model II contains 153,600 bits of refresh memory to maintain the display. Cables are connected to the video board so the graphics screen is synchronized with the character video screen.

Working in tandem with the video board is an enhanced BASIC either for the Z80A or 68000 that provides such graphics attributes as: LINE, CIRCLE, PAINT, and GET and PUT.

Since the operating system for the Model 16 supports both multiuser and multitasking operations, you can attach either two additional TRS-80s or the TRS-80 Model DT-1 Video Data Terminal for $699 each.

This 8-bit microprocessor-controlled terminal emulates a Televideo 910, Adds 25, Lear Siegler ADM-5, or Hazeltine 1410. Terminal characteristics are saved during setup in EPROMs, thus eliminating the necessity of having DIP switches.

Should you already have a Model II and want the additional power offered by the 68000 microprocessor you can purchase the $1499 Model 16 enhancement option. This two-board option fits into the backplane of a Model II, and contains a Z80A and 68000, plus necessary serial I/O. The memory board comes with 128K of memory expandable to 256K, which is the maximum permissable on the Model II due to power supply considerations.

To take advantage of all the attributes available in the system, Radio Shack has developed a multiuser/multitasking operating system. Even though they present the machine as being able to use all current Model II software, they have or are developing a number of application packages to take advantage of the 68000. You should, for example, be able to purchase now a 16-bit version of the popular ScripSit wordprocessing package, Profile database handler, and powerful communication software, that gives you IBM bisync compatibility.

Even more is available, from the Texas giant to enhance your data-processing capability. Introduced at the same time as the Model 16, the TRS-80 Pocket Computer Model PC-2 is priced at $279.95. The PC-2 comes with a 16K ROM BASIC that is equivalent to that available on the Model III and uses a proprietary 8-bit CMOS microprocessor operating at 1.25 MHz. Four AA alkaline batteries supply power.

In addition, the powerful hand-held has programmable function keys. The LCD display has 26 character positions with upper/lower case, and the 7 x 156 dot matrix is completely controllable by BASIC for the generation of special characters including Greek math symbols. Furthermore, the display has an 80-character buffer with automatic scrolling for lines over 26 characters.

The basic unit comes with 2K of user memory, expandable to over 18K with a unique cartridge system that plugs into the back of the unit. Currently, you can purchase a 4K RAM module for $69.95 with larger modules as well as special ROM modules available soon.

To further increase the functionality and expandability of the PC-2, there is a 60-pin I/O bus containing address, data, and control signals that enable connection to a wide range of peripheral modules. One of the first add-ons, is a printer that has 9 different character sizes with up to 36 characters per line in four colors on standard—cash register—2.25-in. paper. Any one of the four colors (red, blue, green, or black) can be selected under software control for creating graphics plots with resolution as fine as 200 x 500 points. When you add this $239.95 option to the PC-2, you also get an additional 25 commands to enhance BASIC with special graphics.

Radio Shack TRS-80 Model 16 Microcomputer

In addition to the above, Radio Shack is offering a low-cost networking scheme called Network III, priced at $599. This clever device is a software-controlled RS-232 serial multiplexer that allows as many as 16 users to share resources at data rates up to 19.2K baud.

Interestingly, the Network III, doesn't necessarily require a TRS-80. Therefore, it may make an ideal solution for networking a number of different systems. Be aware, however, that software is required to handle the polling function, and currently it's only available for Radio Shack equipment.

More for the home than the office, is Commodore Business Machines Inc.'s Ultimax and Commodore-64.

The Ultimax, which has a planned selling price of $149.95, is a programmable color computer, which will compete with sophisticated video game machines like those offered by Atari and Intellivision. The Ultimax connects to any TV set, features a flat membrane keyboard, is programmed in BASIC and uses both ROM cartridges and tape cassettes for games, programming and music synthesis. In addition, you can add joysticks, paddles and light pens to enhance the "entertainability" of the machine.

To match the low end of the small business world, there is the Commodore-64 that has a price of $595. This system is to compete with the Apple II+ and similar machines. It has a CP/M option and comes with 64K of memory and a 66-key keyboard with upper and lower case capability.

Color appears to be the rising attraction as a user-oriented feature. And Astrovision with the Astroarcade is prepared to cash in on the capability it offers.

The Astroarcade is a Z80 based add-on system starting at $299 for the basic game unit with a $599 keyboard unit that houses a disk controller. It also has serial ports, cassette tape controller and voice synthesizer, and is totally oriented toward color.

The system, designed by Jeff Frederiksen, developer of the coin-operated circuitry used in Bally arcade games, says it's the only personal computer that approaches the realism and animation capability found on coin-operated arcade machines. This wizardry is achieved by employing three microprocessors, 4K of RAM, 8K of ROM (expandable to 32K), and an optional Astro BASIC in ROM cartridge.

The custom-designed video processor chip, operating at 7 MHz, handles all color manipulation and NTSC broadcast quality video. The result is a color display that rivals even expensive commercial graphics processors.

In operation, you can select from a pallete of 256 colors (four at a time in video games or two at a time with Astro BASIC). The screen is continually mapped in 4K RAM allowing for com-

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plex imagery that approaches that found on expensive CAD graphics systems.

The second processor, also a custom I/O chip, handles the interfacing to hand-held controls, and is responsible for producing music equal to that available on expensive music synthesizers.

Attaching the Arcade to the ZGrass-32 (keyboard element) computer gives you Z80 power and the use of other peripherals including disks, printers, and modems. (See the color photo in "The Electronic World," made by Real Time Design, Inc., with this system.)

For business applications, there is the Toshiba Model T100. This powerful system built around a 4-MHz Z80A, sells for about $800 with keyboard, 64K RAM, 32K ROM, and audio cassette interface. For $1450 you can add disk storage and $900 attaches the C. Itoh Model 8510 dot-matrix printer.

The display system can either be your home TV or a $900 color monitor. The display is an 80-character x 24-line display and 25th status line, as well as the choice of 8 colors and graphics with resolutions as high as 640 x 200 dots.

By employing the yet unpriced expansion unit, you can add communication interfaces, and special controller cards such as an IEEE-488 board.

To ensure compatibility to a wide range of user software, Toshiba has elected to employ Digital Research's CP/M operating system, with a special BIOS to enhance the user interface via menu selection.

Although the T-100 was shown at the January CES, it isn't planned for full scale availability until sometime after NCC this June.

Even the Chinese are joining the race with a system from Tatung Company of America Inc. Their Model MCS-32xx series, built in Taipei Republic of China, is based on a Z80A 4-MHz single-board computer that supports up to 208K bytes of user memory, 6 serial ports, 1 parallel port and a hard-disk interface. A typical configuration is the Mode MCS-3240-4 with two quad-density, 8-in floppies for 2M bytes storage, 64K RAM, and a parallel port. It can support two users under Digital Research's MP/M II O/S, for under $10,000 including the Model VT-8210 8085 microprocessor based intelligent terminal, which has a price of under $1000 for a version with 8K RAM (expandable to 32K).

Using a memory management scheme, for the 4116, 16K, 200-ns RAM, the unit is able to effectively handle the necessary switching of memory banks to accommodate the needs of MP/M II.

Should small size and small price be what you're looking for, then take a look at Panasonic's JR-100 priced at $199. Employing a Motorola 6802 microprocessor, it has 16K RAM (expandable to 32K) an 8K ROM operating system with integer BASIC, and attaches to your home TV. All the system components are housed in a small typewriter style keyboard. An expansion chassis is used to provide voice synthesis and recognition, and joystick I/O and serial I/O ports for hanging on printers and modems. Power to the system is supplied via an ac adaptor with a more hefty power supply apparently required for the optional high-speed cassette.

Although Panasonic officials were reluctant to discuss the attributes of the machine, they did say that formal introduction is planned for about July with production models being available shortly thereafter. Apparent hang-ups center around the lack of FCC registration and paucity of software. One package that you might expect though is a $10 word-processing system.

FOR MORE INFORMATION

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

Astrovision Inc.
6460 Busch Blvd., Suite 215
Columbus, OH 43229
800-848-6989

Commodore Business Machines Inc.
681 Moore Rd.
King of Prussia, PA 19406
215-337-7100

General Consumer Electronics Corp.
233 Wilshire Blvd.
Santa Monica, CA 90401
213-394-9667

Panasonic
1 Panasonic Way
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201-348-7000

Tandy Corp./Radio Shack
1800 One Tandy Center
Fort Worth, TX 76102
817-390-3300

Tatung Co. of America Inc.
2131 Gladwick St.
Compton, CA 90220
213-637-2105

Toshiba America Inc.
Information Processing Systems
2441 Michelle Dr.
Tustine, CA 92680
714-730-5000

Getting even smaller, there is a microcomputer that fits on your wrist. So if you want to wipe out a few hundred alien invaders while sitting on an airplane, or pit your athletic prowess against the onslaught of nerveless electronic sportsmen, then you're a candidate for a wristwatch microcomputer.

These marvels of electronics couple a quartz watch with a 12x24 cell LCD display and are available from General Consumer Electronics Corp. (GEC) in a game-playing series of watches aptly called: Game-Time, Arcade-Time, and Sports-Time.

Each of these unique watches is priced at under $40 and plays multiple challenging games in the electronic field. The Arcade- Time watch, for example, comes with Hyperblast, Planet Raiders, Galaxy Gunner, and Cosmic Clash.

While playing the games, you can use the built-in micro-joystick and firing button to maneuver your missiles and guns to just the right position to wipe out the opposing side. And as you tire of one game, a touch of another button sends you off on a new adventure.

If you're more addicted to the excitement of sport and want to pit your abilities against electronic Abdul Jabars, then select Sports-Time. With this watch you can play football, basketball, or soccer. Using the joystick, you can move in for that all important goal, hat trick, or out-fox the computer.

The game characters are depicted in multiple cell graphics symbols on the LCD display and interact with your moves. To increase excitement, sound is added as you unleash your weaponry against the unyielding foe.

To keep you in touch with reality, the watch even tells the time and date.

Of course you may have more important things to do in between playing games, like adding up the total of your expense account. GEC has the answer for this also with their under $40 Chase-N-Counter calculators.

As with the watches, you can tell the time, have a quick game of Star-Sweep (a Star Trek type of game), or add up your wins using the calculator keypad.

A game-playing microcomputer on your wrist may seem frivolous now; but so was the Altair microcomputer introduced in POPULAR ELECTRONICS just six years ago. ◇

Radio Shack's Model PC-2 provides pocket-size high-level data processing.

Popular Electronics
MAY 1982

DIGITAL AUTOMOTIVE TUNE-UP METER

Use it to measure and adjust dwell, rpm, voltage on your car, boat, cycle, or lawn mower

BY C. R. BALL

IT's costly to have a mechanic tune up your automobile regularly so that it can run smoothly and use gasoline efficiently. You can do it yourself, however, with no great investment in tools or training. All that's generally needed is a single combination instrument that will measure dwell angle, engine rpm, and voltage.

Such an instrument is the DATUM (Digital Automotive Tune-Up Meter) described here. Featuring a digital readout, it's easier to use and is capable of better accuracy than analog-type meters since there are no scales to be interpolated and there's freedom from parallax error. Cost to build is only about $70.

The DATUM uses a 3-digit, 7-segment LED display, and can measure 0 to 9999 rpm, dwell angles from 0 to 99.9°, and dc levels from −9.9 to 99.9 volts. The instrument is compatible with most factory and add-on electronic ignition systems, as well as conventional Kettering (points/breaker) ignition. Any engine (4-, 6-, or 8-cylinder, 2- or 4-stroke) can be tuned up using this instrument. Therefore it is useful for motorcycles, boats and lawn mowers, as well as cars.

Circuit Operation. The basic voltage-measuring circuit (Fig. 1) is designed around *IC1*, a dual-slope, A/D converter, and *IC2*, a BCD-to-seven-segment decoder/driver. The latter drives the parallel-connected segments of *DIS1* through *DIS3*, while *Q1* through *Q3* provide the digit enable. This chipset,

originally developed for an RCA digital voltmeter, provides a full-scale sensitivity of 999 mV and is used for all DATUM measurements: VOLTS, DWELL, and TACH (rpm). In the VOLTS mode, the input signal applied between *J4* and *J3* is scaled by a 100:1 precision divider (*R14* and *R15*) to yield a full-scale reading of 99.9 V. In this mode, *S1C* provides the decimal point via *R3*.

The TACH and DWELL modes share a common conditioning stage (*C8*, *R10*, *D2*, *R8*, and *Q4*) in which the input signal from the distributor is standardized in height and shape. In the DWELL mode, the low-impedance output from the collector of *Q4* (across *R11*) is routed via DWELL CAL potentiometer *R12* and series resistor *R13* through switch *S1A* to the network consisting of *R16* through *R20* and *C9* which averages the value of the distributor duty cycle. Scaling is achieved by *R19* and *R20* in conjunction with the precision divider network *R16*, *R17*, and *R18*. The proper scale factor is selected by *S2B* for 4-, 6-, or 8-cylinder engines. The signal selected by *S1* is then applied to the input of *IC1*.

In the TACH mode, the signal from *Q4* triggers one-shot multivibrator *IC3* with each point closure. Extraneous triggering from the ignition system ringing is avoided by using a second one-shot within *IC3* to disable the first when the points open. A CMOS one-shot is used because a MOSFET device output does not have the inherent V_{ce} (SAT) offset of bipolar devices. The CMOS thus allows proper zero. The tachometer signal is also routed via *R9* and *S1* to *C9* for averaging, and application to the dc voltmeter chipset.

Five-volt operating power is provided by regulator *IC4*, which is driven from battery *B1* or an external 12-V input applied via *J1*. Diode *D1* protects the circuit from accidental reverse voltage application at *J1*.

Construction. Although the circuit can be hardwired, the use of a double-sided glass-epoxy pc board (as shown in Figs. 2 and 3) is suggested. Two separate pc boards can be fabricated (one for the top and the other for the bottom foil pattern) and used "back-to-back" with interconnections between the boards made via the component leads and IC socket pins (the three ICs should be mounted in sockets). In either case, drill all required holes.

Mount the components on the two sides of the pc board as shown in Figs. 4 and 5. Observe correct component polarity, soldering on *both* sides of the pc board where required. Make sure that there are no solder bridges between adjacent copper traces. Since *IC1*, pin 11, has a very high input resistance (ap-

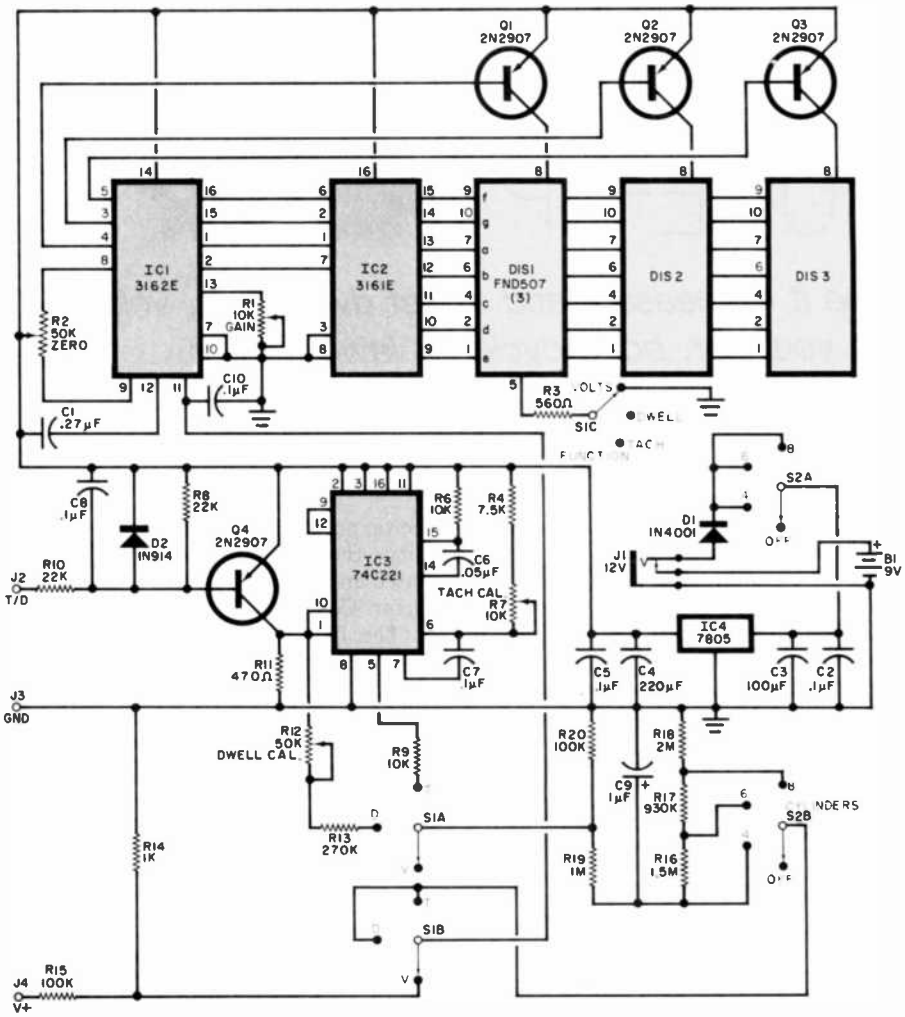


Fig. 1. Schematic diagram of the digital tune-up meter.

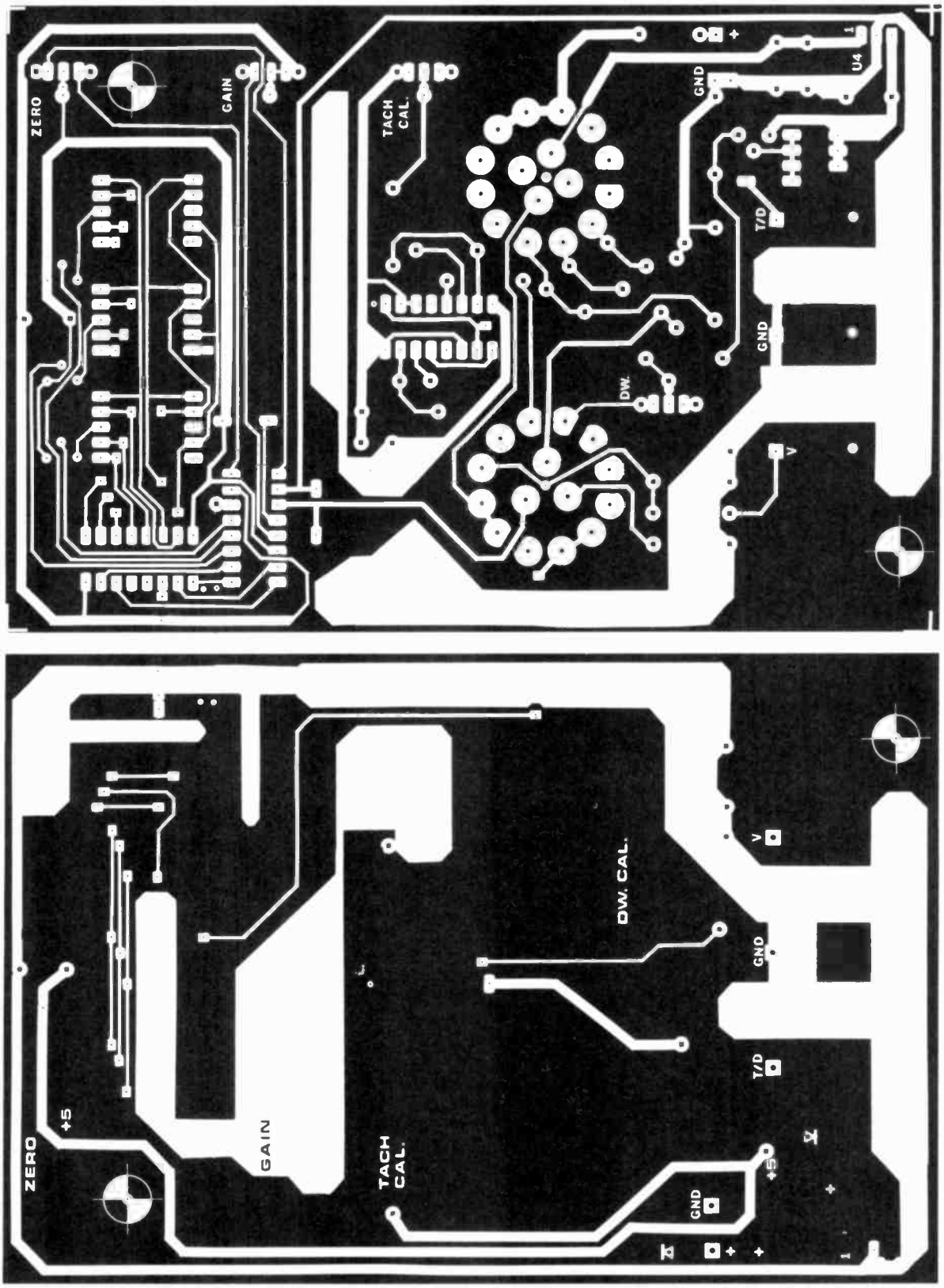
PARTS LIST

B1—Six AA cells, alkaline or NiCd
C1—0.27-µF, 100-V Mylar capacitor
C2, C5, C8, C10—0.1-µF, 25-V ceramic capacitor
C3—100-µF, 16-V aluminum electrolytic
C4—220-µF, 10-V aluminum electrolytic
C6—0.05-µF, 100-V Mylar capacitor
C7—0.1-µF, 100-V Mylar capacitor
C9—1.0-µF, 100-V Mylar capacitor
D1—1N4001 rectifier diode
D2—1N914 signal diode
DIS1 through DIS3—Common-anode seven-segment LED display, (Fairchild FND 507 or similar)
IC1—CA3162E, A/D converter
IC2—CA3161E, seven-segment decoder/driver
IC3—74C221, dual monostable
IC4—7805, 5-V regulator
J1—miniature closed-circuit jack
J2, J3, J4—Banana jack (H. H. Smith 1505 or similar)
Q1 through Q4—2N2907A transistor
The following are 5%, ¼-W resistors unless noted otherwise.
R1, R7-10-kΩ, cermet trimpot (Sangamo-Weston 593-840P-10K)
R2, R12—50-kΩ, cermet trimpot (Sangamo-Weston 593-840P50K)
R3—560 Ω
R4—7.5 kΩ
R5—not used
R6, R9—10 kΩ
R8, R10—22 kΩ
R11—470 Ω
R13—270 kΩ
R14—1 kΩ, 1% metal film
R15, R20—100 kΩ, 1% metal film
R16—1.5 MΩ, 1% metal film (calculated 1.44 MΩ)
R17—930 kΩ, 1% metal film (calculated 910 kΩ)
R18—2 MΩ, 1% metal film (calculated 2.06 MΩ)
R19—1 MΩ, 1% metal film
S1—3-pole, 4-position pc-mount rotary switch (C&K 304-15-N-C-Q)
S2—2-pole, 6-position pc-mount rotary switch (C&K 206-15-N-C-Q)
Misc.—Enclosure (H.H. Smith 2257), heat sink for IC4, knobs (2), battery holder.

Note: The following are available from Ballabe-Atlanta, P.O.B. 776, Duluth, GA 30136: Complete kit of parts including enclosure for $69.95 plus $3 postage/handling. Also available separately: pc board (810403) for $9.95 plus $1 postage/handling; two rotary switches (DSS) for $5 plus $1 postage/handling; IC1, IC2, and IC3 (DIC) for $12.50 plus $1 postage/handling. Georgia residents add 3% tax.

proximately 100 megohms), be certain all solder flux is removed from between this IC socket pin and adjacent foil traces. Other than the ICs that will be plugged in later, the remaining semiconductors—including the three displays—can be soldered in place. Check that the displays are properly oriented.

Before installing the rotary switches suggested for *S1* and *S2*, note that they have adjustable stops. These are set for the proper number of positions by removing the nut and washer and repositioning the stop tab. The circuit board has been designed so that the switches called for in the Parts List cannot be improperly installed. Drill the three 25/64″ holes shown in Fig. 4 for easy wiring



Figs. 2 and 3. Foil patterns for the two sides of the printed circuit board.

to the three front-panel input connectors: T/D, GND, and V+.

The finished pc board can be tested, before final installation, by connecting a 12-volt dc source across the proper *J1* inputs (Fig. 5).

Look for 5 volts at the output of voltage regulator *IC4*. If this voltage is present, temporarily short pins 10 and 11 of *IC1*. The display may show a three-digit number (see Fig. 6F), positive overrange, or a minus sign and two digits (or Fig. 6E), negative overrange. In either case, adjust ZERO potentiometer *R2* until the display shows 000. If any digits or segments are missing, check all connections to *IC1*, *IC2*, the digit driver transistors, and the displays.

Once the pc board is working, then the front panel can be drilled. (Note that the board is slightly smaller than the front panel of the suggested enclosure). Using the finished board as a guide, drill holes for *J1*, *J2*, *J3*, and *J4*, the two switches, and a rectangular cutout for the three displays. The display opening is covered with a piece of polarizing filter that's epoxied on the rear of the front panel.

After cutting the two switch shafts to length, knobs are installed, and each stop position is identified. The six AA cells are installed in a battery holder secured to the bottom of the enclosure housing. Suitable lengths of color-coded lead connect the battery to the pc board. Diode *D1* prevents damage in the case of inadvertant reverse-polarity installation. Before securing the board to the enclosure, test and calibration procedure should be done, as follows.

Test and Calibration. With the DATUM powered from either the internal battery, or from a 9-to-15-V external dc source at *J1*, note that the three displays illuminate. If 000 is not lit, readjust ZERO potentiometer *R2* for this display.

Apply a known dc voltage (less than 99.9 V) to GND (*J3*) and V+ (*J4*). Adjust GAIN potentiometer *R1* until the display indicates the known input voltage (*do not* readjust ZERO control *R2*). Error displays indicating an overvoltage condition and/or lead reversal are as shown in Fig. 6E and Fig. 6F.

Place CYLINDER switch *S2* in the 4 position, and set FUNCTION switch *S1* to DWELL. Allow a few seconds for the system to stabilize, then short the T/D and GND jacks together. Adjust DWELL CAL potentiometer *R12* until the display shows 90.0 ± 1 count. Rotate CYLINDER switch *S2* to 6, and with the T/D and GND still shorted, note a display of 60.0 ± 1 count. Then, with *S2* at 8, the display should indicate 45.0 ± 1 count.

If any variation is greater than one count in the 6 or 8 CYLINDERS position, check the divider network of *R16*, *R17*, and *R18*. To verify the conditioning and averaging circuit, use the test signal source of Fig. 7 connected between the T/D and GND connectors. The display should show one-half the previously mentioned indications.

The circuit of Fig. 7 can also be used to check the tachometer portion of the DATUM. The TACH X10 display (rpm) is derived from (600 x frequency of test generator)/(sparks/second at 600 rpm). Since the output frequency of the test circuit is 60 Hz, and there are 40 sparks per second at 600 rpm for an 8-cylinder 4-stroke engine, the formula yields 900 rpm. The Table gives some pertinent engine ignition information.

With the test generator connected to the T/D and GND front-panel connectors, place the CYLINDER switch at 8 and the FUNCTION switch at TACH X10. Adjust TACH CAL potentiometer *R7*, for a dis-

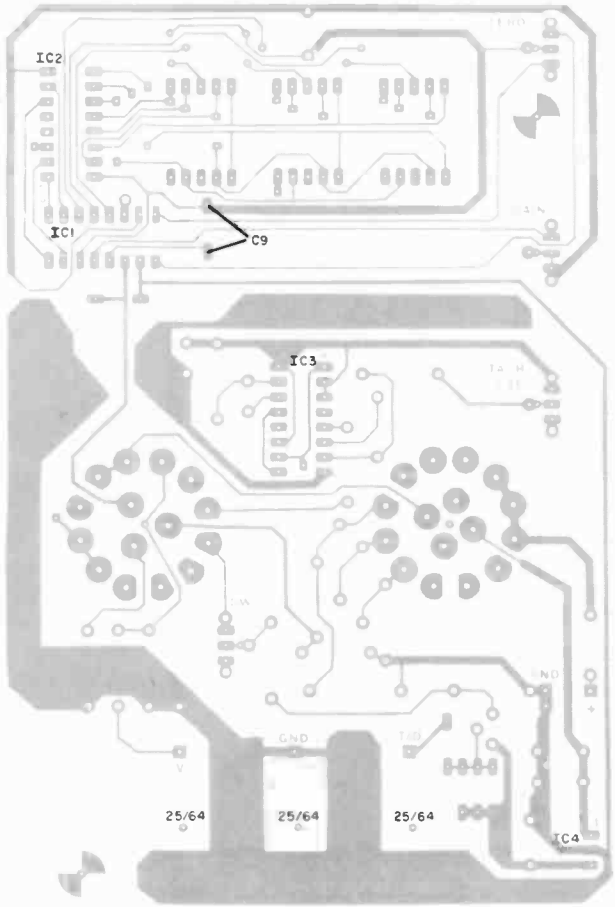


Fig. 4. This side of board goes against front panel.

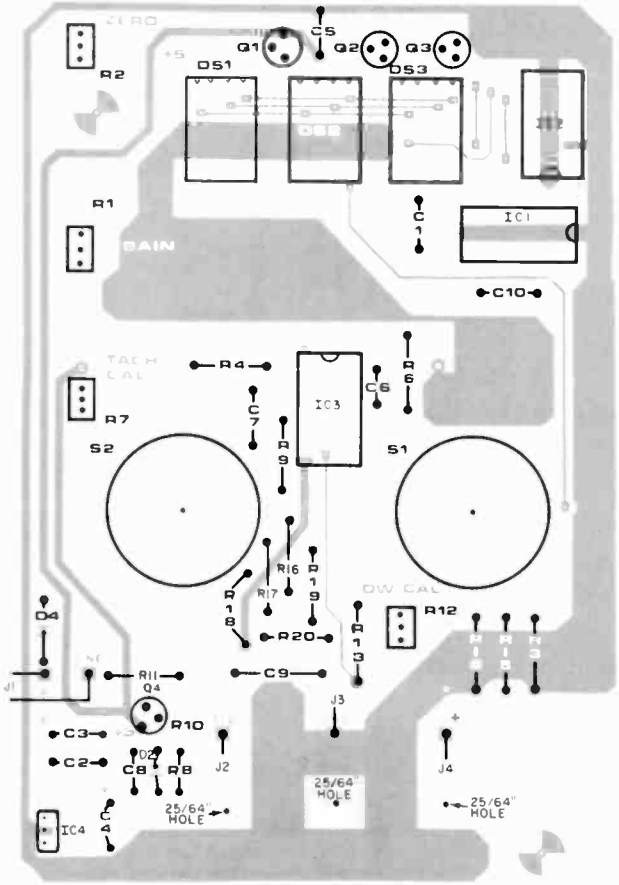


Fig. 5. Component layout for back of pc board.

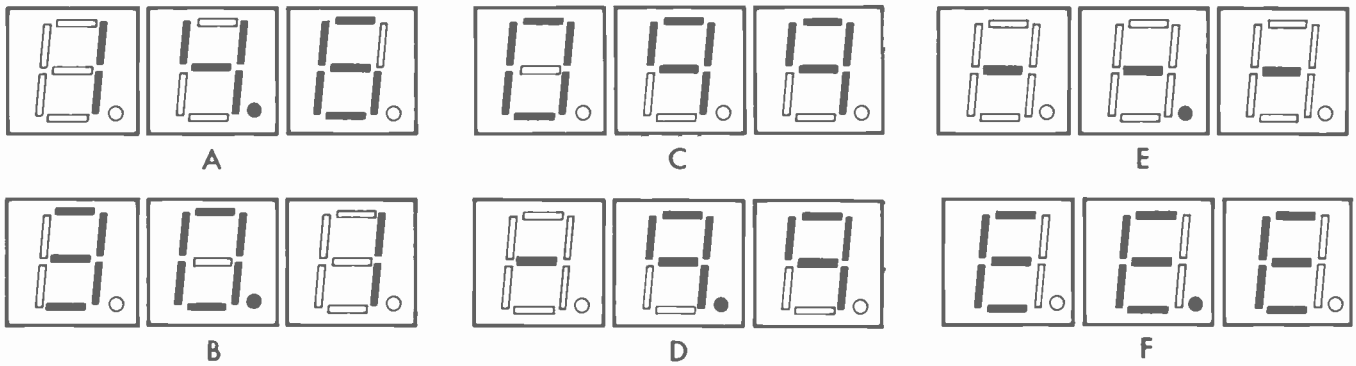


Fig. 6. Typical DATUM displays for different modes of operation.
(Note: Setting of CYLINDERS switch is not important for voltage measurement.)

(A). Battery voltage of a 12-V system with engine running (VOLTS function).
(B). Dwell of 4-stroke, 8-cylinder engine (DWELL function, 8 cylinders) Note: the ".1" is insignificant since meter accuracy is specified ± 1 digit.
(C). Reading of rpm of a 4-stroke engine (8 cylinders, TACH X10 function). Note: Must be multiplied by 10, yielding 990 rpm.
(D). Negative voltage measurement or accidental lead reversal (VOLTS function).
(E). Negative overrange display. Indicates reversed leads and voltage outside meter's range (VOLTS function).
(F.) Positive overrange display indicates voltage outside meter's range but proper lead orientation (VOLTS function).

play of 090. Note that the least-significant digit is not displayed, and all rpm values must be multiplied by 10 in this mode. With the CYLINDER switch set to 6, the display should show 120; when set to 4, the display should read 180.

Once calibration has been performed, place a small drop of adhesive or nail polish on each rotating shaft of the calibration potentiometers to eliminate the possibility of motion with vibration.

Tune-Up Tips. The DATUM is used in much the same way as any conventional analog tune-up meter. Space does not permit detailed information on all ignition systems, so only three basic systems will be referred to as examples (Fig. 8). Here are the basic tune-up procedures as related to the DATUM:

- Always refer to your owner's manual, shop manual, or engine nameplate for the specifications applicable to your vehicle, bike, or boat. Obtain manufacturer's literature for add-on capacitive discharge ignition (CDI) systems.
- For continuity checks, use only the Datum's batteries and disconnect the negative lead of the vehicle battery.
- Our discussion assumes a negative-ground system. For positive-ground systems, all lead connections mentioned here should be reversed.
- Some 24-V systems may have different specifications. Refer to the owner's manual.
- Dwell, rpm, and timing are interactive. Dwell should be adjusted *before* timing since the dwell angle will affect the timing measurement. The best procedure is to repeat all measurements in sequence, trimming the adjustments until all readings are correct.

Continuity Checks. Although the DATUM does not have an ohmmeter function, it can still make continuity checks on wiring, bulbs, fuses, and diodes. Position the CYLINDERS switch to 8, and with the leads plugged into the T/D and GND jacks and shorted together, the DATUM should display 45.0

To check for continuity, connect the leads across the bulb, fuse, or diode of interest. A "good" fuse, bulb, etc., will display 45.0, while a defective or open unit will display 00.0 A "good" diode will indicate 45.0 in one direction and 00.0 with the leads reversed. All bulbs, fuses, and diodes should be checked out-of-circuit to obtain valid readings.

Voltage Checks. The DATUM can measure voltages from −9.9 to 99.9 V dc with the test leads connected to the V+ and GND jacks. Negative overrange is indicated by three minus signs and a decimal point (Fig. 6E), while positive overrange is shown by three Es and a decimal point (Fig. 6F).

With the engine off and no load, the normal battery voltage in a 12-V (6-V) system should be between 12.2 (6.1) V and 12.8 (6.4) V. Readings below these values indicate a need for battery or charging-system maintenance.

Battery voltage drops significantly

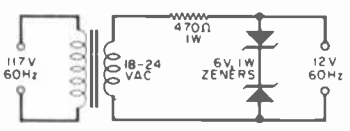
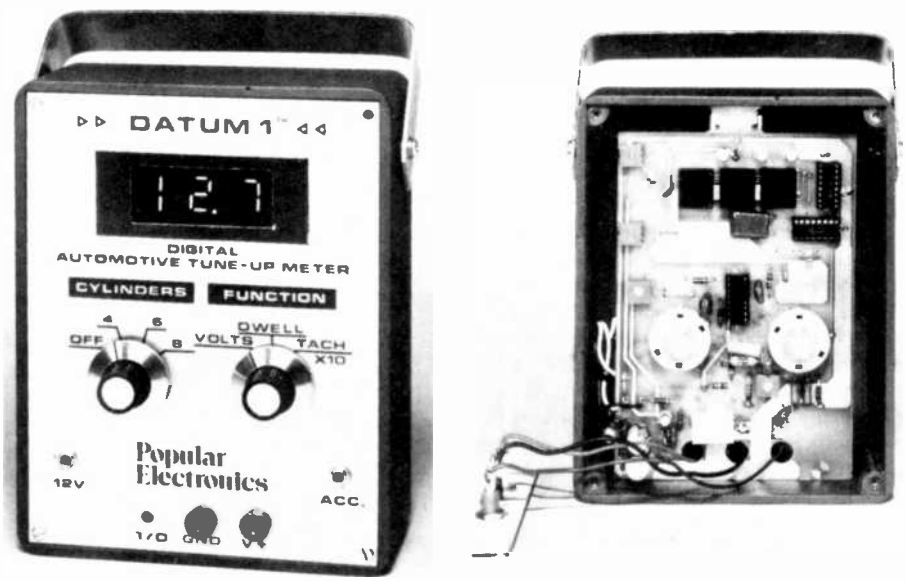


Fig. 7. Use this circuit to obtain a 60-Hz square-wave test signal for the meter.



Front and rear (with back removed) views of the assembled meter.

during cranking due to the high current drawn by the starter motor. In cold weather, this current is even higher because of bearing shrinkage and increased oil viscosity. An adequate 12-V (6-V) battery will measure about 9.5 V (4.75 V) during normal engine cranking at 25°C. Lower voltage measurements may indicate a defective battery, corroded battery posts (or cable), a worn starter, or improper ignition timing.

With the engine running and all accessories off, a fully-charged 12-V (6-V) battery should measure between 13.2 (6.6) and 15.2 V (7.6 V) depending upon ambient temperature. Voltage readings less then 13.2 V (6.6 V) indicate a fault in the electrical system, battery, regulator, alternator/generator, or fan belt. Measurements in excess of 15.2 V (7.6 V) indicate a defective or improperly adjusted regulator, a defective battery, or wiring problems.

Dwell Measurements. Dwell refers to the amount of time the distributor points (or an equivalent electronic switching circuit) remains closed, supplying current to the ignition coil's primary winding. When the points open, the magnetic field created by the primary coil winding collapses, inducing a high voltage in the secondary winding that provides the spark. In capacitive-discharge ignitions (CDI) the energy stored in a capacitor is fed to the coil primary when the points open. Again, the coil is used as a pulse-type step-up transformer to generate the required spark voltage.

If the dwell time is not long enough, the magnetic field created by the primary winding will not contain the correct amount of energy and a weak, intermittent, or nonexistent spark will result. At higher rpms, improper dwell can cause misfiring and poor gas economy. In cold weather, starting difficulty may occur.

To adjust dwell, connect the DATUM GND jack to the vehicle ground and the T/D jack to the points side of the distributor (Fig. 8). Place the CYLINDERS switch to the appropriate position and the function switch to DWELL. Engines with conventional ignitions must have their breaker-point gap set to establish the correct dwell time. Some have "windows" that allow this dwell adjustment while the engine is running. Others require that the engine be turned off and the distributor cap and rotor button removed so that the gap (dwell) can be manually set. (Now this engine may be cranked and the dwell set without the engine starting.) Some breakerless electronic systems have adjustments for dwell. Dwell-extender CDI's must be removed from the circuit when the unit is used to adjust dwell.

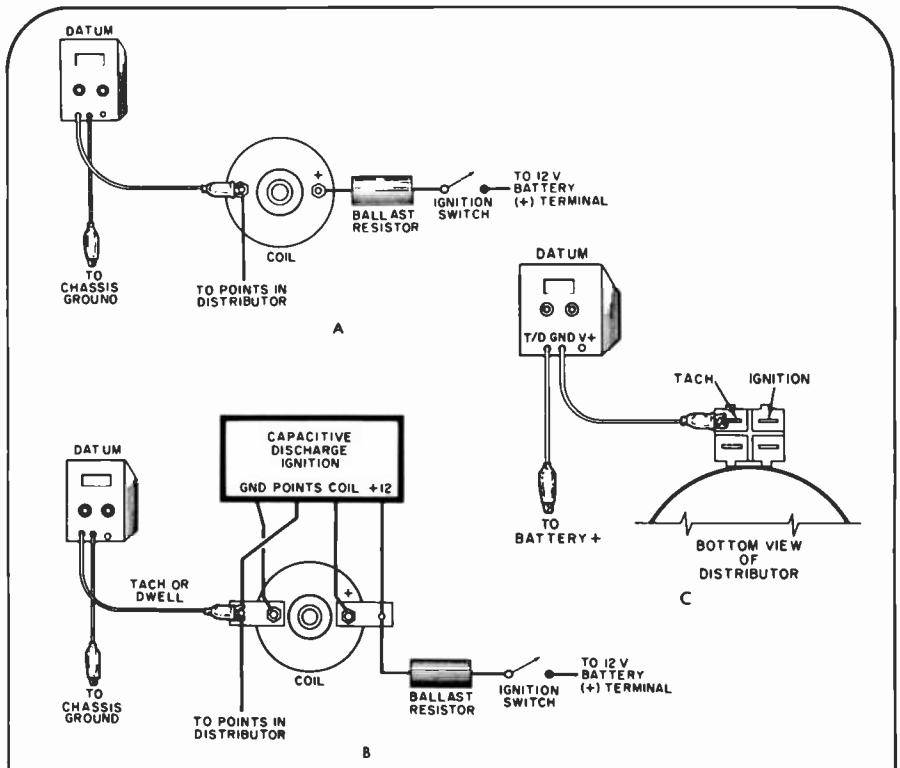


Fig. 8. Connections for testing three basic ignition systems. (A) Conventional Kettering system. (B) Typical add-on capacitive-discharge system. (C) General Motors' High-Energy System.

Although dwell angle is independent of engine rpm, the display will normally fluctuate slightly. Large, rapid readout fluctuations suggest that the points are bouncing. Increasing the tension on the point spring should alleviate this problem. Large gradual fluctuations in the display may indicate a worn and wobbling distributor shaft.

RPM Measurements. Rpm is the number of revolutions-per-minute an engine crank shaft makes. Most electrical (and some mechanical) adjustments are specified at a given rpm. For example, alternator/generator output must be checked at the rpm indicated by the manufacturer. Idle speed adjustments are particularly critical. The fast (cold weather) idle adjustment must allow the engine to run while the automatic choke releases with increasing engine temperature. Normal idle allows the engine to run at the most economical rpm and not stall with accessory loading. Most carburetors have one or two idle-mixture adjustments.

To adjust rpm, connect the DATUM as you would for dwell. Then position the CYLINDERS switch to the appropriate number and the FUNCTION switch to TACH X10. All rpm measurements are made with the engine running and at normal operating temperature *except* fast idle, which should be adjusted when the engine has just started and is still cold. *Caution:* Although the DATUM will measure rpm as high as 9999, do not operate any engine above 3000 rpm under no-load conditions. ◇

AUTOMOTIVE IGNITION INFORMATION

Parameter	Two-cycle			Four-cycle			
Cylinders	2	4	6	2	4	6	8
Sparks/revolution	2	4	6	1	2	3	4
Sparks/second at 600 rpm	20	40	60	10	20	30	40
Sparks/second at 6000 rpm	200	400	600	100	200	300	400
Cam degrees/spark	180	90	60	180	90	60	45
Crank degrees/spark	180	90	60	360	180	120	90

For 2-stroke engines, rpm displayed must be multiplied by 2.

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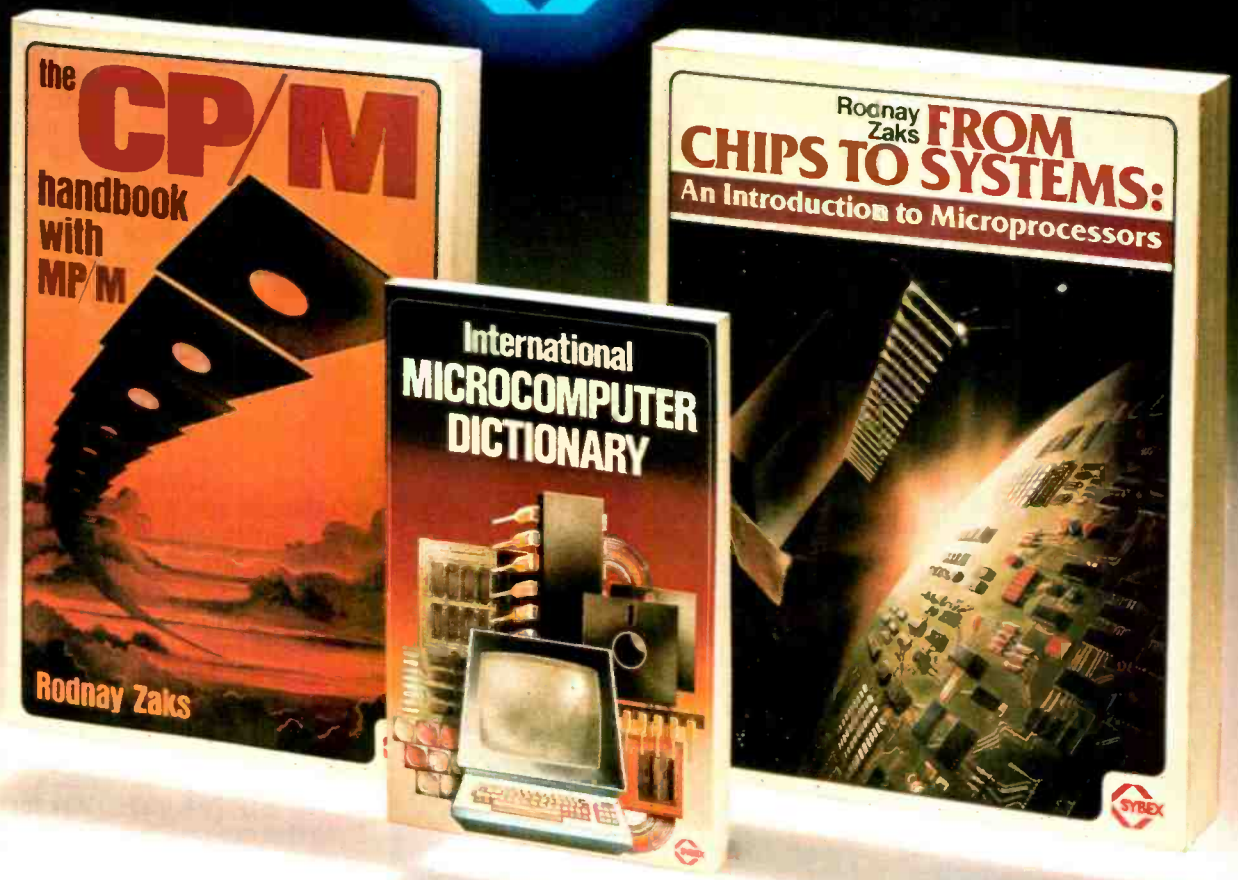

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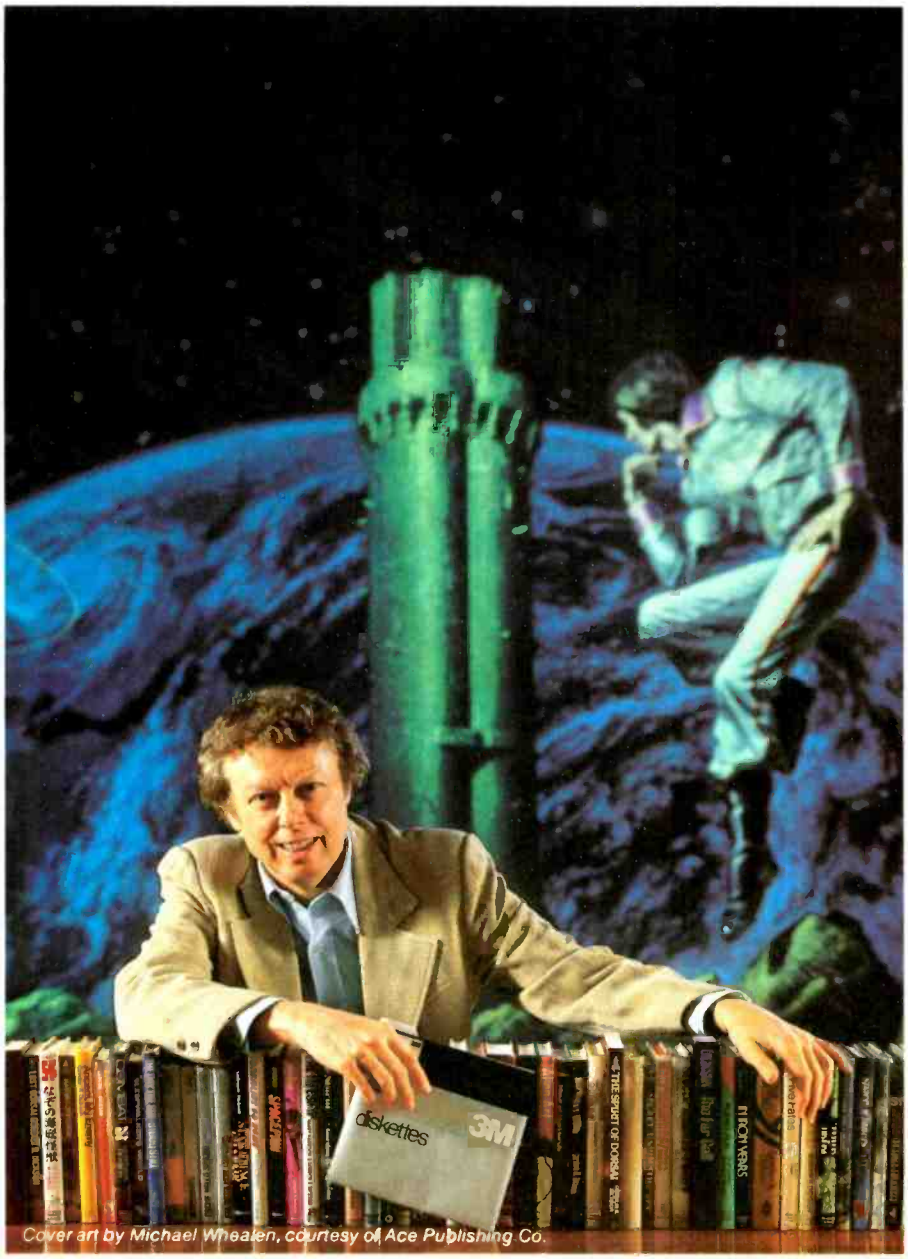

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BY JOE DESPOSITO
Technical Editor

The electronic digital computer has been affecting our lives ever since the room-sized ENIAC fired up its tubes and spewed out answers to complex technical problems more than 30 years ago. In recent years, electronic miniaturization has shrunk the size and cost of the basic unit to the point where virtually anyone can own and use a computer. The problem now is not buying a computer, but buying one that best meets an individual's needs.

A computer purchase follows the same laws as purchases of many other products—to get value, you have to weigh factors like price, performance, and desired functions. However, unlike most electrical and electronic products which are "dedicated" systems (for example, a washing machine can only wash clothes), a computer is capable of performing a variety of tasks from entertainment to record-keeping, to teaching, to communications, etc.

Personal computers come in all sizes and prices so making a decision about which model to buy can be very confusing at times. The uppermost consideration is determining your individual needs, both present and near-future. This will help you narrow your field of choices, and you can make it even smaller by focusing your attention on one of the following areas: personal, professional, education, and small business. You could consider building a kit, too, in the interests of saving money and to provide ease of servicing (should it be required) and hardware education.

Created by Jan Hendricks
Courtesy Real Time Design Inc.

PERSONAL

We will define a personal computer user as someone who plans to use a microcomputer primarily in the home. We'll divide personal users further into two groups: those who want to make a minimal investment in hardware ($100-500) and those who want to make a more sizable investment (more than $1000).

People in the first group can get quite a bit of computing power for their dollar if they know what they want. Let's take a look at the general features available at this level to see how "what you want" can help you determine "what you get."

Computers that sell for less than $500 can accomplish a variety of things. For example, they can help you become computer literate; they can perform calculations; they can entertain and teach you; and they can give you access to data networks by phone. However, not all of the machines in their basic configurations can do all of these things.

Let's consider computer literacy. Many people want to learn about computers and/or want to introduce their children to computer programming, BASIC, RAM, ROM, bits, bytes, input, and output. Low-cost computers can do a thorough job of making a person computer literate. The Sinclair ZX81, for example, sells for less than $150 (assembled), but goes a long way toward educating you in the benefits of having a computer in the home. The unit includes an r-f modulator that's used to connect the computer to your TV set. With the addition of an ordinary cassette tape recorder, you have the essentials of a computing system: a central processing unit, a display for input and output, and a storage medium for any programs that you want to save. How far can you go with this little system? You can learn BASIC and begin writing programs, and you can use pre-packaged software available for this computer (several companies provide such software). If, after a while, you begin to outgrow the basic system, you can add a 16K memory module and a small printer. Even with these add-ons, the system costs less than $350.

However, if you want to play computer games like "Super Bustout" and "Blue Meanies from Outer Space" on your color TV, you'll have to look further than the ZX81. Examples of low-cost computers that offer color graphics are the Commodore VIC-20 for $299.95 and Radio Shack's Color Computer for $399. Both systems offer education and personal finance programs as well as the BASIC language that you can use to develop your

own programs. The VIC-20 needs an optional cassette recorder to store programs, while the Radio Shack model, which also has an optional cassette machine available, has provisions for using plug-in ROMs called "Program Paks." This is a factor to consider when looking at base prices. Among other considerations would be the quality and function of the keyboards, and video alphanumeric resolution.

If you're on a low budget now but would like to expand your horizons later, you might consider starting out with either the TI 99/4A from Texas Instruments or the Superboard II from Ohio Scientific. The TI 99/4A, which "lists" at about $600, but is heavily discounted, can get you started in computing. Like the Radio Shack Color Computer, it uses ROMs that plug into the console so you don't have to buy a cassette recorder immediately. These plug-in ROMs are great for children who might find it difficult to use a tape unit. The basic unit includes 16K of RAM memory, which is considerably more than the other computers mentioned thus far offer with their basic units, though they're all expandable. Probably the most important feature of this machine, for those with expansion in mind, is that it can run LOGO, an innovative language used for educational purposes.

If you're interested in computer music but want to avoid the expense of add-on music synthesizers, the VIC-20, the Color Computer, and TI 99/4A have tone generators that can be programmed to play songs or make other sounds such as whistles or explosions.

The Superboard II is a "bare bones" computer for $329, which comes without case or power supply. If you enjoy looking at the innards of the machine while working, this is the one for you. The addition of a power supply and r-f modulator (another $80) will get you rolling. This machine starts you off with the basics, yet offers a great deal of expandability when needed. (The Superboard II is essentially the "guts" of the Ohio Scientific Challenger 1P).

One note of caution. Of the five computers mentioned (and this does not cover every low-cost model available), all have expansion capabilities such as adding a printer. However, expansion means money! If you think you will eventually spend $1000 or more on a system, you owe it to yourself to check into some of the higher-priced systems *before you buy*. In general, the latter offer more variety of software and peripherals which, in turn, gives a computer more flexibility and power.

Before we discuss higher-priced computer systems, let's examine another type of low-cost item. If you're not interested in programming but would like to hook into one of the giant data networks like CompuServe and The Source, you might consider either the RCA VP3501 Video Data Terminal or Radio Shack's TRS-80 Videotex terminal (each at $399). These are not versatile computers, but they are capable of "plugging into" the big computer telephone networks. Both of these terminals have built-in modems and r-f modulators. This means that you just plug a phone cord into the terminal, connect the terminal to your TV set, and you're ready for action. The data networks offer an incredible amount of information and services. For example, they provide news, weather and sports from many major newspapers and international news services such as Associated Press and UPI. They offer financial information (with updates) and historical information on stocks, bonds, and mutual funds. In the entertainment field they provide theater, book, movie, and restaurant reviews. Electronic mail service is available so you can send and receive messages from other network users. In addition, they have challenging games, programming languages, word processing, and business and education programs. You can even get parts of computer-related editorial matter from PE.

One of the differences between the two terminals is the keyboard. The RCA model has a flat, touch-sensitive board that's impervious to liquid spills, while the Radio Shack model has a standard typewriter-style keyboard. If you're a touch typist, a difference like this would be important to you. Both terminals are portable, so you can take them wherever you go as long as a telephone and TV are available when you get there.

Clearly, there's quite a bit you can do with a low-cost computer or terminal. But, if you want to spend more money, you can buy a personal computer that is more sophisticated than those mentioned thus far.

To get the most out of a computer, however, you will need to add some peripherals and develop a software base. In general, a substantial system should include a printer, one or more disk drives, a modem (for communications), and maybe a few other accessories such as joysticks, a voice synthesizer, a music synthesizer, a light pen, or a graphics tablet. Of course, adding all these peripherals to your system will skyrocket its cost into the thousands of dollars—and we haven't even considered software yet.

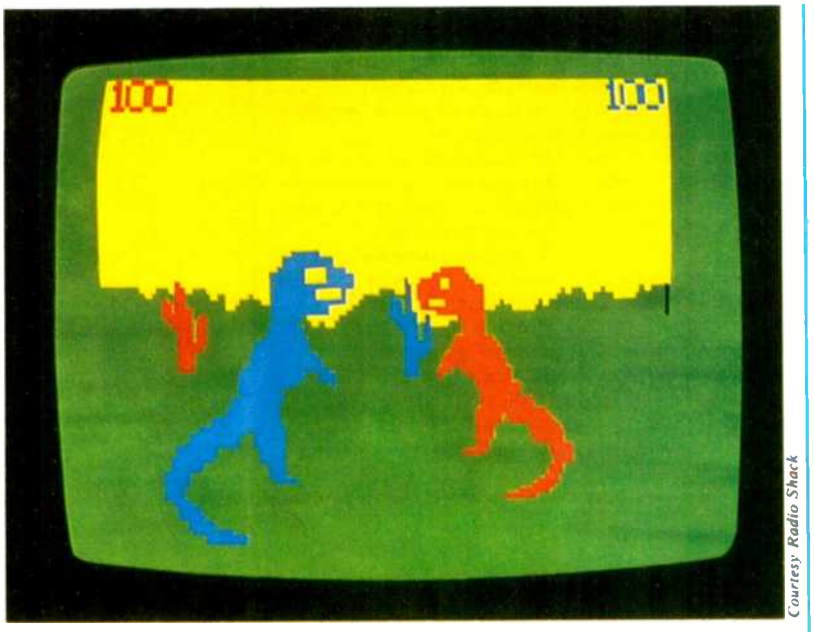
You could write your own programs, but it's more likely that you'll buy most of the software you need. Some of the top software packages are Word Star and Scripsit for word processing, VisiCalc for financial applications, and CP/M for the computer's basic operating system. Besides these, there are thousands of other software packages to enable your computer to work harder for you. As we observed before, though, your own needs must be considered before you purchase anything.

Courtesy Atari Inc.

Sometimes a particular software package will run on one machine but not on another (although most major computers have comparable software packages). Keep this in mind because it might influence you to buy one computer rather than another. (Since usefulness or utility is probably more important than price at this level, we will not make price comparisons among the different computer systems in the following section.)

If you plan on spending more than $1000 on a computer system, some of the models available include the Apple II Plus, the Heath/Zenith Z89, the Atari 800, the TRS-80 Model III from Radio Shack, the IBM Personal Computer, and the NEC PC8001A. To make an intelligent buying decision, you have to look at some of the unique features of the machines that might be highly appealing to you.

If your main interest is color graphics, here are some features to consider. Color is available on all models except the TRS-80 Model III and the Z89, both of which come equipped with their own built-in monochrome monitors. High-resolution graphics are available on all models except the TRS-80 Model III. The difference between



Courtesy Radio Shack

high- and low-resolution graphics is the number of points or pixels on the screen that can be addressed by the computer (turned on or off). The screen is divided into a certain number of pixels. A typical low-resolution number might be 128 x 48 (6144 pixels), while a high-resolution number might be 280 x 192 (53,760 pixels). The higher the number of pixels, the smaller the individual area that is being addressed. The high-resolution feature allows you to produce sophisticated graphics for animation or detailed figures.

Computers have different ways of displaying text. For example, the Z89, PC-8001A, and IBM Personal Computer have displays that are 80 characters across and 25 lines down. However, the TRS-80 Model III has a display that is 64 characters by 16 lines, while the Apple and Atari use 40 characters by 24 lines. In general, you need a video monitor if you want to work with a line that has more than 40 characters. A television set can't handle lines with more than 40 characters too well because of bandwidth limitations, so the letters are not sharply defined. If you want to use your computer with a high-quality color monitor, the Atari 800, NEC PC-8001A, and IBM Personal Computer provide an RGB (not the usual NTSC or composite signal) video output as a standard feature.

When examining the general quality of a text display, you should consider characteristics such as space between lines, sharpness of characters, and whether lower-case letters like g, j, p, q, y have true descenders, that is, the "tails" of the letters fall below the line as they should.

If you want an "intelligent" terminal, the Z89 is the only model of this group that offers this feature. This terminal has its own microprocessor and can perform operations separately from the computer. The most obvious advantage of this is increased speed since the computer doesn't have to share its processing power with the terminal. In addition, through relative or direct cursor addressing, you can insert and delete characters or lines anywhere on the screen, or erase a line or a page. The terminal also provides automatic scrolling and reverse video among other functions.

If you want a computer with expansion slots that are easily accessible, then the Apple or IBM models hold an advantage. The Apple II Plus has eight expansion slots attached to the motherboard while the IBM has five. If you want to expand your system with the other computers in this group, you may need an I/O interface, which usually entails an investment of a few hundred dollars. The Z89 is the only one of these computers that includes an RS-232C port as a standard feature (it has three), the others offer it as an option. The RS-232 is the EIA standard serial interface.

The keyboards differ significantly on these computers. For example, a built-in calculator keypad is available only with the IBM, Radio Shack, NEC, and Heath/Zenith models. Some of the computers include user-definable function keys on the keyboard: the IBM has ten, the Z89 has eight, and the NEC has five. All models, except the Apple, include lower case letters as a standard feature. The IBM has many keys which have four selectable functions. This particular feature, it should be noted, is also available on two low-end computers, the VIC-20 and the ZX81.

The TRS-80 Model III and Z89 offer a compact design that includes a standard keyboard, a calculator keypad, a video monitor and space for a disk drive in one unit. (The TRS-80 has space for two drives.) Should you want a computer that runs a diagnostic test on itself before commencing operation, the IBM is the only one of this group that can.

If game and music playing are high on the list of things you want to do with a computer, the Apple II Plus and Atari 800 are your best choices at this time. Paddles or joysticks can be connected to these units to enhance your game-playing pleasure. Atari is the only one of this group that accepts plug-in modules for game playing (however, modules from their popular video game are *not* compatible with the computer). The Apple II Plus includes a speaker and tone generator for music and sound generation, while the Atari has a speaker and a four-voice sound generator with four octaves per voice. The TRS-80 Model III, because its software is compatible with the pioneer Model I, has many games available for it although you must use the keyboard for input and control of the games, which are in black and white. The IBM computer will be good for games and music, eventually. This computer has excellent graphics capabilities, and a sound generator with one voice and 32 tones. However, because it is a relatively new entry to the market, it lacks the software support of the others.

If home business and professional use are your main concerns, any of these computers can handle word-processing, financial, and data-base management tasks. However, machines like the Z89, NEC, and IBM have an advantage because they have an 80-column format, which is ideal for running programs like Word Star, VisiCalc and DB Master. Also, these computers are CP/M compatible, which opens up a world of software for the machines. To use CP/M on the Apple, you have to purchase a plug-in module.

The TRS-80 Model III and Apple II Plus have the most software support at the present time, although the Heath/Zenith, Atari, and NEC models have a generous amount. It's anticipated that IBM will, too, in a year or two. Again, when attempting to make your choice, you should consider the features that you want both in terms of hardware *and* software before you make a purchasing decision.

PROFESSIONAL

In the last few years, the personal computer has blossomed into a serious tool for professional use. It's being used not only by engineers, scientists, and businessmen, but also by writers, artists, musicians, doctors,

dentists and many others. Usually, no computer knowledge is required because the software is "menu" driven. In other words, a list of options is presented and you need only select the option you want to operate the desired program.

Although the needs of an engineer differ from those of a musician, both can use the microcomputer as an aid to their work. In fact, many professionals are "writing off" the cost of a computer as work-related expense, which indeed it is. Since their needs are different, we'll discuss each area individually.

Courtesy Apple Computer Inc.

Scientists were probably the first group of professionals to use electronic computing power in their work, though they used monster-size computers. Nowadays, engineers as well as scientists use micros for complex calculations, design analysis, graphs, control of experiments, etc. There are tons of programs available, both prepackaged and in books, to accomplish almost any kind of mathematical calculations. The personal computer is a whiz at analyzing the relationships between variables and, in fact, many companies offer software that performs complex chores like linear programming, multiple regression analysis, and circuit analysis. Another great attribute of a micro is that, after all the calculations are made, you can display your results in the form of a graph for visual analysis of the result and communicate with various "mainframes" or with other people.

In addition to the software, there are many electronic instruments available that feed information directly into the computer so that it can be used as a lab instrument for data-recording and device-control applications. These instruments measure temperature and pressure, and sense electrical currents and voltages among other things. The computer acts as a controller that reacts to these inputs by switching circuits on and off to regulate temperature, pressure, etc. The computer can also record, store, analyze, and display the data it receives.

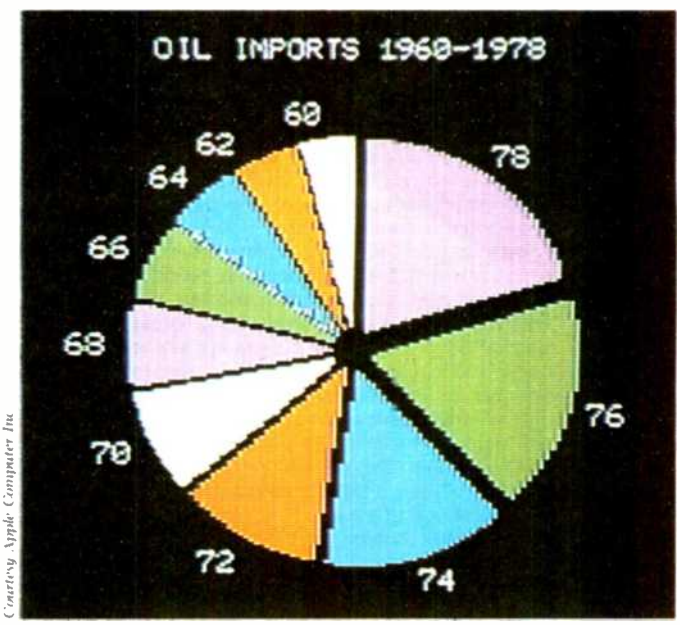
Usually, these instruments are connected to a computer via the IEEE-488 bus. Also known as the General Purpose Interface Bus (GPIB), it is an 8-bit-parallel, byte-serial, standard digital interface that allows your computer to communicate with up to 15 programmable instruments. Using this interface, your computer can control instruments such as logic analyzers, frequency counters, digital multimeters, thermometers, and many others that are manufactured for compatibility with this bus.

When choosing a micro to use in scientific applications you have to consider carefully what you want to do with it. Some computers, like the HP-85 from Hewlett-Packard, are geared to the technical professional. This computer has a compact design that includes a 5" video display, a data cartridge tape drive, a keyboard with programmable keys and a calculator keypad and a thermal printer. The HP-85 has excellent graphics capabilities so that you can easily print out complex graphs. It also has four levels of security protection for files on its data cartridges if you are security conscious. The company also provides an excellent assortment of technical software packages. There are good business packages, too.

The Apple II Plus, TRS-80 Model III, and Zenith Data Systems' assembled Z-89, because of their wide software bases, are likely to be used for technical applications. However, there are other computers available for this type of work so you should hold off buying anything until you've found the software and peripherals that will meet your needs.

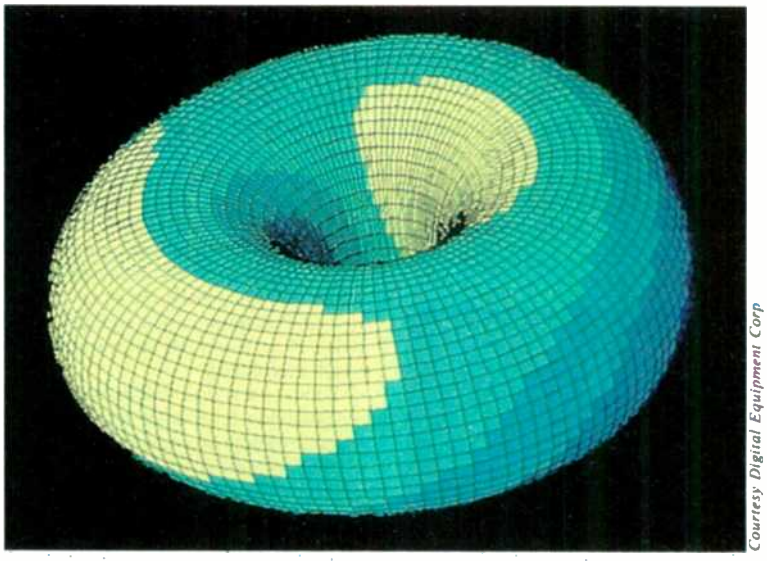
Engineers and scientists are not the only professionals who can take advantage of a personal computer. Medical people like doctors and dentists are finding that computers can help clear up the logjam of paperwork which often overloads their staffs. Billings, for instance, are a source of an endless amount of work that's basically repetitive. Besides using software that is aimed at tackling this kind of work, the computer can be applied to tasks such as appointment scheduling, data management, and word processing. There are also several medical/dental computer bulletin boards that can be accessed by using a modem.

Other people such as writers, artists, and musicians can do wonderful things with a computer. Writers are obvious candidates for word-processing programs. Using a program like Word Star, they can type their manuscripts, edit them on the computer and print them out. Other programs like Spell Star can check a manuscript for spelling errors—it's almost like having a built-in proofreader.



Courtesy Apple Computer Inc.

Artists are finding that the computer is offering them a new mode of expression. Instead of a brush and paints, the artist is equipped with an electronic pen and tablet. Commercial artists can take advantage of the animation properties that a personal computer can provide. Software packages like Painter Power, Micro Painter, Electric Painter, Electric Crayon, and Micro Angelo are designed specifically to exploit a computer's graphic capabilities.



Courtesy Digital Equipment Corp

Musicians can also use the microcomputer as a new mode of expression There are synthesizers available which allow you to enter a musical score and listen to it or play along if you like A musician can enter his own compositions into the computer and it will give him a concrete example of what's been playing in his head Some of the popular music synthesizers are Music System from Mountain Hardware, the Music Composer cartridge from Atari, Casheab (for serious computer musicians) and the Alf Music Synthesizer

If you want to buy a computer for word-processing applications, you can select any model which is compatible with the software and printer that you want Art and music applications narrow your choices down to the Apple and Atari because most of the software is written for these machines

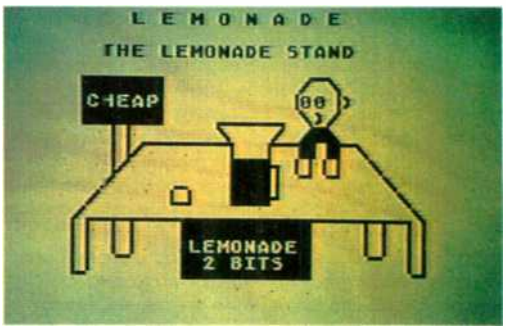
One of the professional types we haven't discussed yet is the businessman The person that we're talking about here is someone like an accountant, marketing manager, actuary, etc This is to distinguish these people from the businessman who owns a small business (to be discussed later)

Businessmen, like other professionals, have certain needs in terms of software and peripherals They might use a personal computer for scheduling, forward planning, investment analysis, income tax preparation, calculations, etc Many standard programs are available in books and magazines In addition, software manufacturers offer an enormous selection of pre-packaged programs A businessman who travels frequently might do well to consider some of the portable computers that are on the market The largest portable computer is the Osborne I This is a full-fledged computer that is approximately the size of a piece of luggage Not only can you travel with this system, but it includes two disk drives, a standard keyboard, a numeric keypad, and a monitor, plus a CP/M operating system, Word Star, and SuperCalc as standard features

Although the Osborne I is portable and can run on batteries, you may want a computer that is small enough to be stowed in a briefcase Computers that fit this description are pocket models like the TRS-80 Pocket Computer (Sharp also markets this model), the Panasonic HHC (also marketed by Quasar), the Hewlett-Packard HP-41, and the Casio FX-702P If you require your hand-held to interface with a TV set or a modem, then you should investigate the HHC model Otherwise, all these models offer a printer and cassette-tape storage as options

EDUCATIONAL

It would seem that the role of the personal computer in education will be a monumental one, eventually However, at the present time, educators are still struggling with the best ways to implement this powerful new tool in the everyday curriculum Where do you fit into the educational picture? Even if you're not a teacher or administrator, you may want to use the computer in an educational way Suppose, for example, you are a parent who is being bombarded by words like LOGO, PILOT, tapes, disks, cartridges, and the like when the kids come home from school You may want to take a more active part in their computer coursework and may even want to supplement it with a system at home that offers comparable material If your main interest is in the educational uses of the computer there are some things you should know



Courtesy Atari Inc

If you're hearing words like LOGO or PILOT being bandied about by your children, the school is using one of the innovative languages developed especially for education LOGO is a language that helps children improve their problem solving abilities It encourages a child to analyze a task, try different strategies, and modify a strategy until the task is completed If you wanted to use LOGO with your child, you would need either a TI-99/4A or Apple II Plus because the language is available only for these computers at the present time To run LOGO on the TI-99/4A, you would have to invest about $300 in a TI LOGO command module Other require-

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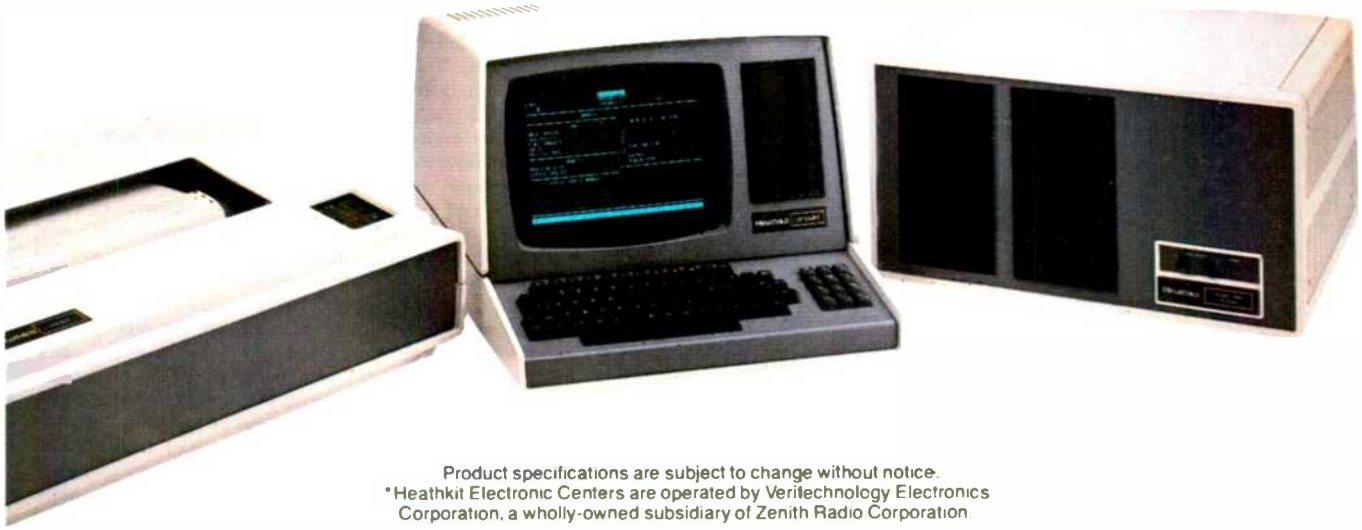

Product specifications are subject to change without notice.
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ments are a color monitor, disk drive, disk controller, and memory expansion unit. To run LOGO on the Apple, you would have to purchase a LOGO disk. In addition, you would need 48K bytes of memory, a color monitor, one disk drive, and an Apple language card.

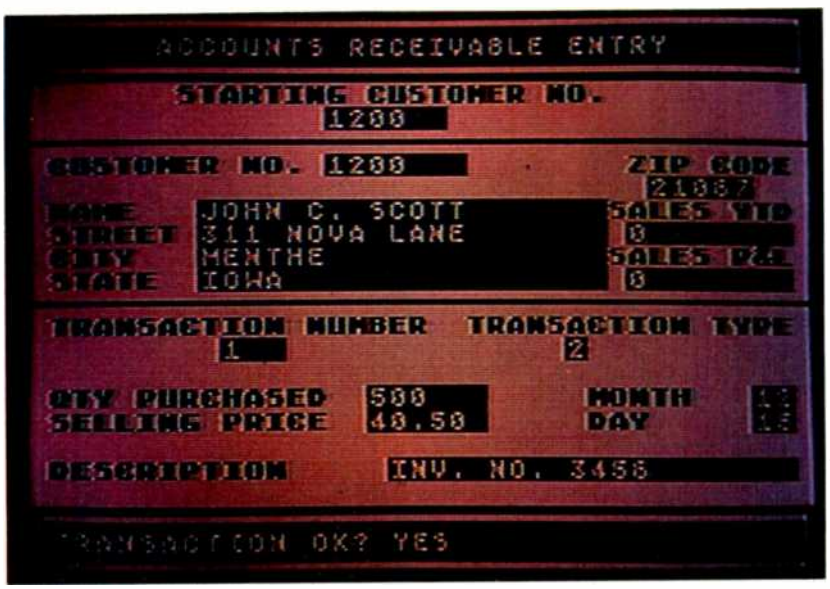
PILOT is another language used for educational purposes. It is an interactive language that introduces students to the fundamentals of computer performance. It is available from Atari in cartridge format, from Apple in disk format, and from other sources.

If you're interested in buying other educational software, you should be forewarned that good software is hard to come by. There are many so-called educational programs that just reprint a textbook on the screen rather than taking full advantage of the capabilities of the computer.

If your child's school is not using computers right now, you may want to start a computer literacy program of your own. Traditional group activities like the Boy Scouts, Girl Scouts, Boys Club and 4-H Club offer a convenient vehicle for introducing children to computer fundamentals. If you're thinking of making a hardware purchase, you might consider trading off quality for quantity. Instead of having 20 people huddled around an Apple, you may be better off having five groups of four people working with Sinclair ZX81s.

Education, of course, is not just for children. You may have in mind furthering your own education or using a computer in an adult education program. Software is available for most subject areas, although as mentioned previously, much of it is not top-quality material. Because of the popularity of the Apple and Radio Shack computers, you'll find that most of the software available is written for these machines. Heath is coming up fast in this area, though.

In general, before purchasing any hardware, you should find the software that interests you. It will be written for a certain machine or machines, will require certain peripherals, and need a certain amount of memory. For example, if you're interested in programs from the Minnesota Educational Computer Consortium (MECC) software library, you'll need an Apple II Plus with a disk drive and a minimum of 48K memory. MECC software is not available for any other computers as of this writing. It's evident that knowing what you want in terms of software can be a big help in hardware decision making.



Courtesy Atari Inc.

SMALL BUSINESS

For the person who owns a small business, runs a business from the home, or wants to computerize a small department of a large corporation, selecting hardware can sometimes be a treacherous undertaking. If things don't work out when you buy a computer for home use, you can always stash it in the closet. But, if you're making a major investment in hardware to help increase the productivity of your business, you can't just throw the computer away if it doesn't do what you want.

A broad strategy for computerizing a small business is to divide the problem in the following way: making the system work and keeping it that way. Making the system work entails the hardware and software aspects of the system, while keeping the system working concerns the service, training, expansion capabilities, and data-protection procedures of the system.

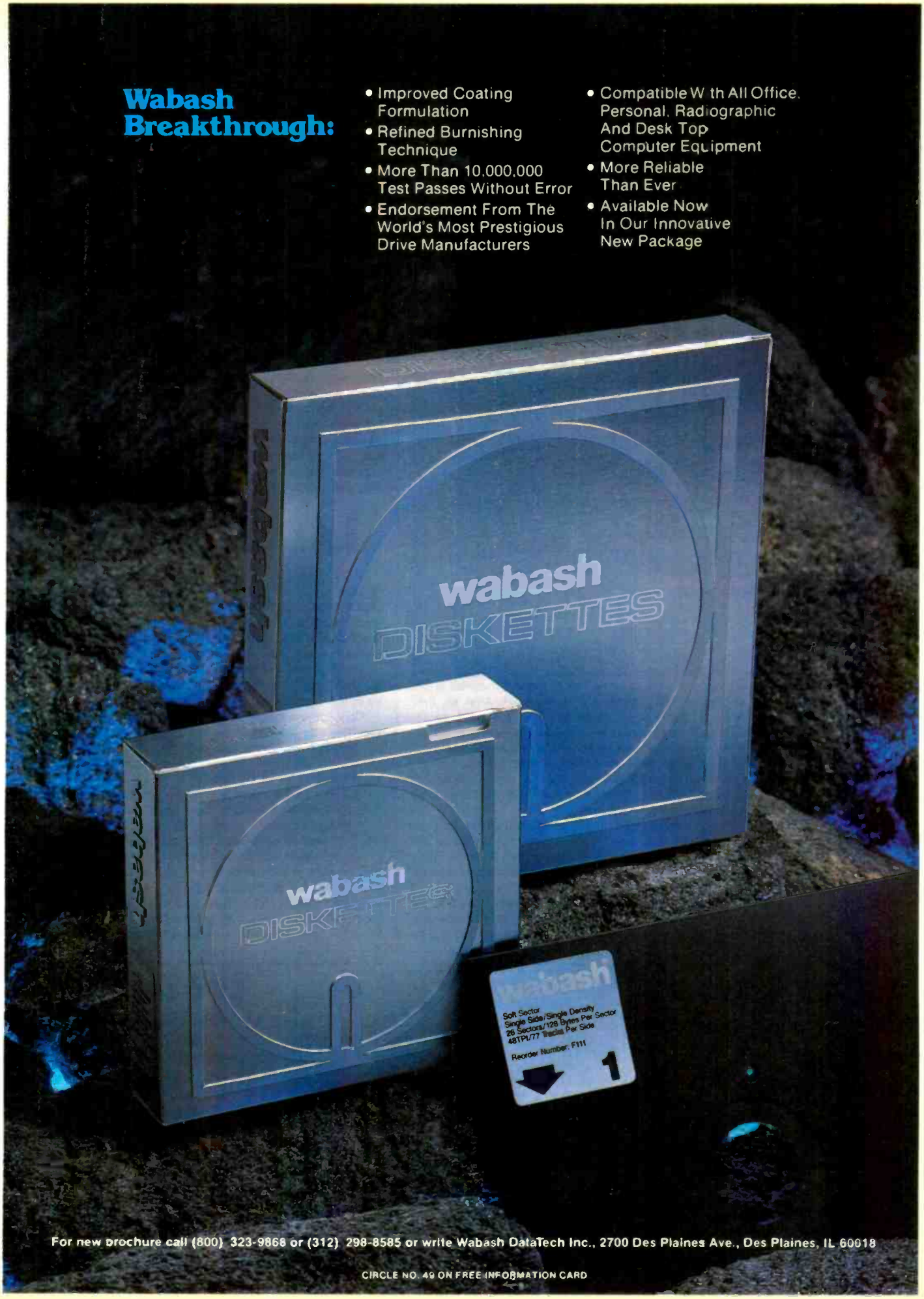
The first thing to consider is whether or not you can make the system work for you. You have to choose the software package that's right for you and you have to find the hardware to run it.

Some of the most popular business packages available are Word Star, Spell Star, and Scripsit for word processing, VisiCalc and SuperCalc for financial applications, and DB Master for data-base management. Other important software is the computer's operating system. The most popular operating system is CP/M, which is available for most computers. Other operating systems are available, too. Besides CP/M, the Apple III offers the SOS operating system, while Radio Shack offers TRSDOS (NEWDOS and LDOS are also available). Of course, if you can't find pre-packaged software that you're satisfied with, you may have to hire programmers to custom design a software package for you.

As far as hardware goes, you will have to think about peripherals as well as the main computing unit. If you buy a computer like the Northstar or Cromemco, which have an S-100 bus architecture, you will need a video terminal. A "smart" terminal offers features like relative and direct cursor addressing, dual intensity, and underlining among other things. This type of terminal can even change its parameters through software control. Disk storage is also an important factor to consider. Disk drives can be single-sided, single-density, single-sided, double-density, or double-sided, double-density. Also, they come in two sizes, 5¼ inches or 8 inches. Note that disk drives, software, and interfaces must all be compatible for a particular system.

Other peripherals that a small business might need that most people wouldn't are a hard-disk drive and a daisywheel printer. The hard-disk drive is usually a sealed unit that stores at least five megabytes of information. Hard disks are important for applications that deal with large amounts of data because they make the operation much more efficient. A daisywheel printer offers true letter-quality printing for use in business correspondence and other applications. Its quality is, of course, reflected in its price.

Keep in mind that the largest share of the microcomputer market is the small-business market. As a result, there is a much greater selection of computers geared for business use than for any other, and it follows that more disk software is available for business purposes than any other. Some popular very-small-business computers are the Apple III, the Xerox 820, the IBM Personal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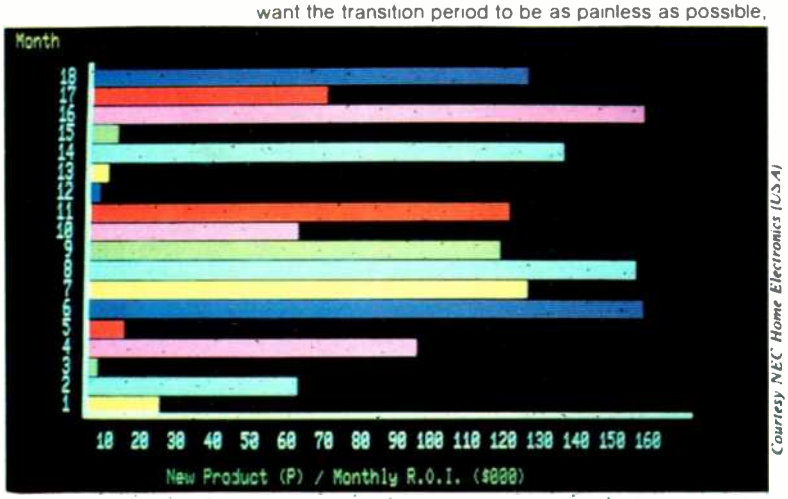
The main factors to consider after hardware and software are equipment service, personnel training, expansion capabilities of the system, and data and information protection procedures

Once your system is in operation, your company will depend on it When it goes down, you will need quick and efficient service to get it running again You won't be able to wait two or three weeks for a part to arrive. Thus, when purchasing your computer you should pay close attention to the service-contract part of the deal. This is also true of any peripherals you purchase.

When your system first arrives, you'll have to train people to use both the hardware and software If you want the transition period to be as painless as possible,



Courtesy NEC Home Electronics (USA)

it's a good idea to have key personnel involved in the decision-making process from the start After all, they are the people most familiar with the day-to-day details of the job and they are the ones who will use the system It's a good idea to think about the "creature comforts" of the system How does the keyboard feel? Is the system easy to use? Will you need a green monitor to reduce eye-strain? These and other questions should be considered before you buy

Keep in mind also that documentation should be clear and easy to understand If a new person is hired after the system is in operation, he or she may have no other recourse than to "read the book" to learn about specific procedures of the system

When making your decision this year, don't forget about next year A system that is operating smoothly and efficiently is a likely candidate for more work. Will you be able to expand your system if you want to or need to? Are capabilities like networking available for the system that you buy? It was only this past year that Radio Shack announced that it had developed a networking system for its TRS-80 computer

Once your system is operating efficiently, you want to keep it that way Inadequate data-protection practices could not only slow you down, they could ruin your business One of the things you have to think about is a file back-up system When considering hardware and software needs, you have to think about the need for more than one set of files to protect you against disasters like fire and theft This may affect your hardware considerations If, for example, you plan on buying just two disk drives, you have to realize that time must be allowed so that the drives can be used just for making a duplicate copy of the files. When considering the cost of the system, all these things have to be taken into account.

The systems available for small-business applications are the most sophisticated microcomputers on the market so we're not going to try to direct you to one machine or another based on hypothetical needs. However, you *do* have specific needs and by analyzing them carefully and taking into account some of the factors presented above you can make an intelligent choice

KIT BUILDERS

Building a computer from a kit will appeal to those who want a better understanding of computers. They're interested in the type of microprocessor used and its instruction set, they're perhaps interested in machine language and assembly coding, and they're interested in building a computer from scratch and want to save money in the process

Kit builders are concerned with either low-cost training computers or full-fledged systems comparable to those discussed in the "personal" users section There are a number of computers available in both classes. We'll discuss some of the more popular ones.

Some kit builders want to learn the basics of computer operation without making a major investment They want a "training computer," which is generally a single-board unit that uses a hex-keypad for program and data entry. In the old days (about six or seven years ago), when micros were in their infancy, you had to program them with switches In a sense, you had to feed the computer a bunch of ones and zeroes (switches that were either *on* or *off*) before you could get the computer to do anything for you. The hex-keypad that's popular today is

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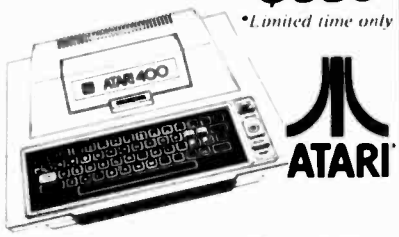

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one step removed from the switch arrangement. This keypad contains the numbers 0 through 9, as well as letters A through F. To program a training computer, one of the things you have to do is enter commands and data in hexadecimal codes like A1 or 11 or 4C (which stand for 10100001, 00010001, and 01001100, respectively).

(Continued on page 60)

SAMPLE CHECKLIST

After you've narrowed your choices to two or three computers, you'll want to take a closer look at each before making your final choice. The checklist shown below is a sample of what you might use to choose among a few high-level personal computers. In this case, the computer is to be used primarily in the home for a range of activities from word processing to game playing, with mailing-list maintenance in between. As you consider each item in the list, check it off. If a particular feature is not standard, but available as an option, note its cost. You may want to keep a notebook to record your observations as you go through the list.

Main Features
- ☐ Microprocessor(s)
- ☐ RAM (standard)
- ☐ RAM (maximum)
- ☐ Language (standard)
- ☐ Languages available
  - ☐ FORTRAN
  - ☐ COBOL
  - ☐ Pascal
  - ☐ LOGO
  - ☐ PILOT
  - ☐ Other
- ☐ Operating system (standard)
- ☐ Operating systems available

Keyboard
- ☐ u/l case
- ☐ Graphics characters
- ☐ Function keys
- ☐ Calculator keypad
- ☐ Typing feel

Input/Output
- ☐ TV output
- ☐ B/W video output
- ☐ NTSC output
- ☐ RGB output
- ☐ Hi-fi output
- ☐ Cassette port
- ☐ Disk-drive port
- ☐ Printer port
- ☐ Modem port
- ☐ RS-232 interface
- ☐ IEEE-488 interface

Graphics
- ☐ Display resolution
- ☐ Number of colors

Text
- ☐ Number of characters/line
- ☐ Number of lines
- ☐ Lower-case descenders
- ☐ Highlighting
- ☐ Inverse video
- ☐ General display quality

Audio
- ☐ Sound generator
- ☐ Number of voices
- ☐ Speaker
- ☐ Music synthesizer

Game Playing
- ☐ Cartridge slot
- ☐ Paddles
- ☐ Joysticks

Software availability
- ☐ Word processing
- ☐ Financial applications
- ☐ Data-base management
- ☐ Games
- ☐ Other

Peripherals
- ☐ 5¼-inch disk drive
- ☐ 8-inch disk drive
- ☐ Television
- ☐ Monitor
- ☐ Modem
- ☐ Printer
- ☐ Graphics tablet
- ☐ Music synthesizer
- ☐ Cassette recorder
- ☐ Speech synthesizer
- ☐ Speech recognition system

General
- ☐ Computer clubs
- ☐ Software exchange
- ☐ Service availability
- ☐ Manufacturer's/dealer's reputation
- ☐ Warranty
- ☐ Documentation
- ☐ Cost

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- Learn to operate a computer
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- For Small Businesses
- For The Home Owner

PLUG IN EXPANSION

GREATEST BUY IN AMERICA

It has color, sound and music with a powerful 6502 microprocessor (Like Apple). 20,000 Bytes ROM with a 16K microsoft extended Level II Basic built in, 8,000 Bytes RAM plug in expandable to 32K RAM, Cursor, Real time, Full size easy to use 66 key professional typewriter keyboard, 62 keys with graphics symbols, 4 programmable function keys. High resolution graphics, 512 displayable characters, Text display is 23 lines 22 characters, 16 colors. Will accept Tape, Disk-Plug In Cartridges. Has low priced plug in peripherals, Connects to any TV or monitor, Includes AC adapter, RF modulator, Switch box, Cables and self teaching instruction book - all in a beautiful Creme Colored Console Case. This is a powerful-full sized-extra featured computer for only $299.00

WHY SUCH A LOW PRICE

Selling on a direct to customer basis, we save you the profit margin normally made by computer stores and distributors. We are willing to take a small margin to develop volume to cut our cost of operation.

COMPETITIVE LIST PRICES

APPLE $1125, T. I. $525, ATARI $399.95, RADIO SHACK TRS 80 color with only 12K memory sells for $399.50.

LOW COST PLUG IN EXPANSION

Expansion accessories plug directly into this computer, extra RAM memory, Controllers, a Cassette, A Telephone Modem for only $109.00, an 80 Column Printer for $375.00, even the 170K Disk Drive plugs in direct. You do not have to buy an expensive expansion interface.

GET JOB OPPORTUNITIES NOW

Every newspaper has several pages of want ads for computer people. You can learn to operate and program a computer for these opportunities available to those who prepare for the computer revolution. This computer has extended Level II Basic with floating point decimal, Integer and String Arrays, Trig functions, Direct Statement Execution, Multi-statement Lines, Cursor, Full screen editing, Color Command Keys, Graphics, Scrolling, File Management, Upper-Lower Case, Direct Memory Access, Peek and Poke and much more! Assembly machine language is available. We have easy to follow self teaching books and programs.

INVEST IN YOUR CHILDREN

Educate your children while they play. Every kid wants to play electronic games. (We have some of the best). The next natural step for their curiosity is to try simple programming. They can do this in 20 minutes with our simple self teaching instruction book. High schools are teaching computer math, science and programming - some start in grammar school. If you provide this computer as a Teacher and Tutor at home, before you know it your child will be writing computer programs. You can use your T.V. to EDUCATE not frustrate your family and eliminate T.V. boredom with programs that challenge, stimulate and entertain the whole family. We have a wide variety of games, recreational, home finance and educational programs to choose from. Why pay $140.00 to $295.00 for an electronic game when you can buy this powerful computer for only $299.00.

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Plug in your VIC telephone modem. Now you can get a world of information through your telephone, plus electronic mail. Just dial up the information you want. UPI wire service, stock market, historical information by topic from over 60 magazines, including New York times. Airline information, order tickets, get weather information anywhere in the world, restaurant and hotel information, thousands of categories are on line for you, business, finance, education, entertainment, games etc. YOU'LL BE THE TALK OF YOUR NEIGHBORHOOD. Our telephone modem price is by far the lowest available.

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If your computer fails because of warranty defect within 90 days from date of purchase, you simply send your computer to us via United Parcel Service prepaid. We will "immediately" send you a replacement computer at no charge via United Parcel Service prepaid. No one we know gives you this kind of warranty service. Most computer warranty service takes 30 to 90 days to handle - this fantastic "immediate replacement warranty" is backed by COMMODORE COMPUTER, a MAJOR national brand electronics manufacturer.

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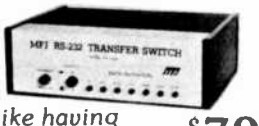

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Then the hex numbers are translated into binary numbers, which are the computer's "machine language."

Originally, the program is coded in assembly language, which uses mnemonics as an aid to programming. The mnemonics represent the instruction set of a particular microprocessor and are unique to that microprocessor. Each mnemonic has a hexadecimal code associated with it which, as we said, gets translated into the binary code.

Two of the popular training computers are the Elf from Netronics and Quest, and the ET-3400 from Heath. When buying a training computer, some important items to look for are the type of microprocessor it uses and the documentation supplied by the manufacturer. You may want to learn more about a particular microprocessor because it's in one of the larger computers. For example, the Z80 microprocessor is used in the Radio Shack and Heath/Zenith models, while the 6502 microprocessor is used in the Apple, Commodore, and Atari computers. You might be interested in a microprocessor for other reasons, too. For example, the 6800 and 1802 microprocessors are great for use in control applications.

If you are an accomplished kit builder and want to construct something more substantial than a training computer, there are a few kits available that can satisfy your desire for computer expandability and power. Why would anybody want to build this type of computer from scratch? Two of the main reasons are the challenge and the cost savings. To give you an idea of the cost savings involved, the Heath/Zenith H-89 is $1895 in kit form, while the assembled version (Z-89) is $2895.

The two full-blown computers in kit form are the H-89, which we've just mentioned, and the Explorer-85 (8085 CPU) from Netronics. Both systems are computers for serious users. They can compete with other top models on the market, and often surpass them.

Another popular kit is the Sinclair ZX81. At $99.95 for the basic computer, you will be hard pressed to find a better value. Though this computer is excellent at its own level, it's obviously not in the same class as the H-89 and Explorer-85.

For more power than either the H-89 or Explorer-85, in a kit-form computer, you might also consider the Heath copy of DEC's very popular PDP-11, the Heathkit H-11A. This is really a minicomputer, which at $2995 represents a saving of about $2300 over the assembled version of the computer.

CONCLUSION

What we've tried to illustrate in this article is that computers come in all shapes and sizes and can perform an amazing number of tasks. In order to choose wisely when buying a computer, there are a great number of factors to consider. The bottom line, however, is individual needs. You want a computer to do something for *you*. If you keep that first in your mind and consider everything else second, you are more likely to be a satisfied buyer.

The computers mentioned throughout this article are some of the more popular models available, but obviously are not the only ones on the market. Others not mentioned here may be more suitable for your particular purpose. Also, new computers are coming out all the time, not only from new companies, but from companies that are improving or expanding their existing line. It's wise to check the features of these new entrants before making a final decision. Also, prices cited are suggested retail selling prices only and you will find that they likely differ from one dealer to another. ◇

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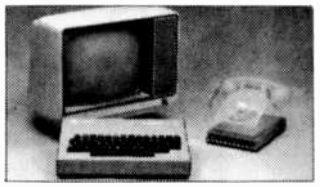

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Price breakthrough!!! Own the FASTERM-64, a complete terminal kit, ready to plug in for just $199.95 or order the SMARTERM-80 kit for just $299.95 (both available wired and tested). Be on-line with the million dollar computers and data services today... we even supply the necessary subscription forms.

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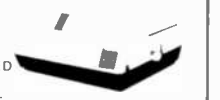

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FASTVID-64 VIDEO BOARD (requires +5 & -12V DC)... kit $99.95 plus $3 P&I... graphics option add $19.95... wired & tested $129.95 plus $3 P&I, graphics option add $19.95

SMARTVID-80 VIDEO BOARD (requires +5 & +/-12V DC)... kit $199.95 plus $3 P&I... wired & tested $249.95 plus $3 P&I

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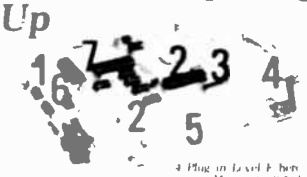

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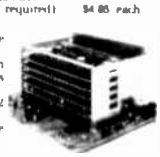

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CURRENT-LIMITING Techniques

BY MARK PITTELKAU

How to protect power transistors from overload damage

POWER supplies, like audio power amplifiers, are designed to deliver a selected maximum current to a load. If for any reason the load should draw more current than the supply can safely deliver, severe damage can occur.

To prevent this from happening, fuses are usually used at the input to the power supply. However, thermal lag and overrating to accommodate turn-on surges often allow damage to occur before the fuse link pops. To overcome this deficiency, more and more designers are turning to fast-acting current-limiting circuits.

In this approach, a circuit is incorporated within the power supply to allow only a preset amount of current to flow to the load. If excessive loading occurs, the circuit will automatically limit the current to a safe value. When the excessive drain is removed, the supply resumes normal operation.

One commonly used technique, shown in Fig. 1 for both an audio amplifier (A) and a power supply (B), requires insertion of low-value resistance R_L in series with the load and power supply. In both cases, transistor *Q1 (and its associated components) acts as a high-speed switch that controls base current to the power transistor.*

Note that R_L is connected between *Q1's* emitter and base, with the *Q1* collector connected to the base of the power transistor to be protected. When load current I_L flows through R_L the voltage generated across it is equal to $I_L R_L$. The load is selected so that when the desired maximum current flows, the developed voltage will turn *Q1* on. When this occurs, *Q1* will shunt the base drive to the power transistor and, in effect, hold it off for as long as load current demand is excessive. Current limiting occurs when the voltage drop across R_L is equal to about 0.6V, the barrier potential of a silicon junction. Therefore, $R_L = 0.6/I_L$. The value of R_L can be quite small and often will have an odd, difficult-to-locate value.

To prevent *Q1* from switching so rapidly that the circuit becomes unstable, parasitic-suppression resistor R_B is included in the current-limiting circuit. (If R_B does not exist in your circuit, you can add one having a value between 100 and 1000 ohms.) The presence of R_B also allows voltage-divider resistor R_D to be added between the base and emitter of current-limiting transistor *Q1*. This in turn allows use of a higher resistance value for R_L. The simplified schematic of Fig. 1A shown in Fig. 2 is similar to that of Fig. 1B, except that I_L flows in the opposite direction and an *npn* transistor is used for *Q1* instead of *pnp* type. This does not affect the following computations since only magnitudes are being considered.

The following example illustrates one method for calculating the correct value for R_D so that it will work with the value of the R_L you have. Assume that I_L = 3.3 amperes, R_L is 0.18 ohm, and we have only a 0.27-ohm resistor on hand. The 0.27-ohm resistor will decrease the current limit to 2.2 amperes, but the addition of R_D will increase the limit to any value within the capabilities of the pass transistor and the power source. At 3.3 amperes current flow (I_L), the voltage (V_{RL}) across the 0.27-ohm resistor can be calculated from $V_{RL} = I_L R_L$ (Eq. 1) which works out to 0.89 V.

Since control transistor *Q1* is silicon, it will turn on when its base is biased at 0.6 volt (V_{BE}). This 0.6-volt must be dropped across R_B when 3.3 amperes flows through R_L. Resistor R_D must then drop V_{BE} or 0.6 volt at this current flow. See Eq. 3.

Using Fig. 1A as an example, R_D = (91 × 0.6)/(0.89 − 0.6), or 188 ohms. Using Fig. 1B as the example, R_D works out close to 970 ohms. In either case, one would use the closest standard value, or a slightly lower value with a series trimmer potentiometer for "fine tuning" if desired. A half-watt rating will be sufficient. To calculate the current flow through the R_B, R_D network, use Eq.2.

To provide an optional variable current limit, a suitably valued potentiometer can be used for R_D. However, if this potentiometer is set to too low a resistance value, excessive current can flow. For safety, insert a low-value resistance in series with the R_D potentiometer. The value of this resistance should be selected so that slightly less than maximum current flows when the potentiometer is set to zero resistance. Be sure to use a resistor with sufficient dissipation capacity for R_L. Failure of this resistor may cause serious damage elsewhere in the circuit.

In Conclusion. The protective circuitry shown here may not work for a load that demands large, rapid changes in current, nor for wide-band width, high-powered audio amplifiers that may feed highly reactive loads.

Difficulties may also arise if the pass transistor (*Q2*) operates very close to its maximum ratings or is driven from a three-terminal regulator. In the latter case, the sum of the current rating of *Q1* and the current drawn by the base of *Q2* at maximum output current must exceed the maximum current delivered by the regulator. In general, the circuit will work satisfactorily for moderate variations in load current that do not occur extremely rapidly. ◇

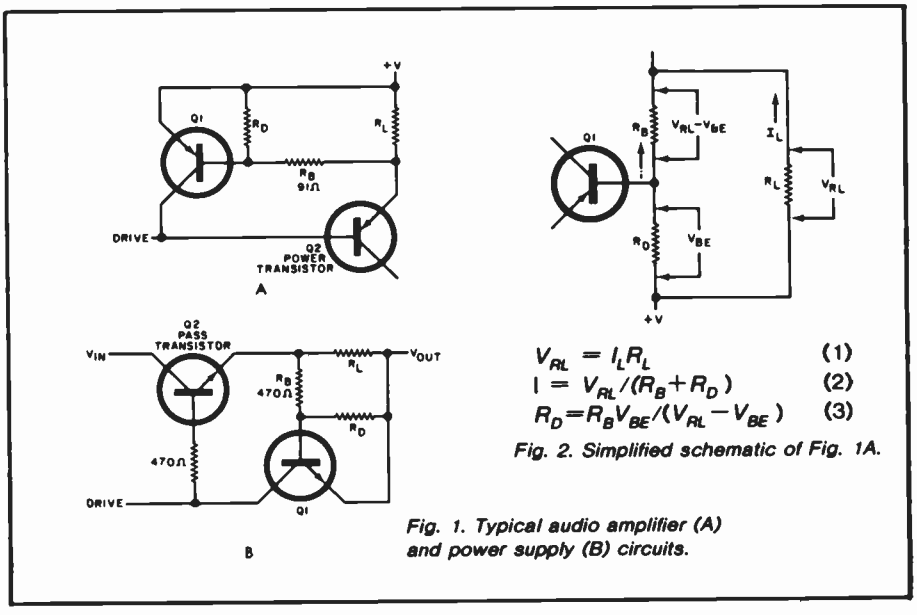


Fig. 1. Typical audio amplifier (A) and power supply (B) circuits.

$$V_{RL} = I_L R_L \quad (1)$$

$$I = V_{RL}/(R_B + R_D) \quad (2)$$

$$R_D = R_B V_{BE}/(V_{RL} - V_{BE}) \quad (3)$$

Fig. 2. Simplified schematic of Fig. 1A.

EXPERIMENTING WITH FIBER OPTICS

Add audio capability to a digital fiber link and get hands-on experience with the latest communications technology

BY TJ BYERS

FIBER OPTICS is fast becoming a major component of communication systems that have traditionally relied on copper conductors. That's because a beam of light traversing a glass fiber no larger than a human hair can carry more information than a half-inch coaxial cable! And now the experimenter/hobbyist can easily get some hands-on experience with this new technology, thanks to the availability of moderately priced fiber-optic kits. Motorola Semiconductor, for example, offers such a kit, the Link II, for $99.

Designed as a total communication system, the Motorola link itself is transparent to the user. All he needs to know is where the signal goes in and where it comes out.

The Link II kit contains a TTL-compatible optical transmitter, a TTL-compatible optical receiver, and ten meters of already terminated optical glass fiber. All are assembled and ready to use.

Though intended to be an engineering evaluation kit, the Link II is far more than a bench curiosity. Several practical applications are easily implemented once a basic understanding of the link's operation has been acquired.

How the Optical Link Works. In a typical fiber-optic communication link (Fig. 1), an electronic signal is processed to modulate a light-emitting source, usually operating in the infrared region. (The light source in the Link II happens to be an infrared LED, but lasers are often used. This is particularly true in telephone communications where bandwidths and distances are much greater.)

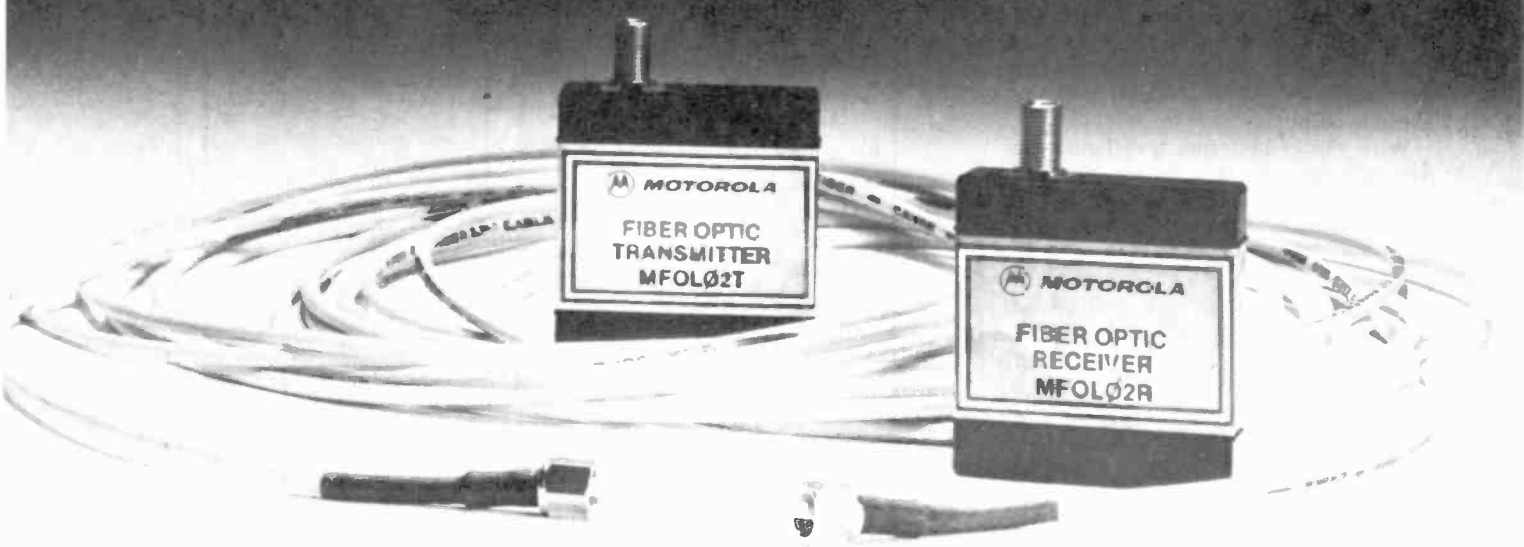
Next, the light is coupled to the optical fiber which will carry the information. This interface is critical. Unless a virtually perfect optical coupling exists between emitter and fiber, much of the light energy will be lost due to dispersion. This problem had been minimized with fiber-aligned LEDs and close-tolerance ferrule connectors.

An identical ferrule connection is provided at the receiving end of the fiber cable to interface with a PIN diode. This photodiode detects the incoming photons and converts them into a current. The output circuit changes the current into a voltage and the signal emerges from the receiver as electrical information.

Two methods are commonly employed to modulate the transmitted light: amplitude—or intensity—modulation, and digital encoding. The Link II uses the latter. A look inside the link modules shows how this electrical-to-light transformation takes place.

Since the Link II is intended to process digital data, assume (for this discussion) that all signals are TTL level, including input and output. Starting with the transmitter, the signal goes to a NAND Schmitt trigger (Fig. 2). The Schmitt gate has a large hysteresis swing, with trip-points typically set at $\frac{1}{4}V_{cc}$ and $\frac{3}{4}V_{cc}$, which conditions the incoming signal by removing unwanted noise. And, since one input is tied to V_{cc}, this gate also inverts the waveform.

At this point, the signal is split, with part of it going to another inverting



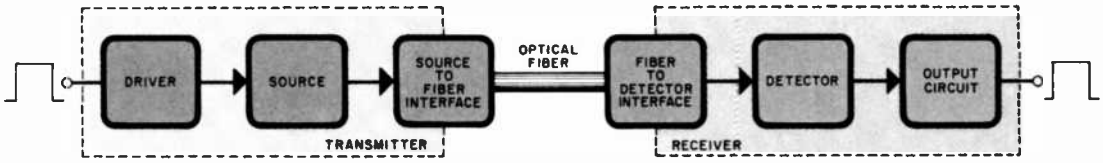


Fig. 1. The typical fiber-optic link with light modulator and demodulator and a length of optical fiber.

NAND gate. Now both the input signal and its complement are available. These complementary signals are then differentiated by a pair of 250-pF capacitors and fed to a bridge rectifier. This produces a positive pulse for every positive- or negative-going transition of the input signal.

These positive pulses are sent to a MC14528 monostable multivibrator (only one of the two available monostable circuits is used.) The one-shot multivibrator is programmed with an external resistor and capacitor (8.2 kilohms and 250 pF) to deliver one 2-μs output pulse per event. These pulses drive the transmitter's infrared LED.

However, rather than drive the LED directly from the 2-μs monostable pulses, the LED draws continuous idle current while its modulated output is determined by the transistor driver circuit. The NAND logic is such that one driver transistor is on while the other is off under no-signal conditions. This supplies about 50 mA to the LED through one of the two current-limiting resistors producing a continuous optical output.

When the input waveform goes positive, a 2-μs pulse is generated by the monostable. This 2-μs pulse is passed along to the NAND driver #2 and compared to the input signal. The resultant logic turns off the idle current transistor, thus shutting down the LED. So, for a period of 2 μs no light is emitted.

During a negative transition of the input waveform, the 2-μs monostable pulse is logically compared to the input in the Schmitt NAND gates. The result causes LED driver transistor #1 to turn on. Now twice the idle current (100 mA) passes through the LED, doubling its light output.

With this modulation technique, the receiver senses a constant optical input and reacts only to relative *changes* in light intensity. System sensitivity to variations in cable performance is thereby eliminated.

At the receiver, a PIN photodiode detects the incoming light and converts it to a current (Fig. 3). This current is changed to a voltage by op amp *IC1A*. It is programmed by a feedback resistor to produce 1 V output for every 4 μA input. This voltage is amplified by *IC1D* which has a gain of 20.

Depending upon the length and optical properties of the fiber cable, there will be a rather wide variation in the received light intensity—and therefore the output voltage level of *IC1D*. To overcome this problem, an integrator formed by *IC1C* clamps the reference output of *IC1D* (no signal) to $^1/_2V_{cc}$. The integrator allows the amplifier to respond to any *rapid* changes in light intensity, but smooths out all long-term variations, thereby setting a constant quiescent level over a wide range of idle-current light conditions (very similar to an automatic gain control).

Comparator *IC2A* is used to reconstruct the original signal. A hystersis bandwidth is programmed into *IC2A* by the 470-kilohm feedback resistor, and the reference voltage is set to $^1/_2V_{cc}$ with buffer amplifier *IC1B*. Pulse polarity can now be sensed; a positive pulse, for instance, flips the comparator output to negative. However, if the pulse is removed, the comparator output remains negative (due to hystersis) until a negative pulse comes along. This drives the comparator output positive, where it latches anew. Boosted to TTL levels, the signal enters another comparator, *IC2B*, which improves rise time and inverts the waveform. Now the received signal is in phase with the transmitted signal.

Digital Applications. Since the Link II kit is built using CMOS chips, both the transmitter and receiver operate from a 5-V supply. This makes it very easy to add them to an existing TTL system. One word of caution: the transmitter and receiver modules *must* be operated from separate power supplies. Although you may be tempted to use only one supply, don't. During switching periods, the large transmitter currents generate glitches on the V_{cc} bus. This noise can easily create false signals inside the sensitive receiver if it shares the same bus. Fortunately, the receiver draws little power and will operate from a 9-V battery supply. (Fig. 4).

Get a feel for the kit by building a simple evaluation circuit such as that shown in Fig. 5. The CD4049 chip operates as a very low-frequency square-wave generator (about one pulse every

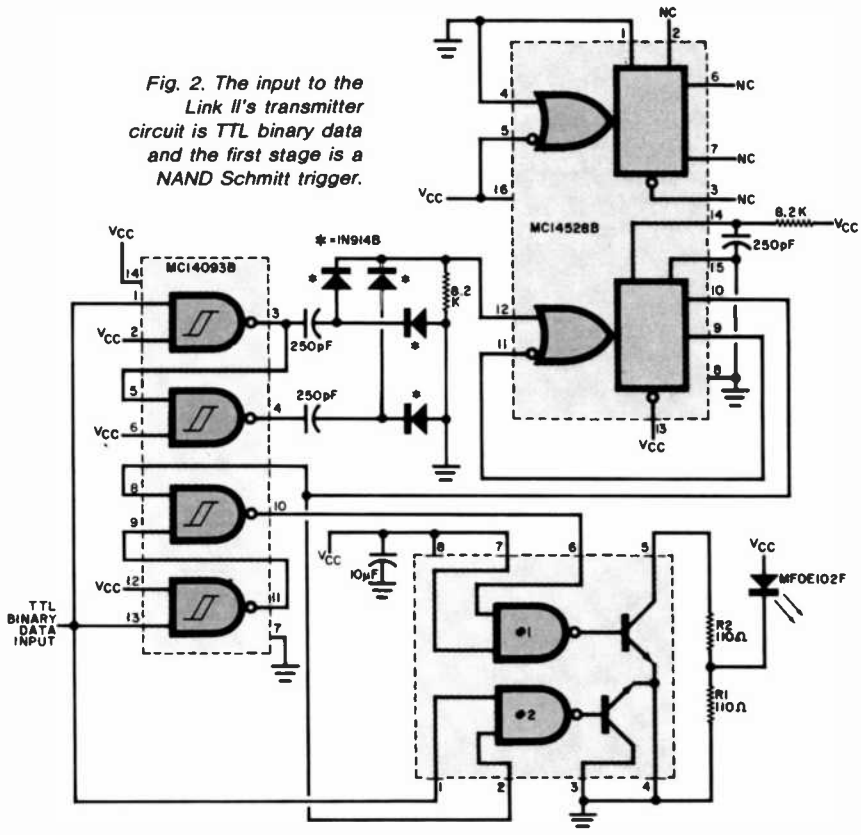


Fig. 2. The input to the Link II's transmitter circuit is TTL binary data and the first stage is a NAND Schmitt trigger.

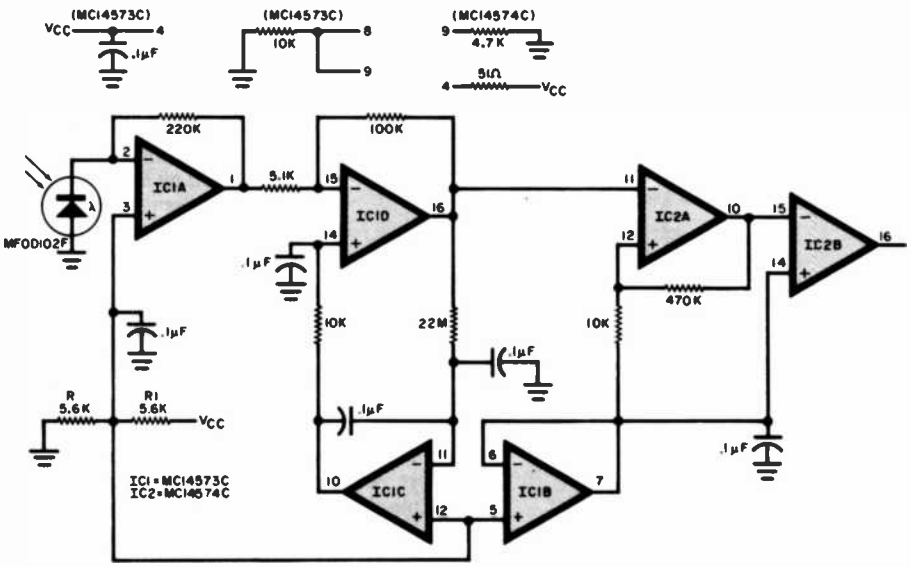


Fig. 3. The light is converted to a current by a PIN diode in the receiver.

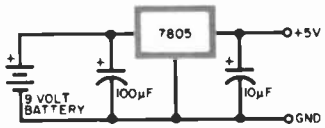


Fig. 4. Do not operate transmitter and receiver from the same power supply. Use a bench supply for transmitter and build this simple circuit for receiver.

three seconds) whose output state is monitored by an LED. This pulse generator connects directly to the Link II transmitter module. Both the generator circuit and transmitter module are powered by a single, regulated 5-V, 500-mA power supply. A single LED monitor is the only addition to the battery-powered Link II receiver module.

Now simply connect the optical cable between the mating connectors on the Link II modules. When the transmitter's input (pin 5) goes low, its LED monitor goes on, and the LED monitoring the receiver's output (pin 8) also lights. (The receiver output will drop as much as 10 mA.) This little setup quickly demonstrates link operation, and suggests how easily the Link II might interface with TTL logic.

An important factor in the development of fiber-optic technology is its immunity to external interference (and thereby error). It is quite easy for a standard coaxial cable to pick up stray signals (error bits), or have its data masked with nearby noise. However, glass fibers are immune to external radio-frequency or electromagnetic interference, so data transfer in noisy environments is error-free. For example the system in Fig. 6 transmits data from the computer to the terminal (reverse the modules and information will flow from the terminal to the computer).

Optical communication links do not emit radiation either, a characteristic suggesting security applications. Eavesdropping is difficult at best, making it unlikely that sensitive information could be intercepted. A "secure" data transfer system using conventional electronics would be extremely costly—perhaps impossible.

Fiber-optic links also have no electrical isolation problems (input to output). With only a strand of glass connecting the active circuits, isolations of thousands of volts are possible. And optical coupling isn't limited to simple isolation; it is also capable of providing an interface for incompatible computer/peripheral formats.

For instance, a hardcopy printer often costs more than the processor and many hobbyists turn to substitutes. But these alternatives frequently present voltage-level and/or ground-loop problems.

A teletype typewriter (TTY), for in-

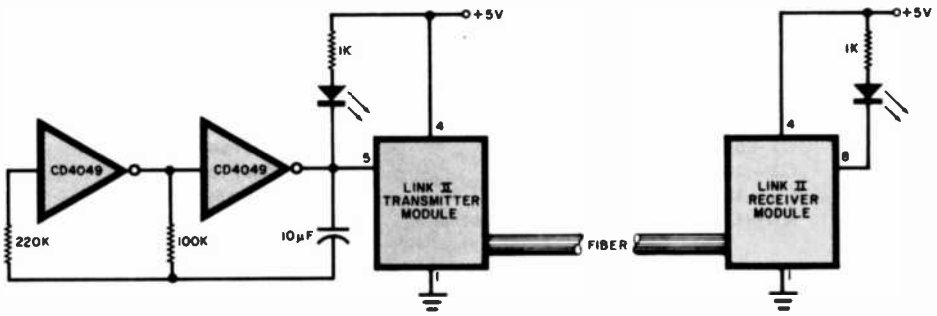


Fig. 5. Build this simple evaluation circuit to get to know the kit's features.

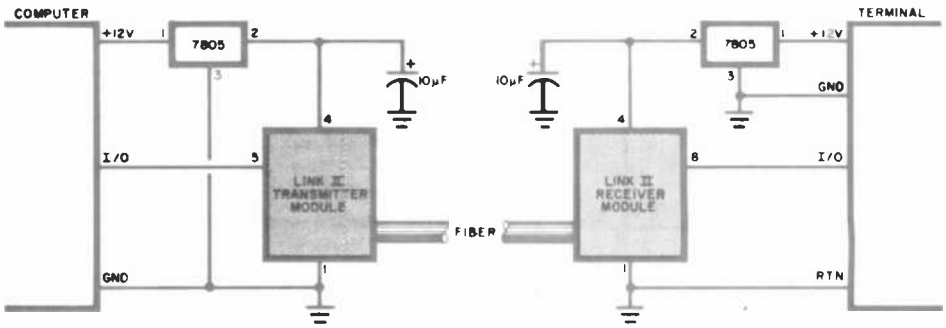


Fig. 6. Using a fiber-optic link between a computer and a terminal.

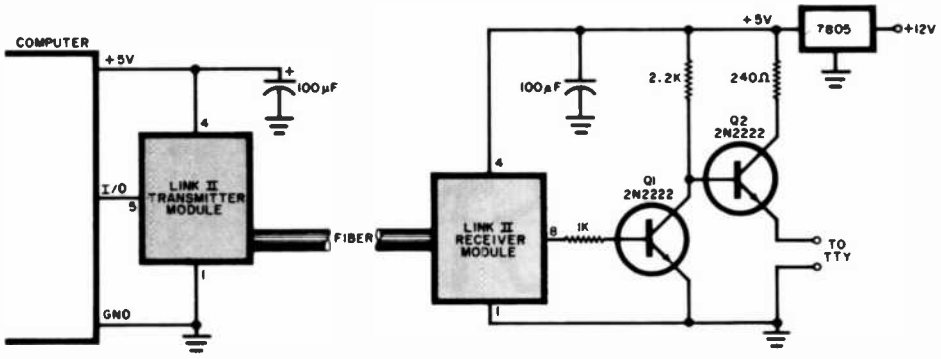


Fig. 7. A teletypewriter can be used at the receiver with suitable interfacing.

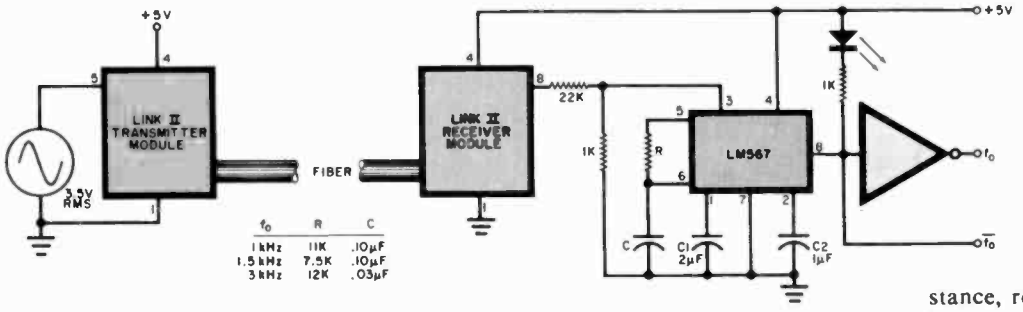


Fig. 8. An analog tone-signal link converts the input to a square wave for transmission. The tone decoder in the receiver circuit produces an output when the incoming frequency is with its bandwidth as determined by the components given in table.

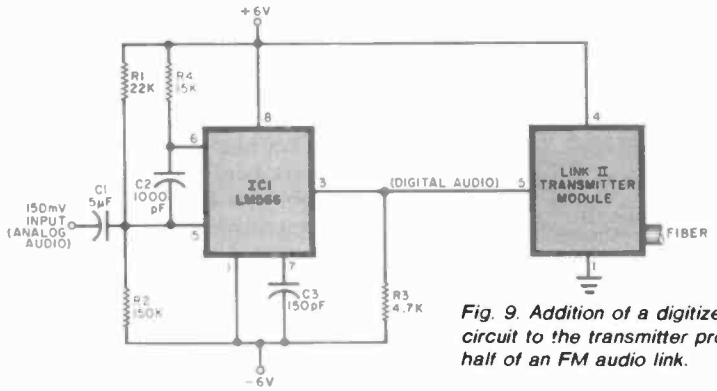
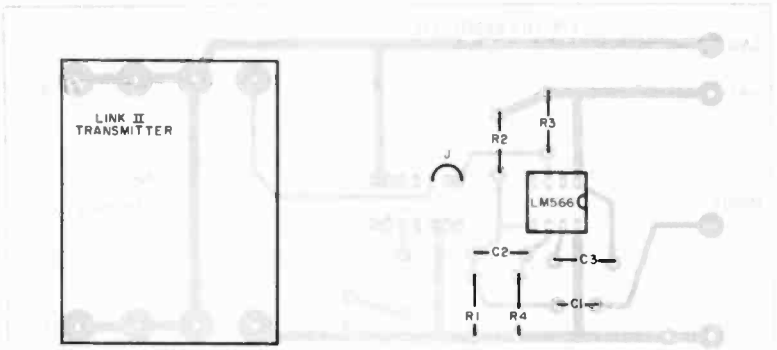


Fig. 9. Addition of a digitizer circuit to the transmitter provides half of an FM audio link.

PARTS LIST (Fig. 9)

C1—5-μF, 16-V capacitor
C2—1000-pF capacitor
C3—150-pF capacitor
IC1—LM566 voltage-controlled oscillator
R1—22-kΩ resistor
R2—150-kΩ resistor
R3—4.7-kΩ resistor
R4—15-kΩ resistor



stance, requires a 20-mA loop for data input. Very few personal computers have provisions for a 20-mA loop. However, the circuit in Fig. 7 isolates the computer and TTY electrically *and* changes format. The transmitter module is driven directly from the computer I/O port. At the receiving end, transistor *Q2* is biased ON with no signal present. This supplies a current of 20 mA to the TTY through the 240-ohm limiting resistor. When a pulse appears at the receiver output, *Q1* conducts, shorting *Q2*'s bias and interrupting the 20-mA flow momentarily. The TTY decodes these pulses and interprets them as characters and instructions.

Some Analog Uses. Although the Link II was designed with digital applications in mind, it will also handle analog signals. Of course the Schmitt trigger in the Link II transmitter will change any applied sine wave into a square wave, but in many instances this doesn't affect system performance. Here are two circuits that prove the point.

In the analog tone-signal link shown in Fig. 8, the input sine wave is boosted to 3.5 V rms and applied to the transmitter module, where it's converted to a square wave and relayed over the glass fiber. The receiver reconstructs the square wave which is sent to the LM567 tone decoder. The latter produces an output whenever the incoming signal's frequency falls within the detector's bandwidth.

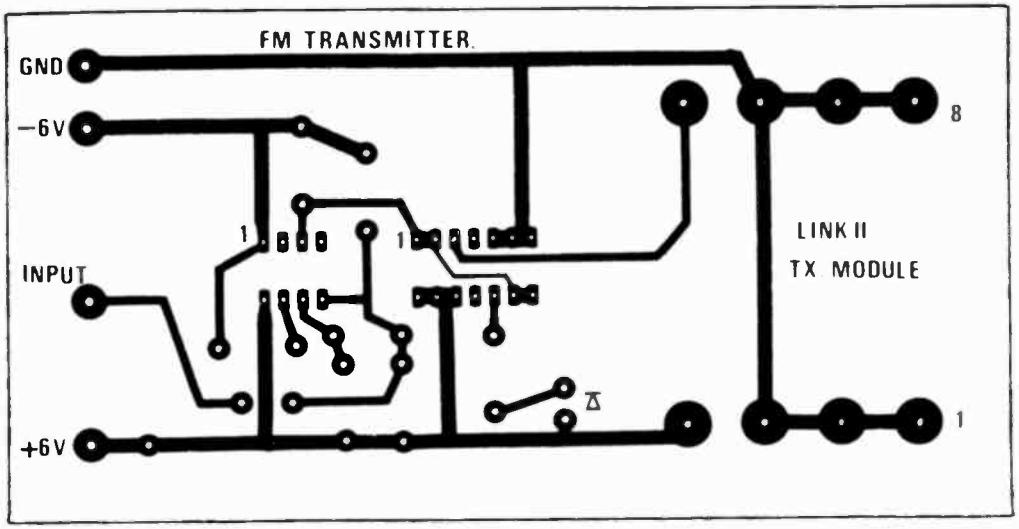


Fig. 10. Use the foil pattern at left and component layout above left to build the circuit shown in Fig. 9.

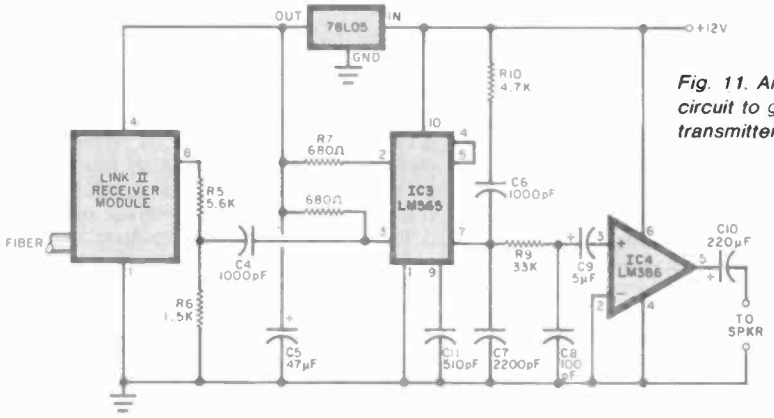


Fig. 11. An FM receiver circuit to go with the transmitter in Fig. 9.

PARTS LIST (Fig. 11)

C4—1000-pF capacitor
C5—47-μF, 16-V capacitor
C6—1000-pF capacitor
C7—2200-pF capacitor
C8—100-pF capacitor
C9—5-μF, 16-V capacitor
C10—220-μF, 16-V capacitor
C11—510-pF capacitor
IC2—78L05 voltage regulator
IC3—LM565 phase-locked loop
IC4—LM386 audio amplifier
R5—5.6 kΩ
R6—1.5 kΩ
R7,R8—680 Ω
R9—33 kΩ
R10—4.7 kΩ

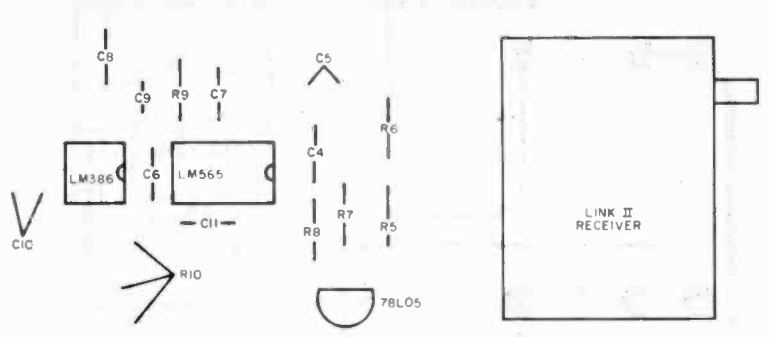
Note: The Link II kit (MF0L02) is available directly from Motorola for $99.00. Write to: Motorola Semiconductor Products, Inc., P.O. Box 20912, Phoenix, AZ 85036. Also available for $40 postpaid from Danacinths, Inc., P.O. Box 261, Westland, MI 48185 is a complete kit of parts for the FM voice link, including a pair of etched and drilled circuit boards. The PC boards are also available separately from the same source for $16 postpaid (request part number RW-109). Michigan residents please add 4% sales tax.

FM voice/music link in Figs. 9 and 11 certainly is. It has a flat frequency response from 20 Hz to 20 kHz. The voice signal (about 150 mV) modulates an LM566 voltage-controlled oscillator. The oscillator frequency is determined by *R4* and *C3* but it isn't particularly critical (about 100 kHz). Two power supplies are used (±6 V) rather than one 12-V source to circumvent interface problems. Ordinarily, when a 12-V source is used, the LM566 vco square-wave output swings between 6 and 11 V. But, by placing the Link II module ground at the power-supply common, the vco output can be connected directly to the transmitter. The transmitter input now fluctuates between ground and 5 V. A full-size etching and drilling guide and a components placement guide for this circuit appear in Fig. 10.

The FM receiver (Fig. 11) contains a companion chip, the LM565 phase-locked loop, which demodulates and amplifies the square-wave output from the receiver. First, a divider network (*R5* and *R6*) reduces the square-wave signal to 1 V for input to the PLL through *C4*. The 78L05 voltage regulator supplies power for the module and establishes a bias current for the LM565.

The PLL center frequency is determined by *R* and *C* using the formula $f_o = 1.1/RC$, where R ranges between 2 and 20 kilohms. When the decoder senses an input frequency within its specified bandwidth, its output goes low. Bandwidth is determined by the loop filter capacitor *C2*, and is adjustable from 0 to 14%. This is an inverse function; the larger the capacitor, the narrower the bandwidth.

Although it might be said that this is not a full-fledged analog application, the



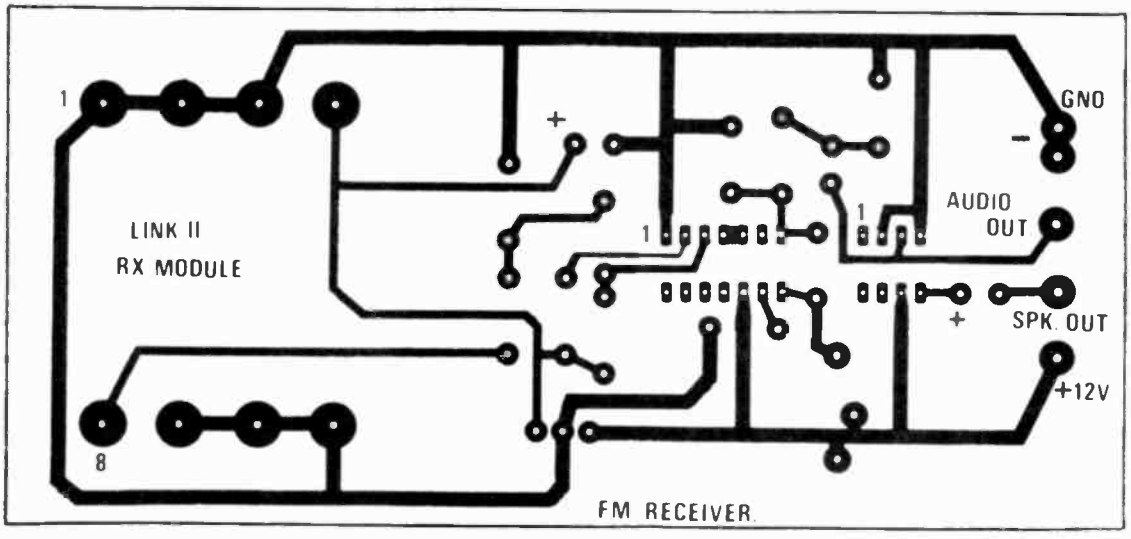


Fig. 12. Foil pattern (right) and component layout (above) for circuit in Fig. 11.

mined by *R10* and *C11;* however, its capture range is ± 40 kHz. Some distortion and noise may result if the PLL has to search extensively before locking. Resistor *R10* can be replaced by a 10-kilohm trimpot if fine adjustment is desired.

The PLL's audio output is filtered and passed along to an LM386 audio amplifier, which can deliver 250 mW to an 8-ohm speaker. Audiophiles should note that, if the LM565 audio output is sampled *before* the power amplifier, a signal-to-noise ratio in excess of 100 dB is available. Refer to Fig. 12 for etching, drilling, and component placement.

Longer Links, Greater Bandwidth. As it comes from the manufacturer, the Link II system is capable of a 200-kHz bandwidth over several hundred meters—almost a half-mile! But, there are improvements which you can make to increase both parameters.

First, and easiest, involves the optical output of the transmitter. Motorola makes an improved version of the transmitting LED, designated the MFOE106F, with increased optical power for greater distance. By substituting the brighter LED, operation is extended to several kilometers with no loss in bandwidth.

This distance can be extended even further by increasing the value of the *IC1A*'s feedback resistor and thus improving (by as much as three times) the sensitivity of the receiver. A maximum of 1 megohm is suggested. Unfortunately, this modification introduces instability and a 2-pF capacitor across the feedback resistor may be required.

Bandwidth can also be increased. Although 200 kHz is suitable for most applications, the limiting factor here is the transmission rate. This is controlled by the monostable multivibrator in the transmitter module. With a clock pulse width of 2 μs, you can't get data through any faster than 200 kHz.

But, if you decrease the transmitter module's 250-pF capacitor (narrowing the trigger-pulse width), the data transmission rate increases. A 1-μs pulse width will double it (400 kHz). This may be tricky, since all transmitter modules do not respond equally to increased data flow, and you'll have to experiment. Also, increasing bandwidth while extending fiber length isn't always possible. Due to modal dispersion in the glass fiber, and decreasing sensitivity at the receiver, a conflict between link length and data rate inevitably develops, and a compromise is necessary.

The foregoing gives you a chance to work with state-of-the-art devices that will undoubtedly shape the future of communications. ◇

FIBER-OPTIC THEORY

ANYONE who has ever seen a sunset across water has witnessed the operating principle that makes fiber optics possible. Basically, it involves the mechanics of refraction (the bending of light as it passes from one transparent material into another).

Light travels at a speed of 186,000 miles per second in a vacuum. However, when a ray of light (or photon) encounters anything other than a vacuum, it slows down, which creates refraction.

Take air and water as an example. The speed of light in air can be considered equivalent to that in a vacuum. However, light travels much slower in water.

The relationship between this decrease in light speed (relative to the speed in a vacuum) is the material's refractive index. When light passes between materials with different indexes (air to water), the change in speed shifts the original direction of travel. According to Snell's law, the amount of deviation is dependent upon the *ratio* between the refractive indexes involved *and* the angle at which the light strikes the boundary, or interface between materials. The light, therefore, enters at one angle and emerges at another.

However, at a certain angle of attack, light will not enter the second substance. Instead, all incident light bounces off the interface. This is called the critical angle, and all light approaching at an angle greater than this is reflected.

Now think of the sunset over water. While the sun is high (any angle less than the critical angle), sunlight enters the water, is refracted, and finally absorbed. However, as the sun drops toward the horizon the critical angle is reached and all the light reflects off the water instead of refracting into it—creating those breathtaking scenes.

This is exactly what happens in the typical optical fiber. The fiber core (the actual path traversed by the light) is usually made of silica glass (although plastic can be, and is, used). Upon that is bonded a cladding of silica glass with a different refractive index. It's the air-to-water interface all over again, only this time it involves two types of glass.

A ray of light entering the center core has three possible paths. It can (1) travel the entire length of the fiber unscathed (highly unlikely); (2) strike the glass/glass interface and be refracted (eventually to be absorbed by the protective outer jacket); or (3) bounce off the interface "wall" and continue on.

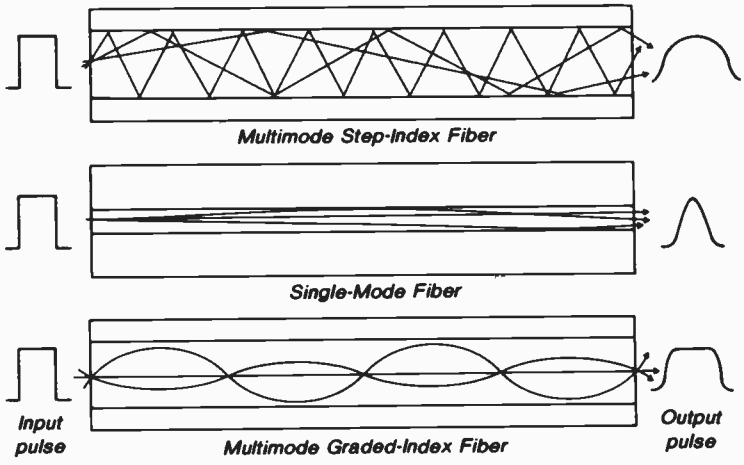
Some opitcal paths will contain more reflections than others, depending upon the initial encounter angle. Light beams that make just a few bounces go the shortest distance and require the least travel time. This effect is called modal dispersion, and it tends to stretch the information pulse (see diagram).

In order to reduce the modal dispersion associated with the simple step-index fiber, other types of fibers have been developed. By reducing the glass core diameter, it's possible to make the light "tunnel" so small that it will propagate only those rays with the fewest reflections. Since the sundry assortment of reflections has been reduced to very nearly one, dispersion is greatly improved in this "single-mode" fiber.

Single-mode fiber is extremely thin (2 μm, the size of a human hair), and is difficult to handle. Nevertheless, it is the most efficient of available fibers and is used extensively in long-distance wideband telephone communications.

Another way to reduce modal dispersion is to eliminate the reflections altogether, as is done in graded-index fibers. Even the name gives you a clue; the higher the refractive index, the slower the light travels. Consequently, the refractive index of this core isn't uniform, but is highest at the center, tapering in value radially. The farther light is from the fiber center, the faster it travels.

Due to the many refractive gradations, the light passing through this fiber isn't simply reflected, but gently bent, with the longest path also being the fastest. This causes all the incident light to reach the end of the fiber at about the same time. Graded-index fiber is difficult to manufacture, and therefore more expensive. However, its minimum dispersion and easy handling characteristics are making it very popular. ◇



SOUND-ACTIVATED PHOTO FLASH

Simple circuit freezes split-second action

BY NEIL ULEVICH

SOUND triggers that activate stop-action flash units have been around for years. However, a couple of inexpensive integrated circuits make the circuit described here one that is easy to build and simple to operate. The circuit triggers a modern automatic electronic flash unit that delivers an ultra-short flash. This, in turn, freezes action of an event such as a bursting balloon or a breaking light bulb.

Circuit Operation. A crystal microphone senses the sound of the trigger event and feeds the signal to *IC1*, an LM386 low-voltage audio power amplifier. The amplifier, wired for maximum gain (about 200) triggers *IC2*, a 555 timer which serves as a monostable multivibrator or one-shot. The timer's output pulse turns on the SCR, which fires the flash unit and also prevents repeat firing of the flash during the duration of the pulse. The LED gives visual indication that the circuit is operating. A single 9-volt battery powers the project.

Construction. Point-to-point wiring works well, or you can design and etch a simple printed-circuit board. Make sure you pay attention to the polarity of the SCR terminals when you connect the flash. Keep the microphone cord short.

Use. Sound is the slowpoke in triggering this solid-state circuit, so adjusting the distance between the crystal microphone and the trigger event (such as a balloon bursting) gives the photographer some control over timing. Just remember that sound takes about a millisecond to travel one foot.

After testing the circuit for operation by clapping, prefocus the camera (a tripod or similar brace is mandatory), turn out the lights, open the camera shutter and trigger the circuit with a loud sound. After the flash, close the shutter and restore the room light.

Modern automatic flash units, many of them moderate in cost, provide the incredibly short flash duration needed to stop most action. A flash used in the automatic mode at minimum distance from the subject can yield a flash as brief as 1/20,000 of a second.

Try it for yourself. Milliseconds never seemed so long! ◇

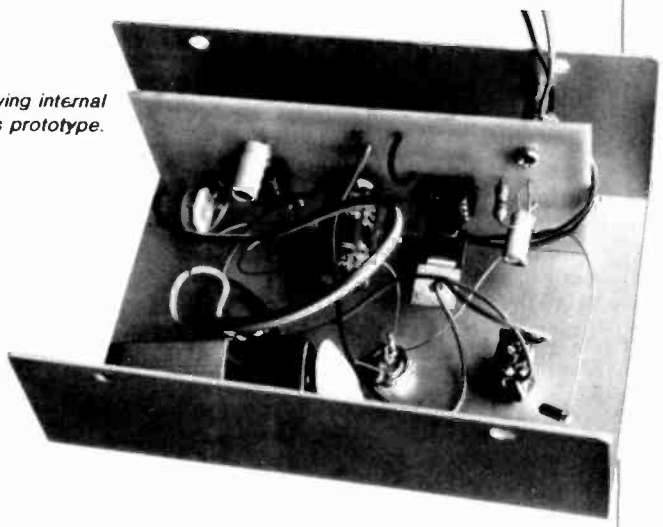
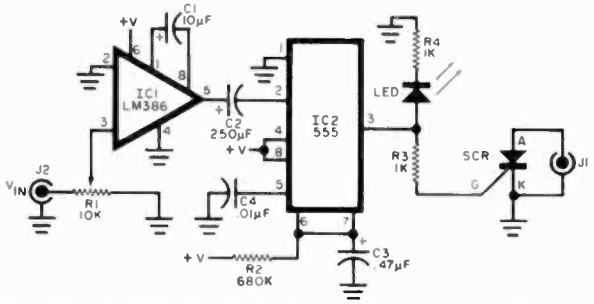


Photo showing internal view of the author's prototype.



Signal from the sound source is amplified and applied to the one-shot 555.

PARTS LIST

B1—9-volt battery
C1—10-µF electrolytic
C2—250-µF electrolytic
C3—0.47-µF electrolytic
C4—0.01-µF ceramic capacitor
IC1—LM386 audio power amplifier
IC2—555 timer
J1, J2—Suitable jacks for microphone input and flash connections
LED1—Red light-emitting diode
R1—10-kΩ variable resistor
R2—680-kΩ, ¼-W resistor
R3, R4—1-kΩ, ¼-W resistor
SCR1—Silicon-controlled rectifier capable of handling the necessary voltage (200 V or more). Radio Shack 276-1067 or equivalent.

HOW TO **SWEETEN** THE **SOUND** OF YOUR **PHONO CARTRIDGE**

A precision equalizer/preamp pinpoints the truly correct impedance match between a phono cartridge and receiver preamp for the best high-frequency response

BY MARTIN NAGEL

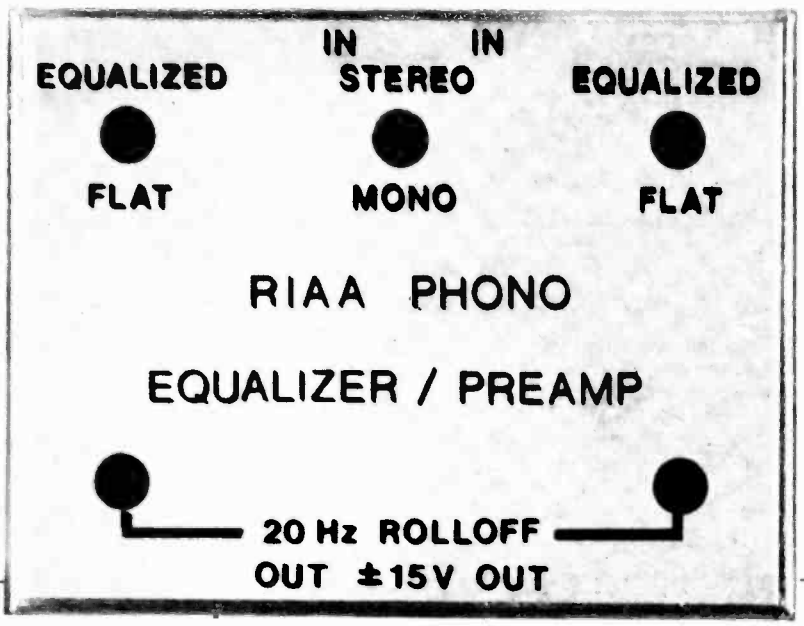
THE BEST LOAD for your cartridge may not be the nominal 47-kilohm phono input impedance available on most commercial preamps and receivers. This is important because incorrect cartridge loading can needlessly sacrifice high-frequency response. However, it is a relatively easy task to determine the optimum loading with a simple RC network. All that is required is an RIAA equalizer/preamp that can be switched between an equalized and a flat response, a flat-recorded test record, and an ac voltmeter or oscilloscope.

For about $50, a compact state-of-the-art RIAA equalizer/preamp can be built that offers the required switching capability plus precision performance and extremely low noise (actually *less* than the thermal noise generated by a moving-magnet cartridge). The design also includes two 20-Hz rolloff switches (one for each stereo channel) that can selectively attenuate sub-audible record warp signals, and a stereo/mono switch to accommodate monophonic records or reduce noise when worn stereo records are played back in mono. Simple plug-in operation is accomplished via the auxiliary input jacks on your present preamp, receiver, etc. You will need to provide a ±15-V dc supply to power the unit, and a CBS STR 100 test record to use as a signal source.

Circuit Description. A dual low-noise operational amplifier, the Exar XR-5532AN, is especially suited to this equalizer/preamp design. The chip offers extremely low noise (input noise voltage specified as 5 nV/$\sqrt{\text{Hz}}$ at 1 kHz), high open-loop gain (typically 100 dB at low frequencies and 40 dB at 20 kHz), and high slew rate (9 V/μs). The device's power bandwidth (140 kHz) and unity-gain bandwidth (10 MHz) preclude any type of transient or slew-induced distortion. And the chip's unusually good low-impedance drive capability (10 V peak into 600 ohms) means that long cables connected to the equalizer/preamp outputs will not attenuate high-frequency response.

In Fig. 1, R and C represent the load on the stereo cartridge. The printed-circuit layout of Fig. 2 was designed assuming that R and C are external to the equalizer. For example, R and C could be soldered inside a phono jack shell, with a phone plug on one end and a phono jack on the other. A load made in this manner would be fully shielded, and is especially convenient if you have two or more different cartridges each needing a different load for best high-frequency response. Furthermore when the cartridge loads are external, the equalizer can be used as a very low-noise microphone or oscilloscope preamp if the EQUALIZED/FLAT switches are set at the FLAT position and dc offset at the preamp output is not excessive. However, when just one cartridge is to be used, it is perfectly acceptable to solder R and C inside the equalizer.

With the equalizer/preamp's inputs connected to a stereo cartridge, the EQUALIZED/FLAT switches in the EQUALIZED position, and the 20-Hz rolloff switches in the upper (no rolloff) position, 1 or 2 volts of dc at the output can be expected. Therefore, it is recommended that the equalizer/preamp be connected to capacitor-



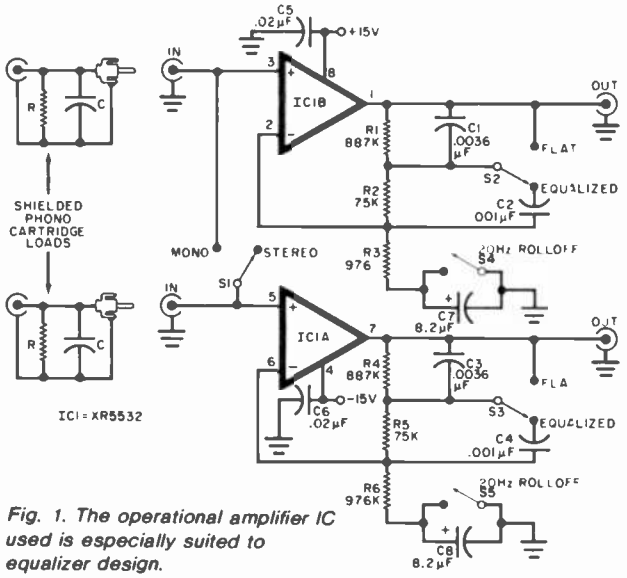


Fig. 1. The operational amplifier IC used is especially suited to equalizer design.

PARTS LIST

C1,C3—0.0036-μF, 25-V, 1% polystyrene film capacitor
C2,C4—0.001-μF, 25-V, 1% polystyrene film capacitor
C5,C6—0.02-μF, 50-V, +80/−20% ceramic capacitor
C7,C8—8.2-μF, 20-V, ±5% tantalum capacitor
IC1—Exar XR-5532AN or XR-5532AP or Signetics NE5532AN dual low-noise operational amplifier
R1,R4—887-kΩ, 1/8-W, 1% metal-film resistor
R2,R5—75-kΩ, 1/8-W, 1% metal-film resistor
R3,R6—976-Ω, 1/8-W, 1% metal-film resistor
S1 through S5—Spdt toggle switch (Alcoswitch TT11DG-PC-1 or C&K T101MH9CB)
Misc.—Fiberboard insulation, pc board, 4 chassis-mount phono jacks, Bud CU-3000A aluminum minibox, decal, wire, ± 15-V regulated power supply, etc.

Note—The following are available from Consumer Electronics Development Corp., 8136 Music Street, Chagrin Falls, OH 44022: Complete kit of parts (#RIAAEQ-1), including cut and drilled pc board and enclosure (less power supply), $50; ± 15-V wallmount regulated power supply, $40; CBS STR 100 test record, $15. Prices include UPS shipping in the U.S. when prepaid by check or money order. Ohio residents add 5% sales tax.

coupled inputs with a time constant of 65 ms (0.1 dB loss at 16 Hz) or greater, and an input impedance of 600 ohms or greater. Most preamplifier or receiver "auxiliary" or "line-level" inputs meet these conditions.

The equalizer/preamp's low-frequency ROLLOFF switches provide a response that is flat to dc in the "up" position or rolled off 3 dB at 20 Hz in the "down" position. This rolloff attenuates subsonic signals from warped records. Unchecked, these signals can cause intermodulation distortion due to excessive woofer-cone motion. The dc output offset voltage is also reduced when the rolloff position is selected. Since the International Electro Technical Commission (IEC) recommends a rolloff time constant of 7.95 ms (which produces a −3-dB frequency of 20 Hz), *C7* and *C8* of Fig. 1 are chosen so that $R3C7 = R6C8 \simeq 7.95$ ms.

Construction. The foil pattern for the pc board is shown in Fig. 2. All holes are 0.035" diameter (#65 drill).

Components are located as shown in Fig. 3. The colored band (outside foil) end of capacitors *C1, C2, C3,* and *C4* should be nearest the center of the pc board. *Do not* mount *IC1* backwards or it may burn out when the power is applied. Note the ground wire that is soldered to the case of all five switches. The purpose of this wire is to prevent hum pickup when the switches are touched (in the event the switch cases do not make good contact with the enclosure).

Mount the pc board in a suitable enclosure as shown in the photograph. Use fiberboard insulation between the board and the enclosure. Drill holes on the top for the switches and on the sides for the input and output jacks and power supply leads. Place a ground lug under the mounting nut of one of the output jacks.

Installation. The outputs of the equalizer/preamp should *not* be connected to the "phono" inputs of a standard preamplifier or receiver since these inputs are designed to receive signals directly from the stereo cartridge. Instead, connect the outputs of the equalizer/preamp to one of the high-level inputs ("aux," "tape," "line," etc.). Now when playing records, simply select the appropriate high-level input instead of "phono."

To avoid hum pickup, a separate ± 15-V regulated dc power supply is required for the equalizer/preamp. Be sure to observe proper polarity when connecting the two-wire power supply cord from the equalizer/preamp to this supply. The COM terminal of the power supply should be connected to the chassis of your existing preamplifier or receiver, and the power supply should be plugged into a switched courtesy outlet. With this arrangement, the equalizer/preamp is connected to the power supply ground through the output cables that plug into the "auxiliary," "tape," or "line-

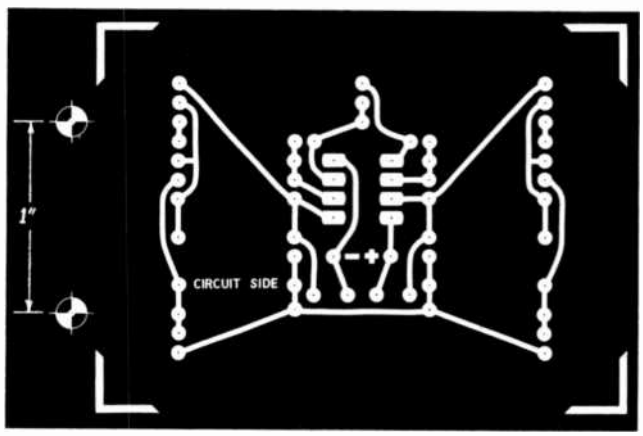


Fig. 2. Same-size foil pattern for pc board.

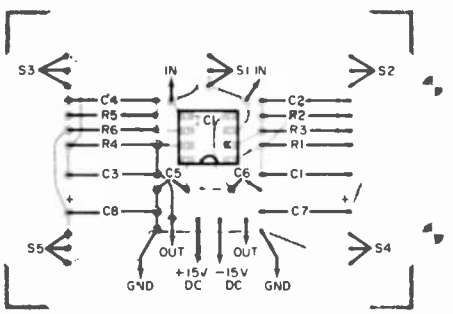


Fig. 3. Component layout for the pc board.

level" inputs of your existing preamplifier or receiver.

The equalizer/preamp will not overload when using high-output stereo cartridges and heavily recorded records. However, the output of the equalizer (which on very rare occasions can reach 5 V peak) may overload the inputs of certain preamplifiers or receivers. If this occurs, it can be corrected by adding resistive dividers at the equalizer/preamp's output.

Optimum Cartridge Loading. If you have an ac voltmeter or an oscilloscope with flat frequency response from 1 kHz to at least 20 kHz, you can now determine the load which produces the flattest high-frequency response from your stereo cartridge. Place a CBS STR 100 test record on your turntable. This record has frequency sweeps from 500 to 20,000 Hz recorded *without* equalization. Therefore, when playing these sweeps, a flat response should be observed with an ac voltmeter (or oscilloscope) connected to the outputs of the equalizer/preamp with the EQUALIZED/FLAT switches set to the FLAT position. This technique drastically reduces the low-frequency "jitter" that would be present if an RIAA-equalized test record were used. (This is because RIAA playback equalization involves considerable low-frequency boost).

Most stereo cartridge manufacturers recommend a load of 47 kilohms in parallel with a capacitance of 200 to 500 pF (which includes the capacitance of the cable from the cartridge to the load). However, it is sometimes possible to get much flatter high-frequency response by choosing the total cartridge load capacitance to resonate with the inductance of the cartridge at 10 to 12 kHz and then choosing the load resistance that provides the flattest high-frequency response. (A low-noise resistor is not required here because the resistor is in parallel with the much lower cartridge impedance, and no dc voltage appears across the resistor to generate current noise. However, because a polystyrene capacitor has a much lower dielectric absorption, it should be used—instead of a ceramic capacitor—for lowest distortion).

To optimize the cartridge load, start with 47 kilohms in parallel with a capacitance of 330 pF. Run a sweep with the CBS STR 100 test record and note the high-frequency response. If there is a rolloff in the 15-20-kHz region (10 dB worst case) or a 5-8-dB peak somewhere around 10 to 12 kHz, adjusting the load can definitely improve the response flatness.

In the case where a rolloff exists at 15 to 20 kHz, the load has too much capacitance and/or too little resistance. Cut back the 330 pF by 20%, and repeat the sweep test. Next, increase the 47-kilohm resistor and again repeat the sweep. Experiment until you are satisfied that the high-frequency response is correct.

If a peak (resonance) at 10 to 12 kHz is evident, try decreasing the load capacitance and resistance alternately in 20% increments. This should move the peak higher in frequency as its amplitude is diminished. Too much capacitance and too little resistance will produce a high-frequency rolloff, so again a trial-and-error procedure is necessary. (If you wish to forego optimizing the cartridge load, then a 47-kilohm ± 10%, 1/4-W carbon resistor in parallel with a 330-pF, ± 10% polystyrene capacitor soldered between each input and ground inside the equalizer/preamp is recommended and will provide reasonably flat high-frequency response with practically all moving-magnet stereo cartridges.)

Moving-Coil Needs More Gain. Owing to the very low output of moving-coil cartridges, an additional gain stage is needed between the cartridge and the equalizer/preamp. Because of its extremely low noise, a second equalizer/preamp is perfect for this function. This second unit should be used with its EQUALIZED/FLAT switches in the FLAT position and its output modified from direct-coupled to capacitor-coupled. Solder an 8.2 μF, ± 5%, 20-V tantalum capacitor in series with each output jack and a 47-kilohm ± 10%, 1/4-W carbon resistor from each output jack to ground. Both equalizer/preamps may be powered from the same ± 15-V supply.

The gain of the second equalizer/preamp is given by $(R2 + R3)/R3$ and can be changed, if necessary, by changing the value of $R3$. This gain should be chosen so that the unit delivers about 5 mV rms when the moving-coil cartridge is playing sinusoidal record grooves recorded at 3.5-cm/second rms velocity. Again, the CBS STR 100 test record can be used for this check. ◇

TYPICAL PHONO EQUALIZER PERFORMANCE

(All switches in "up" position)

Equalization error: ± 0.1 dB (0 to 20,000 Hz)
Hum and noise: 87 dB (A-wtd) below 10 mV rms input
81 dB (A-wtd) per IHF-A-202
Total Harmonic distortion: 0.01% (0 to 20,000 Hz)
Gain (equalized): 100 (40 dB) at 1000 Hz
Gain (flat): 78 (38 dB) (0 to 140,000 Hz)
Input overload level: 100 mV peak at 1000 Hz
Output drive capability: 10 V peak into 600 ohms
Channel separation: 80 dB at 1000 Hz
Channel balance: ± 0.1 dB
Low-frequency response: Flat to dc or −3 dB rolloff at 20 Hz (switch selectable)
Recommended power supply: ± 15 V regulated
Current drain: 8 mA

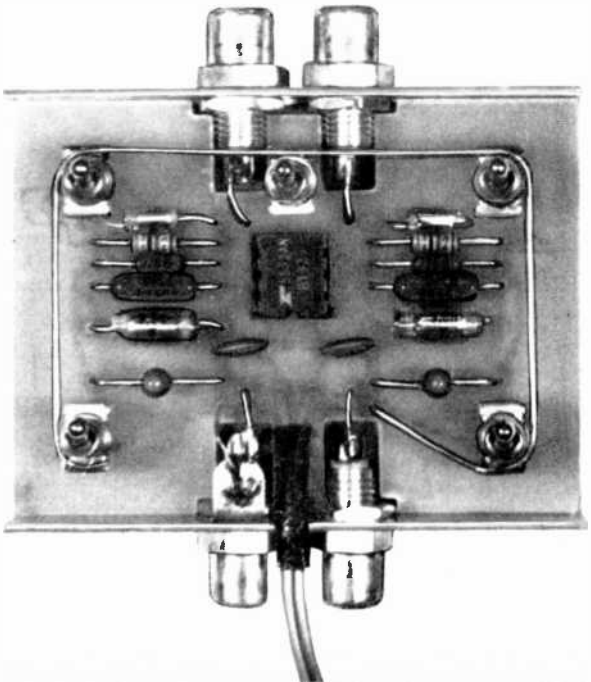


Photo of the interior of the author's prototype shows one way to lay out the project.

BY ROBERT P. COLWELL

TEACH YOUR DIGITAL CLOCK TO CONTROL APPLIANCES

A few simple additions turn a standard clock module into a versatile control center

A DIGITAL alarm clock can control your electronic appliances if you add a simple circuit to the clock module. The circuit, which consists of just one IC and a few other components, transforms the clock into a flexible and useful timing-control device. But before we discuss the circuit, let's take a closer look at the clock module.

The digital alarm-clock module used for this project is National Semiconductor's MA1020. The MA1020 is a complete 12/24-hour digital clock with a full range of alarm functions and includes a 0.84-inch, red LED display.

To use the alarm function, an output device like a buzzer, radio or relay must be connected to the clock so that something happens at the "appointed time." The MA1020 can sound a buzzer or turn on a low-power radio if the buzzer (a small, eight-ohm speaker) or the radio and its power supply are connected to the module as shown in Fig. 1.

To control ac loads such as a stereo system, a lamp or television set, some type of interface circuitry must be provided so that the low MOS signal levels of the MA1020 can switch the 117-V ac power to the load. Besides low signal levels, one other difficulty arises with the MA1020. Its radio output signal (the alarm indication) lasts a maximum of 59 minutes. Thus, if you relied on the MA1020 to turn your stereo off for the night, you would be disappointed because after 59 minutes the stereo would come back on.

To solve this problem, a flip-flop that "remembers" that the alarm has gone off (even after 59 minutes) must be added to the circuit (Fig. 2). The flip-flop outputs to a transistor-controlled relay to switch the ac load.

Circuit Operation. The main element of the circuit in Fig. 2 is the set/reset flip-flop (*IC1B* and *IC1C*). Any low inputs to *IC1B* cause the flip-flop to be set (*IC1B*'s output high), and low inputs to *IC1C* cause the flip-flop to be reset (*IC1B*'s output low). When the flip-flop is set, *IC1B*'s output is a logical one, transistor *Q1* turns on, and the relay is energized.

The MA1020 indicates that the alarm has gone off by supplying base current to a bipolar transistor within the MA1020 module. The emitter and collector leads of this transistor are brought out to pins 23 and 22, respectively. If we connect this transistor as in Fig. 2, with the emitter tied to a positive voltage supply and the collector tied to ground through a resistor, we have converted the base current to a voltage that a CMOS gate will recognize as a logical one or zero. Thus, when the radio output is active, base current is supplied to this transistor, turning it on. When this transistor is on, it effectively "pulls up" *IC1A*'s inputs to a logical one. If the transistor is off (no base current) resistor *R1* "pulls down" *IC1A*'s inputs to a logical zero.

Of course, we'd like the radio output, when active, to set the flip-flop. Since the flip-flop sets when any *IC1B* inputs are logic zeroes, we must invert the radio output signal through *IC1A*. An active radio output signal therefore causes a logic zero at pin 5 of *IC1B*.

Meanwhile, *IC1C* has logical ones at pins 1 and 2 (assuming that both the ALARM OFF switch and the SNOOZE switch are open), and its other input (pin 8) has just gone high as well due to *IC1B's* switching as described above. So with all of its inputs at logic one, *IC1C*'s output is a logic zero.

This completes the flip-flop action because *IC1B* now has a zero at its pin 3 input (because of *IC1C*'s low output).

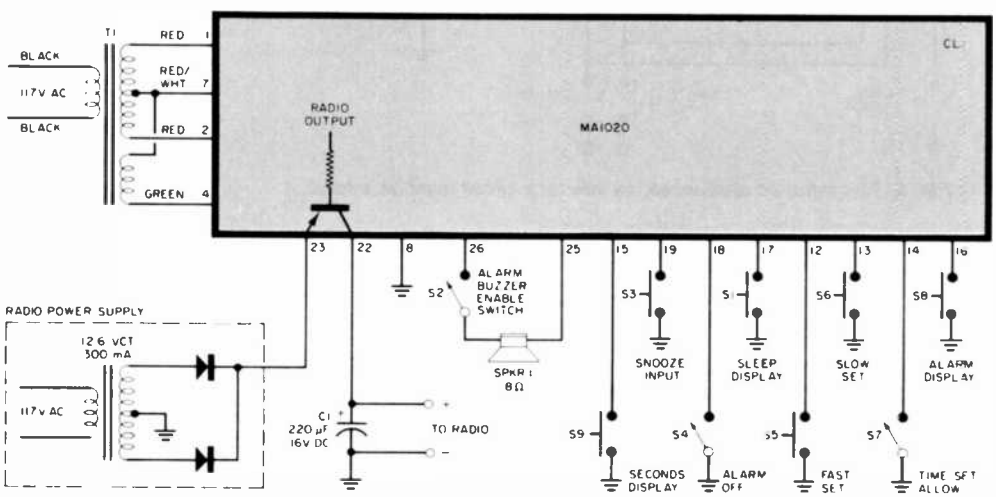


Fig. 1. These basic additions to the clock module will allow you to control a radio and a buzzer alarm.

So even after 59 minutes have elapsed and the MA1020 has removed its radio output, the flip-flop stays in its set state and the relay remains energized. (The stereo stays off as planned.)

Activating the snooze input or shutting off the alarm will reset the flip-flop. The flip-flop can also be manually overridden by inputting a logical zero directly into *IC1B* via switch *S2*. This switch can be very convenient if you want the appliance being controlled to be on or off regardless of the time (and you don't want to unplug the appliance from the clock).

Other Clock Features. Another feature of this clock module is a programmable 59-minute interval timer, which can be used to turn an appliance on or off for a period of up to 59 minutes, after which it will be returned to its original state. This feature could save energy—(if you forget to turn off a lamp, the MA1020 will do it for you).

To use the interval timer, first close the ALARM-OFF switch, *S4*. Besides disabling the alarm inside the MA1020, this puts a logic zero on pin 2 of *IC1C*—a reset. Normally this is enough to keep the flip-flop in its reset state. However, momentarily closing the SLEEP-DISPLAY switch activates the interval timer inside the MA1020, and the radio output goes active. This supplies a set input to *IC1B*, pin 5, as described earlier.

The flip-flop now has both a set and a reset. What will it do? Both pin 6 and pin 9 will go high as long as the set and reset are still present. But the final state of the flip-flop depends on which of those two inputs lasts longest. In this case, the set input is removed after 59 minutes (or the interval you programmed) and the reset "wins" thereafter. The net effect is just what we wanted—the relay energizes only for the interval that the radio output is active.

The interval can be terminated prematurely by momentarily closing the snooze switch, *S3*.

The MA1020 also has battery backup capability. All you need add to the module to take advantage of this feature is a standard 9-volt battery and a 5-megohm potentiometer (Fig. 3).

Normally, the MA1020 bases its time-keeping on the 60-Hz ac line frequency, which permits it to maintain excellent long-term accuracy. However, if the ac power is lost, the MA1020 can switch automatically to a backup oscillator and the 9-volt battery so that it won't forget what time it is. Relatively high-power parts of the clock module such as the LED display and the relay

(Continued on page 80)

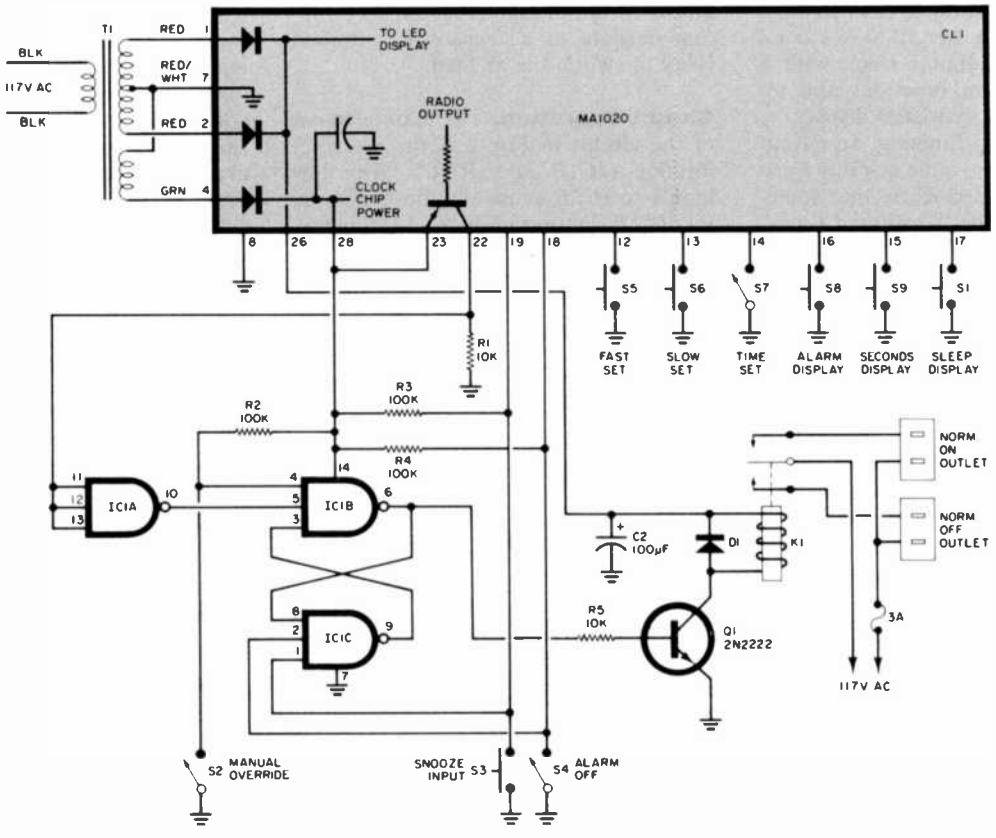


Fig. 2. To control ac appliances, an interface circuit must be added.

PARTS LIST

B1—9-V transistor radio battery
C1—220-µF, 16-V electrolytic
C2—100-µF, 16-V electrolytic
CL1—National Semiconductor's MA1020 clock module
D1—1N4000 series, 1-A rectifier
IC1—CD4012, CMOS triple, 3-input NAND gate
K1—5-V, 440-Ω, spdt relay with 3-A, 117-V contacts
R1, R5—10-kΩ, 1/4-W, 10% resistor
R2, R3, R4—100-kΩ, 1/4-W resistor
R6—5-MΩ, 1/4-W potentiometer
S1, S3, S5, S6, S8, S9—Momentary-contact, normally open switch
S2, S4, S7—spst switch
SPKR 1—8-Ω, 2-inch audio speaker
T1—Digi-Key MA 1020T transformer
Misc.—Ac line cord, 3-A fuse and holder, 2 ac outlets, suitable enclosure, strain relief, pc or vector-board, 14-pin DIP IC socket, hookup wire, solder, etc.

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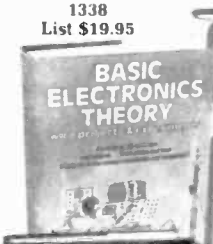

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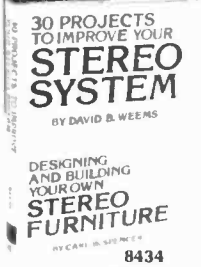

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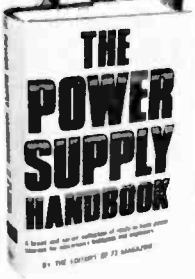

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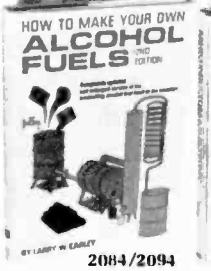

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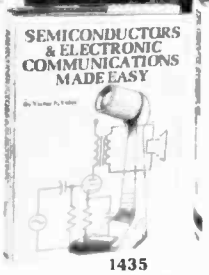

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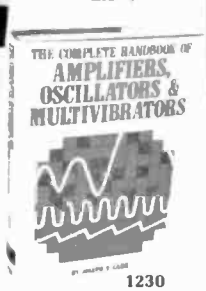

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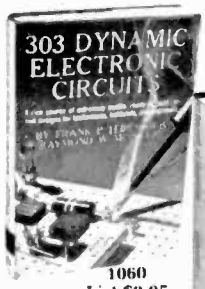

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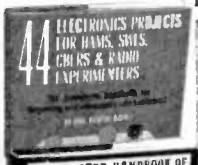

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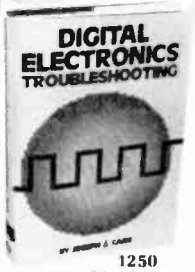

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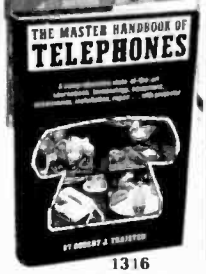

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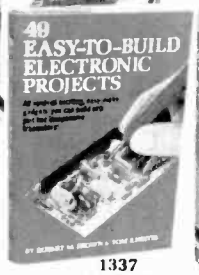

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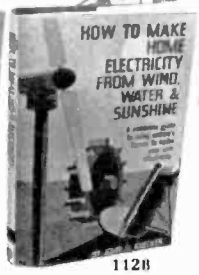

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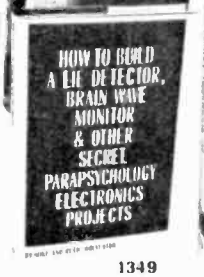

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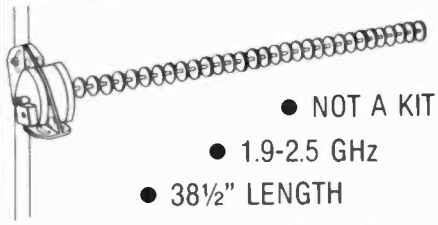

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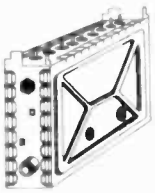

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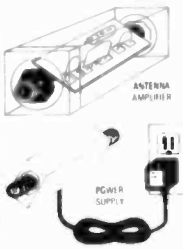

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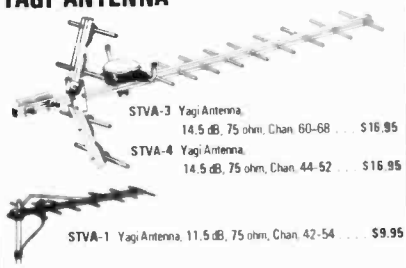

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clock control

(Continued from page 74)

coil are turned off so that battery life is maximized.

The 5-megohm pot determines the frequency of the backup oscillator, which directly affects the timekeeping accuracy when the module is running on backup power. Adjust this pot so that a 20-Hz signal appears at pin 5 for optimal accuracy. (If you don't have a frequency counter handy, you can set this frequency by trial-and-error. Just set the clock to the correct time, adjust the pot, turn off the ac power to the

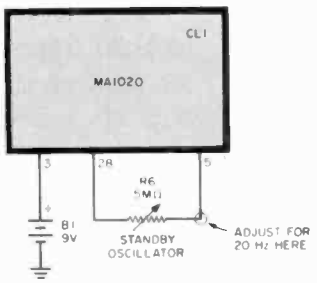


Fig. 3. A battery backup circuit can be added as shown here.

module, and wait a few minutes. When you turn on the ac power again, compare the time the module thinks it is to the correct time. Adjust the pot and try again, but leave the power off longer for each try.)

Use. One precaution that must be taken with this design: the ac load that is switched by the relay must not exceed the rating of the relay contacts. The relay specified in the parts list is rated for 3 A, 117 V, noninductive loads. This means that the relay will handle most lamps, radios, etc. But if you plug in your toaster, air conditioner, or washing machine you'll blow the fuse and may destroy the relay.

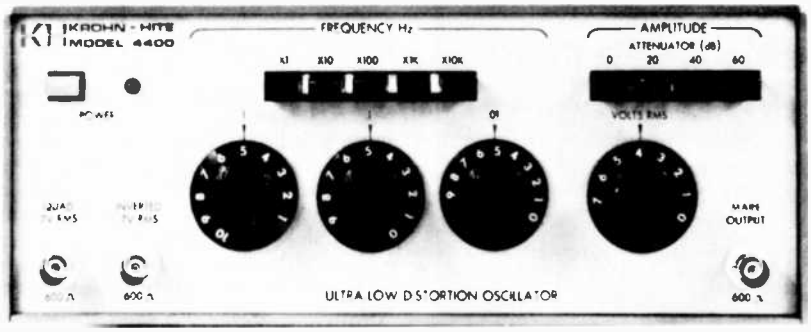
When you construct the physical housing for the timer, you may want to place the snooze switch in a place that is easy to reach. I mounted the switch under the top door of the housing so that pushing down on any part of the clock would activate the snooze feature.

Take the usual precautions that CMOS or NMOS deserve. For instance, the clock module is shipped wrapped in aluminum foil to prevent any possible damage from static electricity. It's prudent to keep this foil on the module until you're ready to wire it up. Also, avoid touching the pins of the CD4023 or the MA1020 as much as possible.

There are more modes and features built into the clock module than were described here. The documentation that accompanies the module covers them all and also describes tests to verify the health of the clock module. ◇

Popular Electronics Tests

Krohn-Hite Model 4400 Ultra-Low Distortion Oscillator



CERTIFICATE OF CALIBRATION

LOCKHEED ELECTRONICS COMPANY, INC.

THE Krohn-Hite Model 4400 Ultra-Low Distortion Oscillator covers the range from 1 Hz to 110 kHz with less than 0.001% distortion and just ±0.05 dB variation in frequency response. This makes the Model 4400 ideal for testing all types of audio equipment, including the latest state-of-the-art systems. It measures 3.5″ H x 9″ W x 8.5″ D, and weighs 5 pounds. Suggested retail price is $600.

General Description. All major controls are on the front panel. These include the FREQUENCY HZ controls that allow two digits of frequency, calibrated in 1- and 0.1-Hz increments with a calibrated vernier between the 0.1-Hz steps, and a 5-decade pushbutton multiplier providing X1, X10, X100, X1K, and X10K steps. The output amplitude is a 7-V rms sine wave controlled by a 4-position pushbutton attenuator switch calibrated in 20-dB steps between 0 and 60 dB. There is a separate vernier providing an additional 30 dB of coverage, for a total dynamic range of 90 dB. The output impedance is 600 ohms.

Simultaneous quadrature (90°) and inverted (180°) outputs are provided for multi-phase applications. Each of these outputs delivers a fixed 7 V rms from a 600-ohm source impedance. All outputs are via BNC connectors.

The rear apron contains a pair of screwdriver-adjust potentiometers for setting level, a slide switch for circuit ground selection, a 120/240-V line-selection switch, the fuse, and a three-

MANUFACTURER'S SPECIFICATIONS

Frequency range: 1 Hz to 110 kHz, 3-digit resolution
Frequency control: 1- and 0.1-Hz steps plus vernier, 5-decade pushbutton multiplier
Frequency accuracy: ± 1% of frequency setting
Frequency stability:
  Vs. time: 0.01% in 1 hr or less
  Vs. temperature: 0.05%/°C
  Vs. line: <0.001% for 10% voltage change
Maximum output: 7 V rms open circuit, 3.5 V rms (+13 dBm) into 600-ohm load
Amplitude control: Four-position pushbutton attenuator calibrated in 20-dB steps from 0 to 60 dB; accuracy is ±0.25 dB per 20-dB steps; VOLTS RMS control greater than 30-dB coverage, accuracy ±20% of setting. Minimum output less than 0.2 mV
Amplitude flatness:
  Main/inverted outputs: ±0.05 dB, 1 to 110 kHz
  Quadrature output: ±2 dB, 1 to 110 kHz
Amplitude stability:
  Vs. time: 0.01% in 1 hr or less
  Vs. temperature: 0.05%/°C
  Vs. line: <0.001% for 10% voltage change
Output distortion:
  Main/inverted outputs:
    1 to 10 Hz: 0.0018% (−95 dB)
    10 Hz to 10 kHz: 0.001% (−100 dB)
    10 to 20 kHz: 0.0018% (−95 dB)
    20 to 50 kHz: 0.0056% (−85 dB)
    50 to 110 kHz: 0.01% (−80 dB)
  Quadrature output:
    1 to 10 Hz: 0.0056% (−85 dB)
    10 Hz to 10 kHz: 0.0031% (−90 dB)
    10 to 20 kHz: 0.0056% (−85 dB)
    20 to 50 kHz: 0.0174% (−75 db)
    50 to 110 kHz: 0.031% (−70 dB)
Output impedance: 600 ohms, ± 1%
Phase accuracy:
  Inverted output:
    1 Hz to 10 kHz, ±0.2°
    10 to 110 kHz, ± 1°
  Quadrature output:
    1 Hz to 1 kHz, ±0.2°
    1 to 10 kHz, ± 1°
    10 to 110 kHz, ± 10°
Hum and noise: Greater than 100 dB below signal (10 Hz to 20 kHz detector bandwidth)
Ambient Temperature range: 0°C to 50°C
Power requirements: 90 to 132 or 180 to 264 V, single phase, 50/60 Hz, 6 W.
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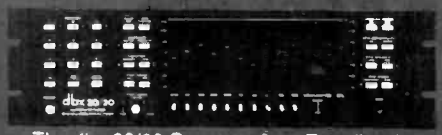

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test equipment

pin power socket. Four large rubber feet and a tilt stand are located on the underside. Complete specifications are given in the Table.

Comments. The Model 4400 Ultra-Low Distortion Oscillator was checked by the Lockheed Electronics Instrumentation Measurements Laboratory (Plainfield, NJ) against a cesium-beam frequency standard (HP 5062C) traceable to the National Bureau of Standards. The Model 4400 met or exceeded its claimed specifications in all respects. And we found that the Model 4400 specifications are equal to or better than the specifications of much more costly instruments.

Since the Model 4400 is an excellent source of very low distortion sine waves, it was put to use in testing and adjusting some audio systems we had on the bench. Before we used it, however, we succumbed to the desire to compare the Model 4400 sine waves with the sine waves we were getting from our bench audio generator (about half the price of the Model 4400). We used a dual-trace scope, with both traces superimposed. Although we could not see any real difference between the two waveforms on the CRT display, our distortion analyzer told a different story. The audio generator produced a small but measurable distortion, while the 4400's output barely moved the analyzer's analog meter on-scale.

Although some might question the use of such a low-distortion audio generator for general-purpose bench work, we feel that test equipment is not "transparent" unless its specs are at least one order of magnitude better than the device being tested. Thus when problems are encountered, suspicion remains focused on the device under test, and is not easily diverted to the test equipment.

We used the Model 4400 to "tweak" a couple of high-quality audio systems. Although the results were not dramatic (our old audio generator was OK), there was enough change to hear.

Not only do we work with audio systems, we also handle ham slow-scan television, radio control, and other equipment using audio filters. Once such filters have been aligned using the Model 4400 low-distortion audio generator, we feel confident that an almost-ideal sine wave has been used to align the filter close to perfection—even though the real-world signal it typically works with is never this clean.

One major "problem" we encountered (as far as money is concerned) was that our audio distortion analyzer must now be replaced so we can take full advantage of the Model 4400 ultra-low distortion audio generator! We have encountered this phenomenon before. As we acquire state-of-the-art test equipment and put it to work, older companion equipment soon comes up short. This is the price to be paid for continuous technical improvement.—*Les Solomon*

CIRCLE NO. 104 ON FREE INFORMATION CARD

COMPUTER SOURCES

By Leslie Solomon
Technical Director

Hardware

IBM Computer Digitizer. The Graphics Analysis Package #1 includes a digitizer having 0.001" resolution (sizes of 11" x 11" to 42" x 60" active area also available), a stylus, power supply, communications interface cable, and manu-

al. The disk software includes material usage, cost; length, distance, and perimeter; area of irregular polygon; display XY coordinates to 0.001 inch; etc. A 22 function menu is provided, eleven predefined and eleven user defined. Requires an IBM Personal Computer, disk drive, and RS232 Interface. $1419 with 11" x 11" digitizer; $2606 with 11" x 17"; or $3025 with a 20" x 20" translucent digitizer. **Address:** GTCO Corp., 1055 First St., Rockville, MD 20850 (Tel: 301-279-9550).

Apple I/O Board. The Programmable Serial I/O Board is fully compatible with current Apple software including Pascal 1.1, Applesoft, and Integer BASIC. It provides full EIA RS-232 DTE interface to most modems, printers, and terminals, as well as an opto-isolated current loop for full or half duplex, active or passive, 2- or 4-wire, and 20- or 60-mA. An on-board 1K ROM enables user-programmable printer width control, delay after carriage return, automatic line-feed generation, and video display. Serial character format is alterable. Baud rate is to 19.2K. Also featured is Automatic recognition of incoming data rate, and firmware routines to pulse-dial calls onto the international Telex-TWX network. $199.95. **Address:** Intra Computer, 120-10 Audiey St., Kew Gardens, New York, NY 11415 (Tel: 212-947-5533).

Color Monitor. The ECM 1302-2 Color Video Monitor produces 580 x 235 pixels at a 10-MHz bandwidth. Input is RGB (TTL level) or NTSC via an optional module. Sync is either composite on NTSC or separate on RGB. High-voltage regulation is within 3%, geometric distortion is less than 3% of picture height, and linearity is maximum 10%, worst-case. The ECM 1302-2 is compatible with the Apple III, and with the NTSC option, with the Apple II. $950. **Address:** Sigma Communications Associates, 59 Remington Blvd., Ronkonkoma, NY 11797 (Tel: 516-585-6800).

Solid-State Disk. The RAMDISK is a 320K memory system that functions like two 35-track floppy disk drives. The 200 ns RAM is compatible with Apple DOS 3.3 and Apple Pascal 1.1 while reserving 32K of RAM for advanced programming. It includes a slot-independent board that takes no power from the computer, memory refresh—even with the Apple turned off, and a built-in

battery system. Software includes diagnostics, fast load and copy routines, and business applications. **Address:** Axion Inc., 170 N. Wolfe Rd., Sunnyvale, CA 94086 (Tel: 408-730-0216). The SEMIDISK is an S-100 bus version having 512K bytes of storage. This requires an IEEE S-100, CP/M 2.x and 8080/8085/Z-80 system. Up to 32 can be linked for 16 megabytes. Operation

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speed of these systems is claimed to be 50 and 500 times faster than an 8" drive, between 100 and 2000 times faster than a minifloppy, and up to 30 times faster than a hard. **Address:** Semi-Disk Systems, P.O. Box GG, Beaverton, OR 97075.

IBM Hardware. A line of add-on and add-in hardware for the IBM Personal Computer has been announced as the TecMate series. There are more than 20 such items in the list covering a broad variety of applications. For example, there is an expansion chassis, BSR X10 controller, voice synthesizer, IEEE 488 interface, several A/D and D/A converters, music synthesizer, extender board, memory boards, and I/O interfaces. **Address:** Tecmar Inc., Personal Computer Products Div., 23600 Mercantile Rd., Cleveland, OH 44122 (Tel: 216-464-7410).

General Hardware. Building on its TRS-80 "work-a-like" computer (the AN-7000) that is compatible with Model I, Level II software, Design Solution Inc. is offering a number of hardware options. They include: AN-587 Interface using a port address isolation technique that automatically masks reserved port address to prevent bus conflicts; AN-549 12-bit Analog Interface; AN-435 Printer/RTC Interface; AN-511 Digital Port Interface; AN-890 32K RAM Expansion Interface; AN-610 Audio Signal Processor; AN-538 8-bit Analog Interface; AN-213 Address-Data Buffer; AN-460 8-Channel MUX ADC Interface; AN-760 Disk Controller Interface; AN-920 Double Density

Converter; AN-522 8K Firmware Interface; AN-551 EPROM Programmer; AN-1000 DSI Megadrive; AN-464 RS-232 Interface; EE-1670 Multi-Range DVM Interface; and the EE-1470 Multi-Programmer. **Address:** Design Solution, Inc., Box 1225, Fayetteville, AR 72702 (Tel: 501-521-0281).

TRS-80 Hard Disk. The TRS-80 Model II Hard Disk System features an 8-inch Winchester that permits the storage of over 8.4 million characters on each drive. Up to three secondary hard disks can be added for a total storage of over 33 megabytes. TRSDOS is used, with two new utilities—Save and Restore. The Save utility saves data from the hard disk to one or more backup floppies, while Restore writes data from a floppy to the hard disk. $4,495 with secondary disk units at $3,495. **Address:** Radio Shack Computer Centers and dealers.

IBM Memory. The DSI-xx RAM Boards are a series of memory expansion plug-ins for the IBM Personal Computer. The DSI-64K is $395, the DSI-192K board is $845, with the DSI-256K board selling at $1075. Each board is completely compatible with the IBM Personal Computer software and hardware, and can be placed in any free slot. **Address:** Davong Systems, Inc., 1061 Terra Bella Ave., Mountain View, CA 94043 (Tel: 415-965-7130).

VIC-20 Modem. The VICMODEM is a plug-in to the user port of the Commodore VIC-20 computer and is a direct connect, 300-baud modem having originate/answer and half/full duplex capability. $109.95. **Address:** Commodore Business Machines, Inc., Computer Systems Div., 681 Moore Rd., King of Prussia, PA 19406 (Tel: 215-337-7100).

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Sinclair Extensions. SUPER Z is a program for the Sinclair ZX-80 and MicroAce computers that adds TAB, SCROLL, MEM PAUSE, READ, RESTORE and DATA to the BASIC. The statements are contained in a machine-code module that is invisible to the user. $9.95. **Address:** Lamo-Lem Laboratories, Box 2382, La Jolla, CA 92038 (Tel: 714-262-5681).

Spelling Proofreader. "Spell" is available for CP/M and HDOS systems. It detects misspelled words in documents such as WordStar and Magic Wand. Effective dictionary size is over 50,000 words with a user-expandable prefix/suffix table. Spell processes 4000 input words per minute and requires 48K of RAM. $49.95 plus $3 shipping. On 8" CP/M or 5" Heath/Zenith CP/M or HDOS. **Address:** The Software Toolworks, 14478 Glorietta Drive., Sherman Oaks, CA 91423 (Tel: 213-986-4885).

Learning Software. "Counting Bee" is designed for children ages 3 to 6 and introduces them to counting, addition, and subtraction. It features a learning management mode that allows parents and teachers to preset the system with emphasis and duration tailored to individual needs. Requires Applesoft, 48K, DOS 3.2 or 3.3. $29.95. **Address:** EduWare Services, Inc., 22222 Sherman Way, Suite 203, Canoga Park, CA 91303 (Tel: 213-346-6783).

Communications Package. "Intercom" is a communications package for CP/M and is written in 8080 code. Designed for interactive communications as well as verified quantity file transfers (including object files) it uses several standard protocols. Features include four auto sign-on routines, four user-definable routines, batch mode for unattended operation, CP/M system level commands including directory with disk space utilization. $75. **Address:** End of File, Inc., 3140 E. Shadowlawn Ave., Atlanta, GA 30305 (Tel: 404-233-9825).

Apple WP. "Word Three" is a full-screen editor designed for the Apple computer. Users can scroll forward or backward; modify or replace text; insert and delete characters, lines, paragraphs; insert or append text from other files; move blocks of text; set margins, tabs, page length; perform line centering, indenting, and justifying; and make automatic text search and replace. Multiple files can be printed, starting on any page. $195. **Address:** Westico, Inc., 25 Van Zant St., Norwalk, CT 06855 (Tel: 203-853-6880).

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Osborne 1 Utility. Micro-Link is a communications package for the Osborne 1 that supports communication with bulletin boards and information retrieval services, as well as send and receive files from other computers. It uses the RS-232 port with a standard modem. It supports originate and answer mode, full and half duplex, and operates at 300 baud. Files can be transmitted in character, line, or memory block protocols. $89. **Address:** Osborne Computer Corp., 26500 Corporate Ave., Hayward, CA 94545 (Tel: 415-887-8080).

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Apple Atlas. What's Where in the Apple? is a comprehensive reference of Apple II firmware and hardware listing memory locations of PEEKS, POKES, and CALLS. A numerical atlas having 2,293 entries and an alphabetical Gazetteer with 1,419 entries provide names and locations of various monitor, DOS, Integer BASIC, and Applesoft routines and show what they are used for. Applesoft and Integer BASIC users will find information which will enable them to speed up programs. Assembly language users can simplify coding and interfacing. 128 pages. $14.95. **Address:** Micro Ink, Inc., 34 Chelmsford St., P.O. Box 6502, Chelmsford, MA 01824 (Tel: 617-256-5515).

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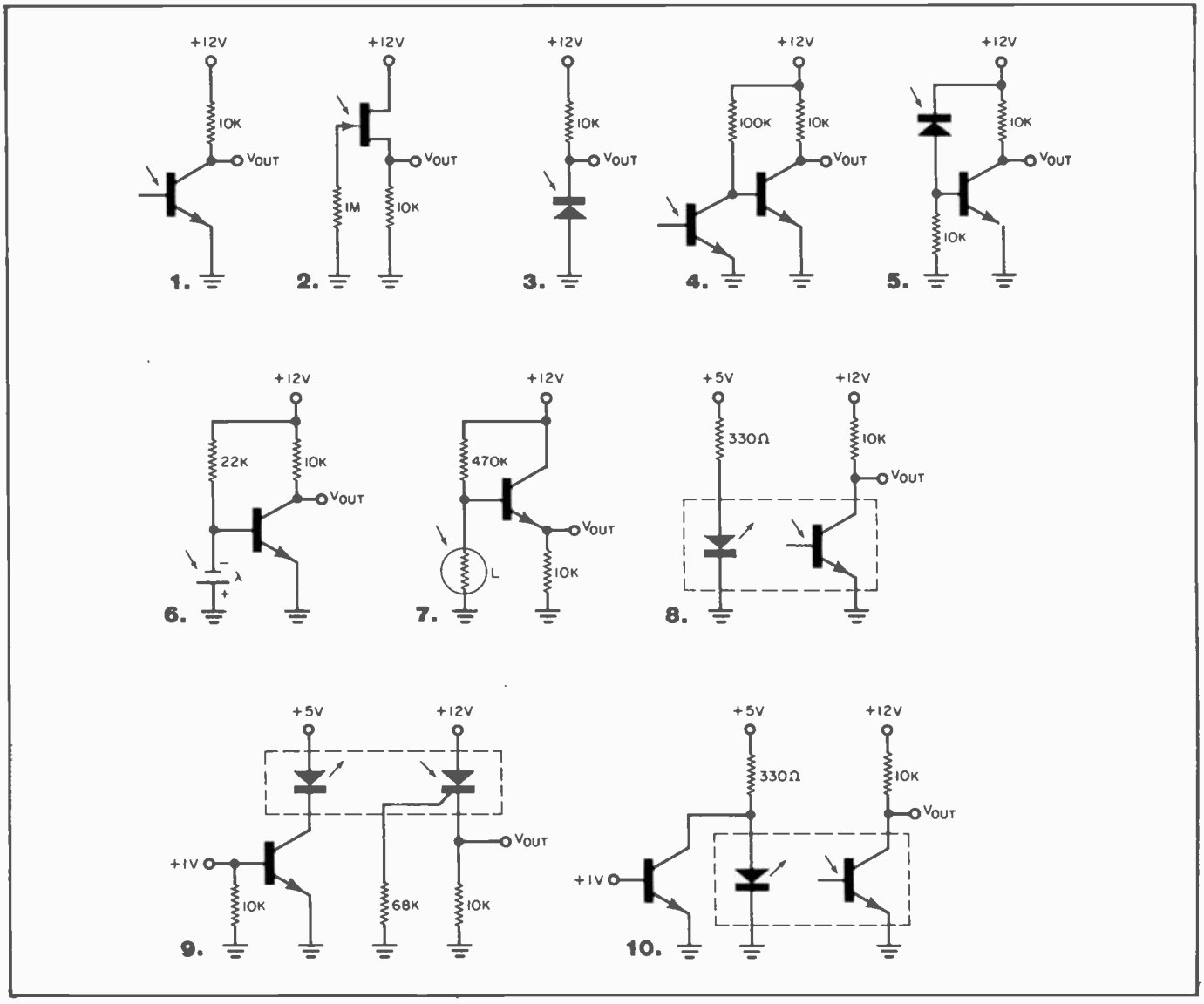
LEARNING QUIZZES FOR ELECTRONICS

By FREDRICK W. HUGHES

Optoelectronics Quiz

Optoelectronics consists of two types of devices, sensors (photodiode, phototransistor, photoFet, LASCR, light activated resistor, solar cell) and emitters (incandescent lamp, LED). When light strikes a sensor, its resistance decreases (except for a solar cell which produces a small voltage). When voltage is applied to an emitter it produces light. Which of the two choices shown below is the output voltage of the following circuits when light strikes the optoelectronic device? (Consider the device's internal resistance to be zero ohms when conducting and infinite when not conducting.)

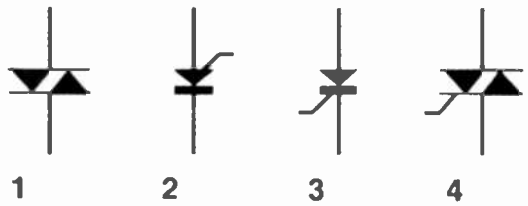


Choices: a. 0 V b. + 12 V

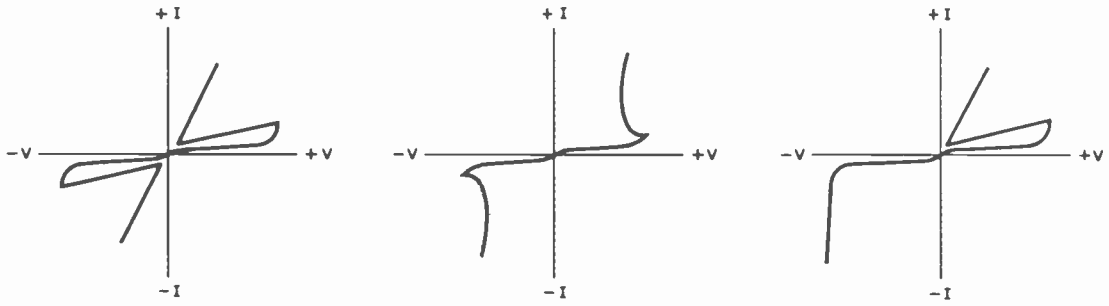
Answers: 1. a, 2. b, 3. a, 4. b, 5. a, 6. b, 7. a, 8. a, 9. b, 10. b.

Thyristors Quiz

Thyristors are solid-state switches. Match the following symbols, graphs, and statements with the correct device given in the choices.



1 2 3 4



5 6 7

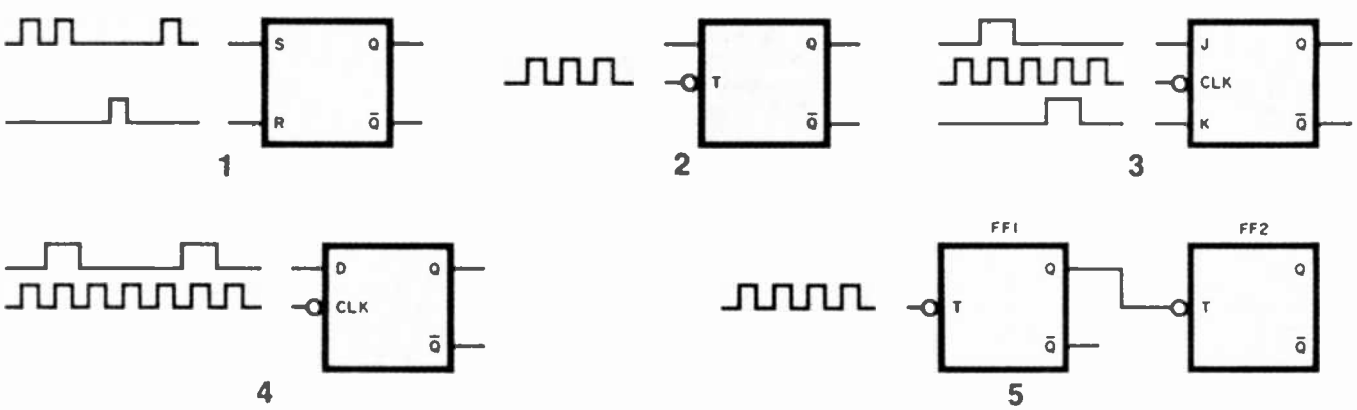
8. The device that conducts only in one direction and can be turned on with a negative pulse.
9. The device that conducts in both directions and can be turned on by a negative or positive pulse.
10. The device that conducts only when breakover voltage is reached.
11. The device that conducts only in one direction and can be turned on by a positive pulse.
12. The device that is most likely to be found as the active switch in a relaxation oscillator.

Choices: a. SCR b. PUT c. DIAC d. TRIAC

Answers: 1. c, 2. b, 3. a, 4. d, 5. d, 6. c, 7. a, 8. b, 9. d, 10. c, 11. a, 12. b.

Flip-Flop Quiz

Flip-flops can be turned on and off in various ways, depending on the type of flip-flop. A bubble at the input means a negative going pulse will cause the appropriate action. When a flip-flop is off, its Q output = 0 and its complementary $\overline{Q}$ output = 1. When a flip-flop is on, its outputs switch states so that Q = 1 and $\overline{Q}$ = 0. With the input pulses shown, determine which choice represents the state of the outputs for each circuit. Consider all flip-flops initially off.



1 2 3 4 5

Choices: a. Q = 1, $\overline{Q}$ = 0, b. Q = 0, $\overline{Q}$ = 1

Answers: 1. a, 2. a, 3. b, 4. b, 5. b (Pulse 1 turns on FF_1, pulse 2 turns off FF_1, which turns on FF_2, pulse 3 turns on FF_1, pulse 4 turns off FF_1, which turns of FF_2)

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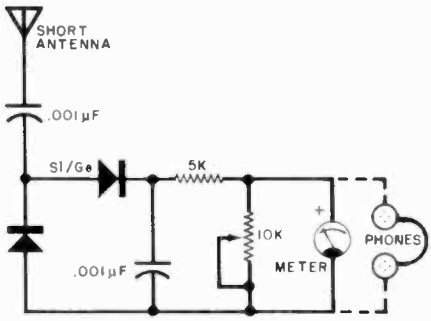
HOBBY SCENE

By Joe Desposito
Technical Editor

Simple FS Meter

Q. My club does a lot of radio control flying/car racing. Although most of the guys keep their batteries charged, it often appears that some transmitters are not tuned for maximum output. Since commercial field strength meters are somewhat expensive, do you have a low-cost substitute?—Karl Elder, Mobile, AL

A. The simple circuit shown here is a voltage-doubling field strength meter



that requires no battery. The pot acts as a sensitivity control, and almost any low-current meter indicates relative field strength. You can use an earphone to listen to the modulation if desired. To use, place the FS meter a few feet from the transmitter, then touch up the output for maximum field strength.

Power-Supply Design

Q. I would like to build a regulated power supply. Specs: 0 to 50 V dc, 0 to 5 A. It should include voltage and current meters for output. I want to use it for transistor work.—S. Thompson, New York, NY.

A. I question your power supply specs. Do you really need the power you're asking for? If not, the "1982 Electronic Experimenter's Handbook" on the newsstands includes the complete design of a power supply that is adjustable from 1¼ to 33 volts and delivers up to 1½ amperes with excellent regulation. I'm fairly sure that this supply will meet most of your needs if you are working with transistors.

Bomb-Burst Synthesizer

Q. I'm writing you in regard to the "Project of the Month" in the February 1982 issue. The project is a bomb-burst synthesizer, and the main component is a Texas Instruments sound generator chip, SN76488. It says in your article to consult the Texas Instruments data sheet for more information. I am interested in making the project, but do not know where to get this component (or where to get the Texas Instruments data sheet).—Mark Scalise, Titusville, PA.

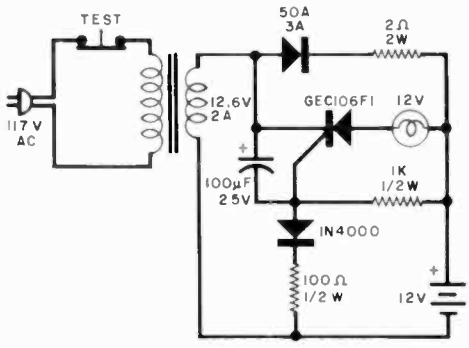
A. The chip is available from some of the companies that advertise in the back of this magazine. Data sheets can be purchased in book form (for example, Radio Shack sells the Archer "Semiconductor Replacement Guide") or ordered directly from the manufacturer. However, most electronics retailers will include the data sheet with the chip if you request it.

If you don't live near a good electronics parts store, it would be wise to stock up on catalogs from parts manufacturers. This way you will have a handy reference whenever you need parts.

Emergency Light System

Q. I would like to make my own emergency light system—the kind that turns on a battery-powered lamp when the commercial power goes down. Do you have a circuit?—Alexander Olson, Rochester, NY

A. Here is your circuit. All parts are readily available. The battery could be



any lead-acid ranging from automotive, motorcycle, through garden tractor variety. The battery will be kept on charge as long as the commercial power is on. To test the system, depress the normally closed pushbutton switch. The lamp should light.

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

SOLID-STATE DEVELOPMENTS

By Forrest M. Mims

The Rainbow LED

A LIGHT-EMITTING diode capable of emitting each of the three primary colors (red, yellow and blue) in any combination would be an optical-display designer's dream. Such a LED would be far more than a tri-color emitter, for it could generate any color or hue. With all three colors activated, it would appear to be a white light.

So far, the rainbow LED remains an elusive goal. The major obstacle is the design of an effective blue emitter. Experimental gallium-nitride and silicon-carbide blue-emitting diodes have been demonstrated, but they are very difficult to make. A mass-produced blue LED has yet to appear.

I'm convinced that a practical rainbow LED will someday be developed. In the meantime, the next best substitute may be a gallium-phosphide (GaP) multicolor LED developed by Takao Yamaguchi and Tatsuhiko Niina of the Sanyo Electric Co., Ltd. (Hashiridani, Hirakata, Osaka, Japan). This new LED consists of a stacked pair of pn junctions arranged as shown in Fig. 1.

The new LED is constructed by first depositing n- and p-type layers of crystalline GaP on an n-type GaP substrate. The resulting pn junction emits *red* light when forward biased.

Next, a second pair of n- and p-type layers is deposited over the first two layers. This junction emits *green* light when forward biased. It also permits the passage of red light emitted by the underlying junction.

The green-emitting GaP layers block electrical access to the p-side of the red-emitting junction. Therefore, it is necessary to etch through the uppermost n-type layer to provide electrical access to the top side of the red junction. This explains the mesa structure in Fig. 1.

A non-mesa or *planar* diode may be formed by etching channels through the uppermost n-type layer. Contacts are more easily applied to a planar version of the diode.

You may be wondering why the first GaP pn junction emits red light while the second junction emits green. The key is the doping of the GaP crystalline layers, which are epitaxially deposited (grown) over the GaP substrate. When oxygen is added to p-type GaP, a red-emitting junction is formed. A green-emitting junction is formed when nitrogen is added to both p- and n-type GaP.

Either junction of this new LED may be biased independently of the other. This permits the diode to function as an emitter of either red or green light. When *both* junctions are simultaneously forward biased at various current levels, the eye perceives the resulting two-color combinations as red, orange, yellow or green. The perceived hue is determined by the relative brightness of the two junctions.

An identical effect can be obtained by switching each junction on and off at a rate greater than about 20 Hz. Even though only one junction is biased at any given instant, the human eye's persistence of vision causes the red and green to merge into intermediate hues. The color perceived is governed by the duty cycle and current level through each junction.

Applications for Sanyo's new LED include multi-color indicators and displays. The most interesting applications will incorporate arrays of the new diodes to form multi-color characters, digits, and even images.

Yamaguchi and Niina have published an interesting paper that describes in detail the construction and operation of this new LED. Entitled "A High Brightness GaP Multicolor LED," it appeared in the *IEEE Transactions on Electron Devices* (Vol. ED-28, No. 5, May 1981, pp. 588-592). You can find this journal at most technical libraries.

Conventional Multicolor LEDs. Until LEDs like the one in Fig. 1 become

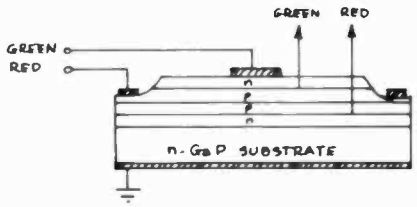


Fig. 1. Cross section of the new monolithic dual color LED.

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available commercially, you can experiment with two-chip versions that are available *now*. These devices are made by installing red- and green-emitting chips side-by-side on a single LED integrated circuit header.

Dual-chip LEDs made in this manner are called bi-color or tri-state LEDs. Tri-state refers to the possibility of obtaining a third color, yellow, by biasing both diodes simultaneously or in rapid sequence.

You can obtain bi-color LEDs from Radio Shack, Opcoa (330 Talmadge Rd., Edison, NJ 08817), AEG-Telefunken (Rt. 22, Orr Drive, Somerville, NJ 08876), and possibly other sources. The Radio Shack and Opcoa diodes are two-lead devices in which the two chips are internally connected in reverse-parallel. This means the direction of current flow must be reversed to switch colors. For the intermediate color of yellow, an ac bias must be provided.

Figure 2 shows a simple circuit to apply an ac bias to two-chip diodes like these. The two TTL gates form an astable multivibrator whose switching rate is controlled by potentiometer *R1*. At slow switching rates, the diode alternates between red and green. The effect is quite striking. At faster rates, the two colors merge into a washed-out orange or yellow hue.

For more information about this circuit and driving such dual-chip LEDs,

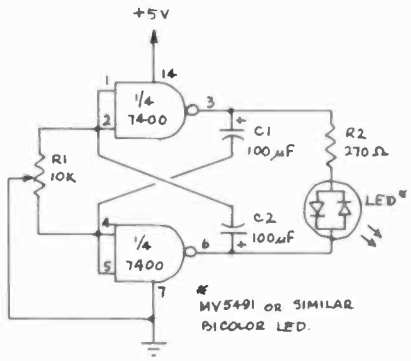

Fig. 2. Simple bicolor LED driver.

see "Tri-State LED Demonstrator," the "Project of the Month" in the September, 1979 issue of this magazine.

AEG-Telefunken's dual-chip LED, designated the V 518 P, incorporates separate anode connections to each of the two chips. The header to which the chips are soldered serves as a common cathode. Though I've not yet experimented with this new LED, I suspect it is better suited for the production of yellow than the two-lead, tri-state LEDs. A simple battery and potentiometer arrangement should be all that is necessary to produce red, yellow, green and intermediate hues.

A High-Quality Audio Amplifier. In an era of increasingly low-cost audio amplifier integrated circuits, who would spend $52 for a hybrid amplifier? Apparently, dedicated audiophiles and those requiring very-high-quality audio amplification.

Modular Audio Products, a unit of Modular Devices, Inc. (50 Orville Drive, Airport International Plaza, Bohemia, NY 11716), recently introduced the Model 5008 Hybrid Dual Balanced Transformerless Amplifier. The amplifier is housed in a nine-pin package measuring 1 inch by 0.8 inch by 0.25 inch.

The 5008 will operate from a bipolar supply of 12 to 20 V. The equivalent input noise is an exceptionally low −110 dB. Total harmonic distortion is 0.05% over a range of 20 to 20,000 Hz. The frequency response over this range varies within ±0.25 dB. Crosstalk between the two channels is −80 dB at 20 kHz.

Modular Audio Products notes that the 5008 can be used in many different audio applications. For example, it can provide a pair of noninverting, high-impedance input amplifiers with up to 40 dB of gain, or it can be used to make a pair of inverting summing amplifiers. It can also be used in various differential input/single- and double-ended output applications. Write the company for more information.

Sensitive-Gate Triacs. Motorola (Box 20912, Phoenix, AZ 85036) has announced a new family of triacs designed to be triggered directly by microprocessors and microcontrollers. The new triacs, which will switch up to 8 A, can also be interfaced directly with 5-volt, low-level logic.

The MAC228-2 through MAC228-10 have a gate sensitivity of only 5 mA and can switch a maximum of 50 to 800 V, depending upon the device.

These new triacs range in price from 75¢ to $2.55 in quantities of 100. They are well-suited for interfacing home computers with ac line-operated appliances and devices.

A High-Power Light-Activated SCR. Low-power light-activated SCRs (LASCRs) have been available for many years. They are often used to make remote photographic flash units (*slave* units), which fire when a master flash unit is activated some distance away.

An important application for LASCRs is in circuits susceptible to noise-induced false triggering. Ordinary SCRs are highly susceptible to false triggering.

Westinghouse Electric (Pittsburgh, PA 15222) has gone a step farther by making a high-power LASCR capable of switching up to 800 A at 3000 V. A standard SCR was used to make the new light-triggered version. The gate region of all SCRs is light sensitive. Westinghouse exploited this fact by placing one end of an optical fiber adjacent to the light-sensitive region of an existing SCR. The SCR is triggered by

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a pulse of infrared from a semiconductor laser.

Westinghouse plans to use the modified SCR in ac power-transmission systems. Though the light-triggered unit is more costly than the standard version, overall cost is lower since elaborate noise-reduction circuitry is no longer needed.

Light-activated SCRs are very useful for many hobbyist and experimenter applications. I last covered their use in the "Experimenter's Corner" published in this magazine in November, 1975 (pp. 109-110). If you cannot find this issue at a library, the column has been reprinted in *103 Projects for Electronics Experimenters* (Tab Books, Inc., 1981). If there is sufficient reader interest, I'll work up some new LASCR circuits and describe them in another column.

LED Numeric Display Price Breakthrough. Remember MITS, Inc., the company that introduced the first complete hobby computer kit? Before developing the Altair 8800, MITS developed several versions of a kit calculator. I well remember how Ed Roberts, then president of MITS, longed for the time when LED displays would be available for "only" $1 per digit in large quantities.

Recently I received from Jameco Electronics (1355 Shoreway Road, Belmont, CA 94002) a flyer offering dozens of different kinds of LED displays at closeout prices as low as 5.5¢ per digit! For example, the National NSA198 9-digit multiplexed common-cathode display can be purchased at two for 99¢.

I assume these displays are being "dumped" as a direct result of the virtual demise of LED calculators and clocks. Liquid-crystal displays have almost taken over this market because they use much less current than LED versions. But at these ultra-low prices, I plan to stock up on some LED displays! They are very handy for circuits designed for operation at night or in darkrooms. They're very small and can be operated at 5 to 10 mA in many cases. If that's too much current drain, it's possible to switch the display on for brief viewing periods every few seconds.

Jameco has a minimum order requirement of $10. Their flyer reports only limited quantities available so act fast if you intend to order.

A New Timer. Panasonic (division of Matsushita Corp., 1 Panasonic Way, Box 1503, Secaucus, NJ 07094) has introduced a long-period timer in a 7-pin SIP (single in-line package). Designated the AN6780, the new timer can provide delays lasting one second to one week depending on the values of an external resistor and capacitor.

The timer consumes a maximum of 10 mA and can be operated from 4.5 to 12 V. It can directly drive a low-power relay. I haven't determined the single-unit cost of this new chip, but in 1000-unit quantities the AN6780 can be purchased for only $1.05. For pricing and a data sheet, write Panasonic. ◇

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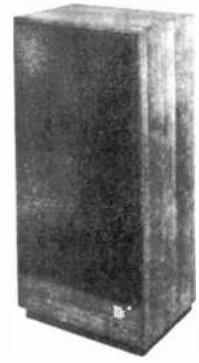

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DX LISTENING

By Glenn Hauser

Taiwan Gets American Relay Station

THE *Voice of Free China*, Taipei, Taiwan, has broadcast to North America in English for many years. But because of relatively low power, unfavorable program scheduling, and poor propagation conditions, it has been particularly difficult to hear, especially along the eastern seaboard.

All this changed dramatically January 1, 1982, when *WYFR* (Family Radio) in Okeechobee, Florida, started relaying *VOFC* programs. There was no advance notice, and the move took everyone by surprise. This is the first time, to our knowledge—at least since World War II—that a private U.S. shortwave broadcaster has relayed programs for a foreign station.

WYFR believes in expanding its services. But just as the *VOFC* is tough to hear in eastern North America, *WYFR* has the same problems being heard in China and India. The only practical solution is to broadcast from a point closer to the target area, either by building a new relay station or by using an existing facility. *WYFR* had approached several other overseas stations about swapping program material (among them *Israel Radio*), but the first mutually satisfactory agreement involves the Nationalist Chinese.

The *VOFC*'s facilities carry *WYFR* broadcasts in Mandarin and English to China and India, for approximately the same number of hours that the *VOFC* is heard over *WYFR*. (*WYFR* says no money is changing hands.) However, this is not the first time the Broadcasting Corporation of China has carried a U.S. station's programs. Until a few years ago, several Taiwanese transmitters were at the disposal of *Radio Liberty*, so it could reach the Soviet Union from the east as well as the west.

The program trade did not begin until *WYFR* had an additional transmitter in use at Okeechobee, so there would be no net loss in its own broadcast time. The arrangement has raised some eyebrows in Washington, DC, since U.S. broadcasters, including shortwave, are supposed to operate in the "public interest, convenience and necessity," and not serve as foreign propaganda outlets. But lately, the FCC has attempted to limit its authority to technical matters, staying out of programming decisions. Three weeks after the *VOFC* broadcasts were first heard on *WYFR*, an FCC spokesman publicly stated that the Commission did "not officially know about" the arrangement.

The initial schedule for *VOFC*-via-*WYFR* (which by now may have made seasonal frequency changes, if the experiment has continued) included English at 0200-0300 GMT on 11,740 kHz, and 0300-0400 on 5985 kHz; three different Chinese dialects at 0000-0300 GMT on 5985 kHz; more Chinese at 2200-2300 GMT on 15,130 kHz; and Spanish at 2100-2200 GMT on 15,130 and 0400-0500 GMT on 11,740.

To keep programs timely and costs down, only the news portion of each broadcast is fed via satellite telephone; the remainder of the hour-long programs are on pre-shipped tapes. *WYFR* is well acquainted with this technique since all its regular programming is produced and recorded 3000 miles away in Oakland, California.

Starting a couple of weeks before the *WYFR* program swaps was another new shortwave English broadcast to North America. Muammar Qaddafi authorized his *Radio Jamahariyah* to insert an hour of English into its already extensive schedule of Arabic broadcasts, at 2300-2400 GMT on 11,815 kHz. At first the audio quality was incredibly bad. The programs include lots of material on U.S.-Libyan relations (mostly negative), readings from the Green Book, and news at 2330 GMT. Bending over backwards to attract an American audience, the station also plays Western music during this hour.

Americans who understand only English also benefit from the brief English segments broadcast by the Nicaraguan clandestine station, *Radio Quince de Septiembre*, 5565 kHz (variable). However, the accent is rather heavy, as the material is intended for the Caribbean minority along Nicaragua's east coast. These English segments are heard at various times (such as 1220 and 0355 GMT) within longer programs that are mainly in Spanish.

On the minus side, *Radio Free Europe* has dropped its weekly ten minutes in English because it wasn't getting much response from Czechoslovakia, the broadcast's target area. This program could be heard quite well even in the U.S. (except wintertime).

In December 1981, the Salvadorian government swept through a rebel stronghold in an effort to put clandestine station *Radio Venceremos* off the

air. Though the station disappeared for a couple of weeks, it came back with a stronger signal around 6907 kHz at 0000 and 1200 GMT and was soon joined by two more allied stations: *Radio Farabundo Marti*, first on 6914 and then on 6900 kHz at 1100-1200 and 0130-0230 GMT; and *Radio Unidad*, around 7000 kHz, which at first confined its broadcasts to weekends at about 2100 GMT.

Traveler's Information Service. Besides the Caribbean Beacon, Anguilla, on 1610 kHz (which plans to add 1570 kHz from Grand Turk), there are an unknown number of very-low-power stations in the U.S. on this same frequency. They are Travelers' Information Service (TIS) stations, each with just a few watts of power for local reception. But under quiet nighttime conditions they can be heard hundreds of miles away. Programming is limited to a brief, repetitive tape loop.

We uncovered a few of these stations during a vacation trip last summer (some may be active only in the summer). There's one in Davenport, IA, advertising about highway construction much farther west on the Interstate. Devil's Tower National Monument sported signs about such a station, but it was not heard, and Mount Rainier is supposed to have a TIS station at its southwest and northwest entrances. Just southeast of the mountain, on U.S. 12 near Naches, another TIS transmitter advises about fire dangers in the national forest.

Yellowstone National Park has several such stations, one at each entrance and at major stops inside the park. (The transmitters at Old Faithful and Uncle Tom's Parking Lot were slightly off frequency—around 1609.8 kHz.) A new TIS station just went on the air this past July at Curecanti NRA, at the Elk Creek Visitor Center on U.S. 50 west of Gunnison, CO. The Elk Creek unit is mounted on a pole, including the solar cell power supply! Other TIS stations reportedly operate from the Sierra Nevadas, Cape Canaveral National Seashore, and airports in Cincinnati, OH, and Tampa, FL.

At the bottom of the AM band (530 kHz) are more stations of this type, along with *Highway Advisory Radio* (*HAR*) outlets. There's an *HAR* station in Atlanta, GA, at the southern junction of I-75 and I-285, and another one recently appeared between Dallas and Fort Worth in Texas. Recently, Knoxville, TN, used a cluster of synchronized HAR transmitters while extensive construction to correct "Malfunction Junction" was underway. These have been heard as far away as Maryland and Florida. And at least one such outlet may continue to help expedite the 11-million visitors expected for the 1982 World's Fair opening in Knoxville for a six-month run starting May 1. Another low-power 530-kHz transmitter promotes the facilities at Gatlinburg. ◇

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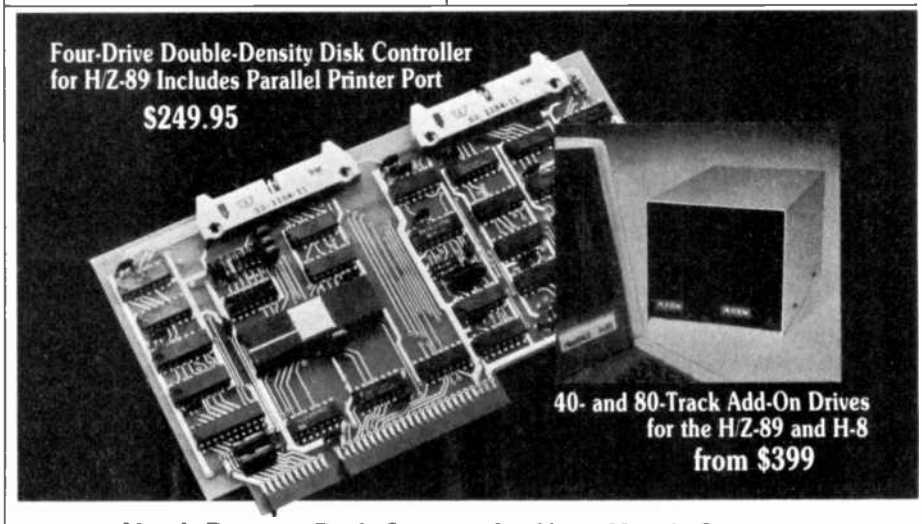

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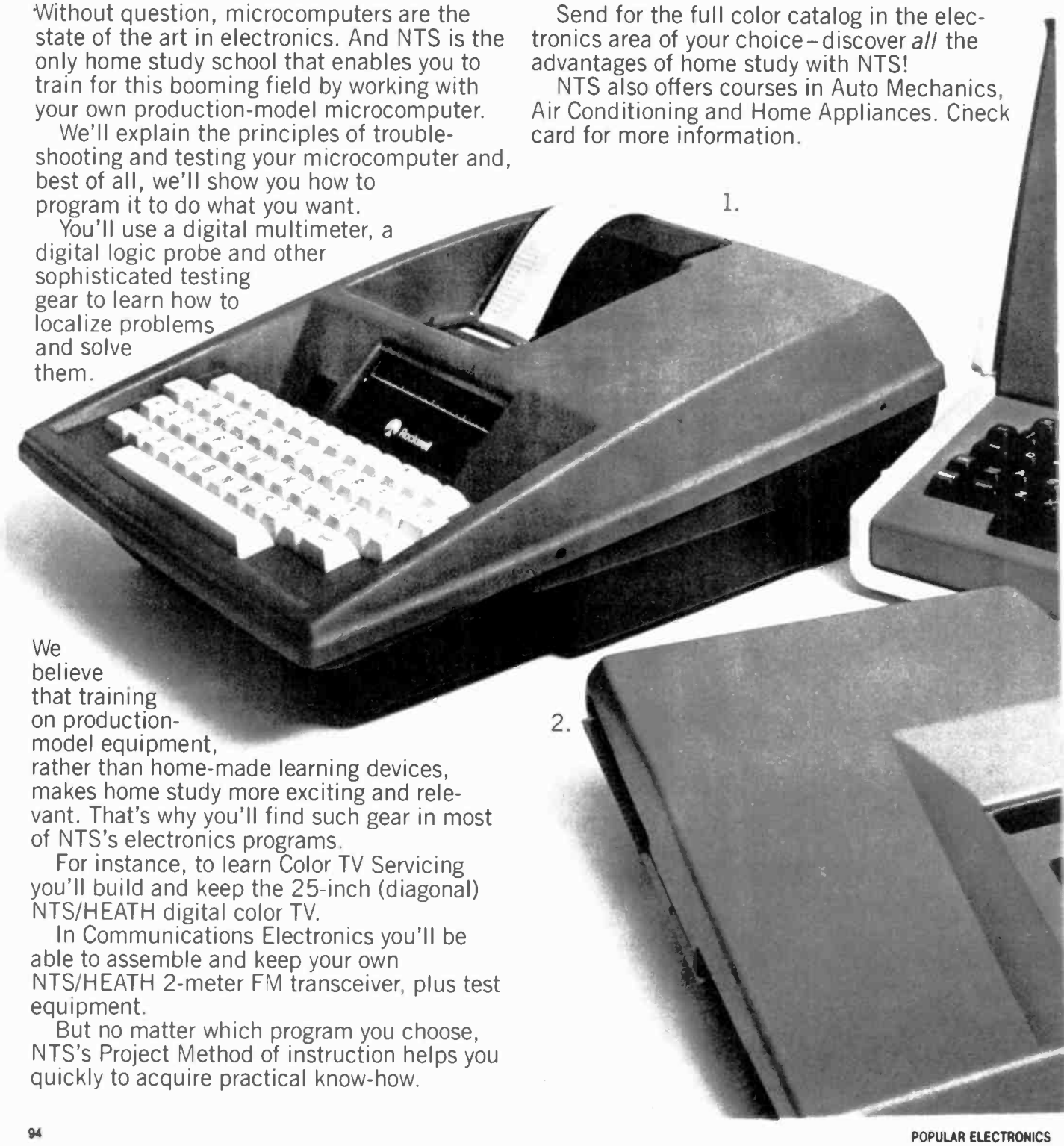

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EXPERIMENTER'S CORNER

By Forrest M. Mims

Experimenting with Low-Power Integrated Circuits

INTEGRATED circuits did not replace discrete component circuits overnight. While it's true that some of the delay in switching to ICs was caused by resistance to new technology, early integrated circuits were often slower and more expensive, and usually required more power than their discrete transistor counterparts.

Today's ICs are far less costly than those sold a decade ago. They also operate at much faster speeds. Recently, considerable attention has been given the development of new ICs that consume much less power than their predecessors.

Though CMOS technology is the best known low-power IC technology, other kinds of micropower integrated circuits have been developed. Some combine conventional bipolar and MOS transistors. Others employ conventional bipolar fabrication in circuits optimized for low-power operation.

Though many one-of-a-kind low-power linear (analog) and digital chips have been available for some time, several semiconductor companies have concentrated on the development of low-power versions of existing conventional chips. The new chips can usually be substituted directly for their power-hungry predecessors.

Although low-power versions of existing chips often cost more, they pay their own way with the extension of battery life they provide. Keep this in mind as we examine several circuits before and after a low-power IC has been substituted for a functionally similar, or even identical, conventional IC.

555/7555 Bouncefree Switch. Figure 1 shows a straightforward bounceless pushbutton made by connecting a 555 timer or its low-power equivalent, the 7555, as a monostable multivibrator. Initially, *C1* is short-circuited by a transistor in the timer. This forces the output (pin 3) to go low.

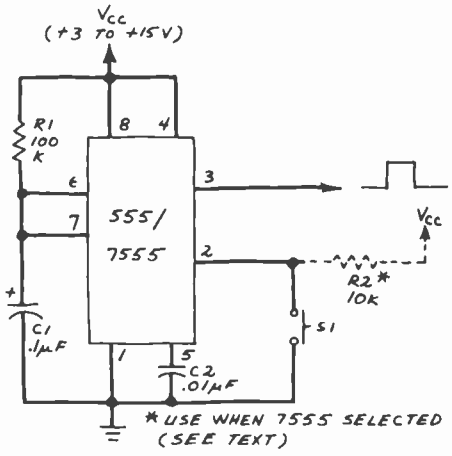

Fig. 1. Adjustable-output bouncefree switch.

A negative pulse at the trigger input (pin 2) sets an internal flip-flop which turns off the transistor across *C1*. This causes the output to go high and allows *C1* to charge through *R1*.

When the voltage on *C1* reaches 2/3 V_{cc}, an internal comparator resets the flip-flop, thereby turning on the transistor across *C1*. This discharges *C1* and forces pin 3 low.

The time constant of the circuit is 0.69 x *R1C1*. Therefore, when *R1* is 100,000 ohms and *C1* is 0.1 microfarad, the positive output pulse at pin 3 will be about 7 milliseconds.

Since the timing cycle does not begin until the trigger pulse is complete, momentary spikes such as those which accompany the closure of most mechanical switches will have no effect on the circuit's operation. They will merely reset the one-shot.

I have tried both 555 and 7555 versions of the circuit in Fig. 1. The 555 version worked perfectly the first time, but a problem developed when I exchanged the 555 for a 7555. The output remained high indefinitely. Sometimes it even switched from high to low for no apparent reason.

Since the low-power 7555 is supposed to be a direct replacement for the standard 555, I could not understand this problem. Besides, I have used the 7555 in various other circuits with no problems whatever.

Then I recalled the trigger input of the 7555 is a MOS transistor having a very high input (gate) impedance. When such an input is allowed to float, as when the input switch is open, the lead connecting pin 2 to the switch acts as an antenna which couples stray signals directly to the trigger input transistor. This explains the erratic operation of the circuit.

I solved the problem by inserting a 10-kilohm resistor between the trigger input and V_{cc}. This resistor forces the trigger input high when the switch is not depressed. It can be used with the 555 version also, but my 555 version did not trigger on stray signals.

As you can see, the 7555 is not necessarily a direct substitute for the 555 in all applications. Its use, however, does not always mean additional components are required. For example, in the free-running astable mode, the 7555 does not require a decoupling capacitor between the control-voltage input (pin 5) and ground. Furthermore, the 7555 has a wider supply voltage range (2 to 18 volts) and can operate at a speed of up to 500 kHz. It also requires much smaller trigger, threshold and reset currents, typically 20 picoamperes.

How do the supply currents differ? The standby current drain of the circuit in Fig. 1 is 6.7 milliamperes when a 555 is installed but only 0.16 milliamperes when a 7555 is used. When the output is triggered high the drain of the 555 version falls to 5.5 mA while that of the 7555 rises to 1.1 mA.

Obviously, the very low current consumption of the 7555 version makes the circuit in Fig. 1 well suited for battery powered operation. The 555 version consumes 42 times more current in the standby mode!

Though the 7555 typically costs twice the price of the 555, I've had very good success using it in a wide range of circuits, and I plan to use it in all battery powered circuits which require 555 timer chips.

The 7555 is made by Intersil (10710 N. Tantau Ave., Cupertino, CA 95014) and Exar (750 Palomar Ave., Sunnyvale, CA 94088). It's available from Jameco, Radio Shack, and other companies that advertise in this magazine.

567/XR-L567 Tone Decoder. Figure 2 shows a basic tone-decoder circuit that uses either a 567 or its low-power counterpart, the XR-L567, to detect a signal having a fre-

quency of about 10-kHz. The L567 achieves low-power operation by means of high-value resistors. Conventional on-chip resistors cannot have high values without taking up considerable space. However, the L567 employs ion implantation, a method of selectively disrupting the silicon surface with an ion beam, to produce small resistors with high resistances.

I've had mixed results using the L567. The circuit in Fig. 2

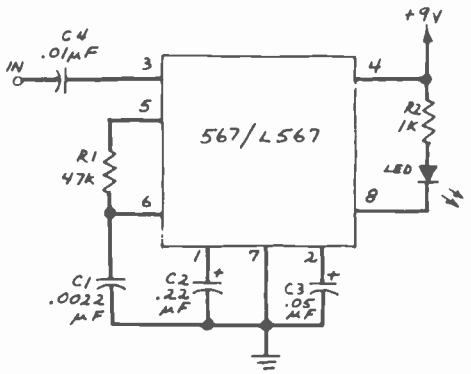

Fig. 2. A 10-kHz tone decoder.

works fine with either the 567 or L567. No component changes are necessary. The frequency responses of the two versions, however, are slightly different. The 567 version turns on the output LED when the input signal is about 10.3 kHz. The L567 actuates the LED when the input signal is about 9.1 kHz. This means *exact* substitutions may not be possible since trimming of some external components may be required before the L567 version will respond to the same frequency as the 567 version.

Current consumption of the L567 circuit in the standby mode is a very low 0.97 mA when V_{cc} is 7 volts. When a signal is detected and the LED is glowing, the current drain rises to 6.8 mA.

The standard 567 consumes much more current. During standby the drain is 10.4 mA. This rises to 22.5 mA when the LED is on.

Though the circuit in Fig. 2 works well, I've not been able to get the L567 version to respond to a 1-kHz signal. For this experiment, *R1* was changed to 10 kilohms, *C1* to 0.1 μF, *C2* to 2.2 μF, and *C3* to 1 μF. Though the 567 version of the circuit responded well (at about 1.1 kHz), the L567 version failed to respond. I intend to continue working with the L567 in an effort to better understand this problem. Since many applications for this chip involve very low signal frequencies, it is imperative that the L567 work as well as its high-power counterpart.

The L567 is made by Exar (see the address given above). It costs about 50 percent more than the 567. In quantities of 100, the price is $1.23. Contact an Exar distributor for current pricing and availability. Jameco stocks Exar chips and might have the L567 available. Their latest catalog, however, doesn't list this relatively new chip.

Low-Power Op-Amps. Many different low-power operational amplifiers are available. RCA's CA3440 BiMOS (bipolar/CMOS), for example, dissipates only 500 nanowatts. RCA also makes a low-power version of the 741. Designated the CA3420, the chip operates from as little as ±1 volt and draws only 350 microamperes. National's LF441 is a low-power version of the LM148, which draws only 150 μA.

One of my favorite low-power op-amps is the LM108/208/308. This family of op-amps will operate over a supply voltage range of ±2 to ±20 volts. The maximum supply current is 300 μA. *(Continued overleaf)*

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The high input resistance of this op-amp family (70 megohms for the LM108/208 and 40 megohms for the LM308) allows its use in applications normally filled by FET amplifiers.

Figure 3 shows a high-performance, photodiode amplifier designed around an LM308. Though many different op amps can be used in this circuit, including the popular 741C, the LM308 provides superior gain (up to 300 V/mV), low-noise operation (about 300 μV at 10 kHz), and reasonably good frequency response (a unity-gain frequency of nearly 1 MHz).

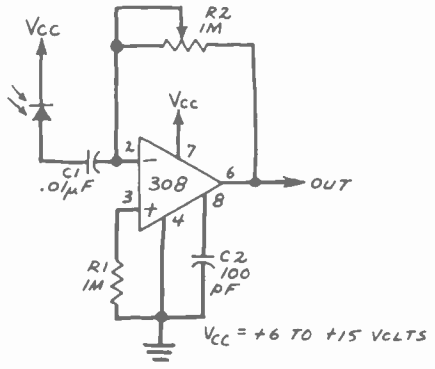

Fig. 3. An op amp photodiode amplifier.

The circuit in Fig. 3 consumes 230 μA when the supply provides 6 V. When a 741C is substituted for the LM308, the current consumption rises to about 600 μA. In addition, the noise level rises when a 741C is used, and both the frequency response and the gain fall. Obviously the LM308 is superior to the more economical 741C in this and many other applications. The 741C, however, does not require an external frequency compensation capacitor (*C2*).

Incidentally, *C2* can be connected to the LM308 in one of two ways. One enhances the chip's frequency response while the other reduces noise coupled from the power supply. See the LM108/208/308 data sheet for specific information.

The circuit in Fig. 3 is designed to receive pulsed lightwave signals. For dc applications, such as detecting starlight, remove *C1* and connect the photodiode directly to the inverting input (pin 2) of the op amp. In either mode, the circuit functions as a current-to-voltage converter with gain. The output voltage is the product of the photodiode current and the feedback resistor (*R1*). When used with an LM308, this circuit provides the input stage for an exceptionally sensitive, high-performance, lightwave receiver.

TTL vs TTL LS. TTL is well liked for its fast switching speed (10 nanoseconds propagation delay per gate). However TTL is power hungry. The four gates in a 7400 Quad NAND gate package, for example, consume a total of 4 μA when all four outputs are high. The drain rises to 12 μA when all four outputs are low.

Low-power Schottky TTL preserves the very fast switching speed of conventional TTL but provides much lower current consumption. The 74LS00, for example, consumes a total of 0.8 μA when all outputs are high and 2.4 mA when all outputs are low. This is only one-fifth the current required by the TTL 7400. Although TTL LS costs more than standard TTL, the low power consumption is worth the added price. Battery-powered operation becomes a real possibility for many TTL LS circuits.

CMOS. The advantages of CMOS have been proclaimed many times in this column. Consider, for example, the 74C00, which is the CMOS equivalent of the 7400/74LS00 described above. This gate package typically consumes a minuscule 0.01 μA and a maximum of 15 μA. What's more, CMOS ICs can operate over a supply voltage range of about 3 to 15 V. CMOS is also characterized by its high noise immunity.

Summing Up. Low-power chips represent one of the most important trends in today's integrated circuit technology. In coming years you can expect to see much more emphasis on CMOS and less on TTL or even TTL LS. You can also expect to see more low- and micropower versions of many kinds of linear ICs. ◇

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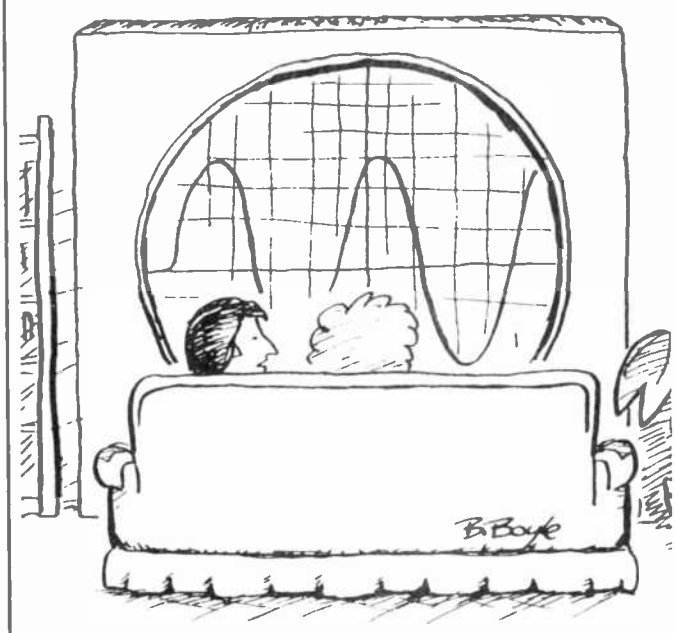

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Hewlett-Packard Model 410C voltmeter. Need owner's manual, service manual, and schematics. J. Douglas Heath, 1602 Pat Dr., St. Joseph, MO 64506.

Sinclair Project 605, 606, & 608. Need manuals, schematics, or any technical information. Funk Ink Industries, P.O. Box 275, Downsview, Ontario, Canada M3M 2A6.

National Semiconductor Model SC/MP ISP-8A/500D microprocessor IC and SC/MP kit. Need data sheet and technical description for IC, user's manual, and assembly language manual for kit. Michael F. Morra, 450 Villa Ave., Fairfield, CT 06432

RCA Model MI-31023-A distortion and modulation test unit, **DuMont** Model 333 oscilloscope (dual trace), and **Analab** Model 1100 oscilloscope with #600 plug-in. Need manuals and schematics. Glenn Gordon, 31722 W. Lk. Ketchum Rd., Stanwood, WN 98292

Collins R388/URR communications receiver. Need operation manual, gear and front end alignment. Errol May, 74, Delhi, Ontario, Canada N482Wa

Marantz Model 250M power amp. Need service manual and output transistors marked F649 461-2010 and F718-462-2021. Winifred Kramer, Rua D. Pedro II, 798, Porto Alegre 90000, Rio Grande do Sul, Brasil

RCA Model AR77 & GR10 receiver, and BC 733-D receiver. Also, **NARCO** Omnigator KM II transceiver and modulator. Need schematics and service manuals. A.J. Kammersgaard, RR3, Lanark, Ontario, Canada.

Sansui Model UE-930 AM/FM multiplex stereo. Need schematic. Roy H. Wilkinson, 10041 Penn Ave. S., Bloomington, MN 55431

Sencore Model PS120 oscilloscope. Need 3RP1 CRT tube. R.W. Beck, 466 Sharon, San Antonio, TX 78216.

Vitro Electronics Type 1432 Nems Clarke phase-lock receiver. Need schematic. Wesley D. Lord, 2231 W. Page, Springfield, MO 65802.

EMC Model 215 tube and transistor checker. Need new setup manual. Ed Tanrath, 3035 LaSalle Ave., Rockford, IL 61111.

Fisher Model 800T, receiver, **Marantz** Model No. FA-247 mobile equalizer, **RCA Victor** Model GL66L color TV, **Sylvania** Type 108 oscilloscope, and **Heathkit** Model EA-3 mono amp. Need schematics. Andy Gregory, 4 Nibang Ave., Old Gaybrook, CT 06473.

Inland Dynatronics Model 206 auto radio. Need parts. Thomas R. Loch, Box 818, Valier, MT 59486.

Concord VTR-700 video tape recorder and **Hughes** 105AR Memo-Scope. Need schematics and manuals. K.R. Johnson, Box 10063, Austin, TX 78766

Monsanto Model 114A frequency counter. Need schematic and service manual. Robert Bollinger, 823 Belvedere St., Carlisle, PA 17013

Yankee Model 1254 electronic siren. Need schematic and owner's manual. AIC Kenneth K. Jones, PSC Box 3756, APO San Francisco, CA 96328

Sabtronics Model 1011C transceiver. Need schematic diagram. R. Craig Bracken, Rt. 2, Box 64A, Davenport, WA 99122.

Heathkit Model W5M amplifier and Model WAP2 preamplifier. Need schematics or assembly manuals. F.N. Lockwood, WA6UCP, 910 Jack London Dr., Santa Rosa, CA 95405

Tektronix Model 454 oscilloscope. Need manuals and schematics. John Gador, Box 1174, Gaylord, MI 49735

Delmonico Nivico Model CT-151 Run #3 color TV. Need schematics and repair manual. Phillip Dumey, 412 S. Missouri, Cape Girardeau, MO 63701.

Sierra Electronics Model TS-1836 transistor tester. Need operations manual, schematic, and parts list. Also for **Precision Apparatus** Model CR-60 picture tube tester-rejuvenator. Joseph Chiaravolloti, 1212 Bullens La., Woodlyn, PA 19094

Minshall-Estey Model "S" electronic organ. Need schematic and any other information. Richard Wood, 3636 W. 11th, Topeka, KS 66604.

Crosley Model 649-A radio, chassis #649. Need schematic and pertinent data. S.J. Dennis, 164-B Bradford St., Provincetown, MA 02657

Hoffman Model TS-323/AU frequency meter. Need manuals. Bill O'Meara, 807 E. Seminary Ave., Towson, MD 21204

Hammarlund Model HQ-129X shortwave receiver. Need instruction book or Sams Photo Fact. James F. Quinney, 7 Carlson Rd., Hampton, NH 03842

Analex Model 4-1000 high-speed printer. Need microprocessor controller plans and interface to RS-232 plans. Mario Pineire, 1237 Castre Barros 1224, Buenos Aires, Republica Argentina

Macom Inc. Model 2001 and 3001 name caller automatic phone dialer. Need schematic and instructions. Bob Anderson, 1095 Dewey, Plymouth, MI 48170

Raulanc Corp. Model BC-1306 receiver and transmitter. Need operating instructions and any operating information. Bill Olson, 11765 Kelley-Rae Dr., Hayden Lake, ID 83835.

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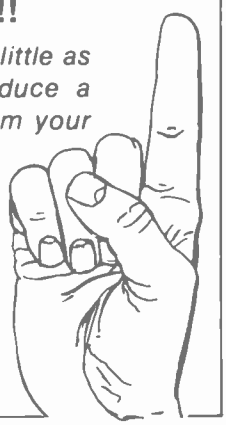

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Sabtronics Model 2000 DMM. Need source, schematic and parts list for PS-1 dc to dc converter. Michael Dombusch, 7249 Summerdale Dr., Dayton, OH 45424.

Paco Model Z-80 audio-r-f signal tracer. Need schematic. Clifford V. Rowe, 1675 Berkeley AP26, Pomona, CA 91768.

Hazeltine Model 1200 video terminal-keyboard. 300/1200 baud-upper and lower case. Need schematic and service manual. Joe F. Sobleski, 2277 Menoher Blvd., Johnstown, PA 15905.

Heathkit Model O-11 oscilloscope. Need power transformer: 400-0-400 @ 80 MA, 650 @ 3 MA, .625 @ .6A, 6.3 UCT @ 3.5 amp and 6.3 U @ .6A, or plans for a power supply: +420 and −1300 vdc. John F. Jarrett, Box 1222, Showlow, AZ 85901.

Elco Model 470 oscilloscope. Need schematic. D.R. Christensen, 10134 Ladybird Dr., Auburn, CA 95063.

Lafayette Model 1TE-55 99-5011 tube tester. Need original tube chart. Also, **Lafayette** Model KT-202 VTVM operating instructions. Frank S. Bunting, 61 Ward Ave., Mt. Kisco, NY 10549.

Elco Model 753 ham transceiver. Require assembly manuals and vfo pc board, part #82520-1. Rick Gerson, The Ontario Cancer Institute, Physics Dept., 500 Sherbourne St., Toronto, Canada M4X1K9.

Heathkit Model V-7A VTVM. Need schematic and operating manual. Walter M. Signmund, 132 Spring St., Syracuse, NY 13208.

Hallicrafters Model S38B radio. Need schematic. John H. Taylor, Box 380 RD2, Glen Mills, PA 19342.

Concord Model 1207-inch reel. Need complete set of belts. Walter H. Walkup, 1035 Arlington Ave., Apartment 402, St. Petersburg, FL 33705.

CMI Electronics Model SG-410 2-channel power amplifier. Need schematic and owner's manual. K. Phelan, 75 Davis St., Revere, MA 02151.

Miller Model 585 high fidelity-germanium-crystal tuner. Need schematic and parts layout. Robert M. Holberg, 805 Harris St., Lansing, MI 48906.

Computer Measurement Systems Model 204-A frequency counter. Need schematic and manual. Andy Sporner, RR3, Box 202, Walkerton, IN 46574.

Electro Instruments Model 8409 digital voltmeter. Need service manual and schematic. A. Reges, 16W761 White Pines, Bensenville, IL 60106.

Hallicrafters Model S-120A 4-band receiver. Need schematic. K. Berkeley, 57 Cedar St., Cambridge, MA 02140.

Federal Model 804-CS1 signal generator. Need instruction manual. John Phelps, 2025 Thousand Oaks Dr., Orange, TX 77630.

Conar Instruments Model 255 oscilloscope. Need schematic and service manual. James W. Lee, 6725 Spoonwood Ln., Fort Worth, TX 76137.

Flexowriter Model FL recorder-reproducer. Need maintenance and repair manual. Harry Mazur, 1450 Chestnut Pl., Boulder, CO 80302.

Detectron Model DS-222 geiger counter. Need schematic and manual. T. Lindquist, 1740 Beechwood Ave., St. Paul, MN 55116.

National Model NC-88 SW receiver. Need operation manual and schematic. Vito Paul Marrone, 497 S. Meadow Rd., N. Merrick, NY 11566.

Video Brain Model 1001 computer. Need schematic, accessories, cartridges, and any other information. Donald Campbell, 1616 Reed St., Kalamazoo, MI 49001.

Lectrotech Model 7060 oscilloscope. Need circuit or schematic. Alberto Gomez C. Apolinario Figuero, 1.390-1B, Buenos Aires, Argentina 1416.

Gregory Model 22A musical instrument amplifier. Need schematic. H. E. Pierce, RFD. 1, Box 232, Lamar, AR 72846.

Crown Model SX824 open reel tape deck. Need schematic or manual. Bill Stottlemyer, Rt. 1, Box 125, Corinth, MA 38834.

Symphonic Model 112-235001 stereo with changer. Need schematic and power transformer. Leon Weston, PO Box 13, Winthrop, ME 04364.

Allied Model 333 stereo receiver. Need schematic and service information. John Beard, 1210 Willow, Pekin, IL 61554.

Precision Model E420 white dot and bar generator. Need schematic and any other manuals. Vernal Wood, 1002 E. Millbrook Way, Bountiful, UT 84010.

Hickock Model 750 Dynamic Mutual Conductance tube tester. Need schematic, operating instruction, and tube-checker guide. Michael Crain, RD1, Box 472, Harveys Lake, PA 18618.

Bradfor Model 1405C30 AM/FM stereo. Need owner's manual, service manual, and schematic. Mike Little, 4440 NW 171 Terrace, Opa-Locka, FL 33055.

Pilot Model 4024 stereo receiver. Need schematic and service manual. Randy J. Chartier, 5913 Craig St., Springfield, VA 22150.

Tennelec Model MCP-1 programmable scanner. Need schematic, service manual, and technical information. Bud Wintcher, 4714 Oklahoma Ave., Tampa, FL 33616.

Extensys Model RM-650 memory board for S-100 bus. Need documentation and schematic. W.R. Crawford, 6973 Miami Bluff Dr., Cincinnati, OH 45227.

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Analog and Digital Multitesters

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Power Line Noise

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Test Equipment Brochure

Global Specialties Corporation announces the availability of its new, four-page brochure detailing the company's line of portable logic-oriented test equipment. Included are descriptions and specs on a full line of logic probes, pulsers, monitors, and logic analysis kits; along with information on the new LM-4 Logic Monitor and LP-4 ECL Logic Probe. **Address:** Global Specialties Corporation, 70 Fulton Terrace, P.O. Box 1942, New Haven, CT 06509.

Fluke DMMs

A twelve-page brochure from Fluke describes the company's entire line of seven handheld and bench/portable DMMs. Included is the new 8020B-Series—said to be improved versions of Fluke's standard handheld DMMs. The instruments feature high-speed (50 μs) response time, continuity beepers, and a two-year warranty. Also described are four new DMM probes designed to be used as voltmeter accessories.
Address: John Fluke Mfg. Co., Inc., P.O. Box C9090, Everett, WA 98206.

Solution to Static

A four-page brochure from 3M's Static Control System's Department offers what it claims is a solution to static-caused problems with commercial electronic equipment. Namely, mats for stand-up and sit-down applications in several colors and sizes. 3M points out that the mats are conductive and not merely anti-static.
Address: 3M, P.O. Box 33600, St. Paul, MN 55133.

Federal Frequency Directory

Covering the EMR spectrum from 2-420 MHz, this recently declassified directory contains 100,000 frequencies, together with the locations of the U.S. agencies associated with them. The listings are compiled exclusively from official Government files, and include as-

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Collections of Steve Ciarcia's perennially popular columns from BYTE Magazine, these three volumes are sure to please home computer users and electronic hobbyists. **Volume I** include power conversions, programming EPROMs, remote terminal interfacing, touch-input video display, and more. **Volume II**, focusing on projects which interface the personal computer with the home, features useful applications such as computer-controlled home security system, computerizing appliances, input-output expansion for the TRS-80, and even a computer-controlled wood stove. **Volume III** offers low-cost construction projects such as an ultrasonic rangefinder, handheld remote computer control, two speech synthesizers, and a remote-control motorized platform, to name just a few.

Build Your Own Z80 Computer
by Steve Ciarcia

This complete guide to building a working computer offers engineers, students, and hobbyists an exciting alternative to buying a computer. With clear instructions, Steve Ciarcia fully explains how to build a basic single-board microcomputer based on the Zilog Z80 microprocessor. The finished product features a 1 K-byte operating system, serial and parallel ports, hexadecimal display, audio cassette mass storage, and easy expansion to include a video terminal.

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new literature

signments for the Armed Forces, Coast Guard, Treasury, Postal Service, NASA, and others. It costs $14.95. **Address:** Grove Enterprises, Inc., Route 1, Brasstown, NC 28902.

Computer Supplies Relays

A new catalog from Universal Relay Co. is now available. It includes information on relays such as: solid-state, printed circuit, hermetically sealed, high speed, power, etc. There are also stepping switches. Universal points out that fluctuation in the prices of precious metals has invalidated some of the prices quoted in the catalog; and the reader should call for an update. **Address:** Universal Relay Corp., 42 White St., N.Y., NY 10013.

Energy Management

Hy-Cal Engineering has released a six-page bulletin describing a family of sensors and signal conditioning devices designed for installers of energy management and control systems, i.e., the products are for measuring and monitoring temperature, humidity, and solar energy. Information is also included on the calibration facilities for in-house testing at Hy-Cal, as well as calibration systems for the users' test laboratories. **Address:** Hy-Cal Engineering, 12105 Los Nietos Road, Santa Fe Springs, CA 90670.

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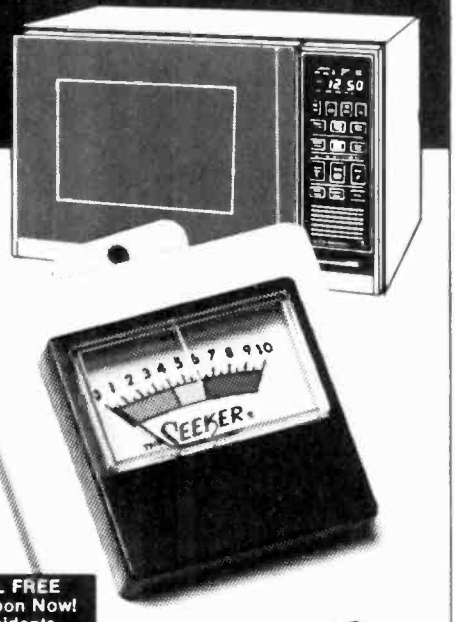

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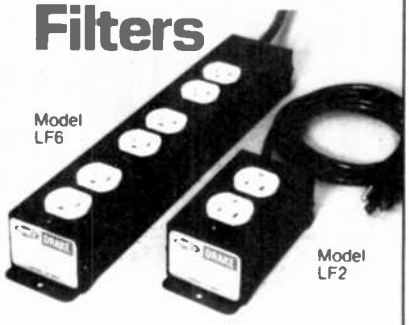

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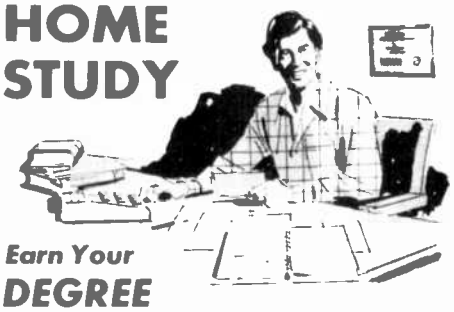

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The BASIC Handbook—2nd Edition

by David A. Lien

The BASIC Handbook (1st edition) was written in 1978. Since then, the BASIC language has undergone substantial change—hundreds of new computers were introduced over the last four years, and the BASIC vocabulary has expanded accordingly. Thus, the 2nd edition has been fully revised to document and explain the nearly 500 BASIC words (238 of them not included in the 1st edition) used by businessmen, programmers, and students who employ micro, mini, and mainframe computers. The focus of the book is on providing information to help users solve the problem of program incompatibility due to the existence of so many BASIC dialects. Each word, therefore, is defined in plain English, and cross-referenced against possible alternate spellings and variations in usage. Especially helpful is the test program, which allows a user to enter a brief program into his computer to see if the interpreter or compiler recognizes the word in question. Another section offers advice, i.e., a roughly equivalent word, if your computer does not have the word you looked up.

Published by: CompuSoft Publishing, 1050 E. Pioneer Way, El Cajon, CA 92020; Soft covers. 480 pages. $19.95.

Interference Handbook

by William R. Nelson

RFI is everywhere. Everyone has heard static on a radio, or seen "snow" on a TV caused by radio frequency interference. This book explains the effects of virtually all the usual sources of RFI, and suggests remedies in plain, nontechnical language. If you have only a minimal background in electronics, you'll find the sections explaining the physics of interference informative and easy-to-understand. If your electronics background is more extensive, the circuit and block diagrams for defeating RFI will be useful. Barry Goldwater, Chairman of the Senate Communications Subcommittee, calls the book "a tremendous help to me and my staff."

Published by: Radio Publications, Inc., Box 149, Wilton, CT 06897. Soft cover. 247 pages. $8.95.

Experiments in Telecommunications

by Morris Tischler

This book is part of the LINEAR INTEGRATED CIRCUITS APPLICATIONS SERIES that is aimed at presenting linear ICs in a variety of applications. Here, telecommunications is covered. Some back-

(Continued on page 114)

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PROJECT OF THE MONTH

By Forrest M. Mims

A Dual-Polarity Five-Volt Power Supply

A positive 5-volt power supply is required for TTL and low-power Schottky TTL integrated circuits. Many op-amp and MOS chips can be powered by a dual polarity, 5-volt supply; and most CMOS circuits can be powered by 5 volts. All these power-supply needs can be met by a very simple circuit assembled from a handful of components. Figure 1, for example, is a straightforward dual-polarity, 5-volt supply designed around a pair of fixed output, integrated voltage regulators.

The supply's positive output is provided by a 7805 5-volt regulator. The output of this chip is from 4.8 to 5.2 volts at a current up to one ampere. It requires a minimum input voltage of 7.3 V, and it can withstand a maximum input of 35 V.

An external heat sink is required for maximum power output. If the area of the heat sink is insufficient to dissipate the heat generated within the IC, an automatic thermal shutdown circuit will turn off the 7805 and prevent it from being damaged.

The power supply's negative output is provided by a 7905 −5-volt regulator. This chip provides from −4.8 to −5.2 volts at a current up to 1.5 amperes. It requires a minimum input of about −7 V, and it can tolerate a maximum input of −35 V. Like the 7805, the 7905 includes on-chip thermal shutdown circuitry.

Operation of the circuit in Fig. 1 is straightforward. Transformer *T1* drops the line voltage to 12.6 V. It also provides isolation from the ac line. A full-wave rectifier bridge, *B1*, converts the low-voltage ac from *T1* into a series of dc pulsations.

Since the secondary of *T1* is center-tapped, it can be used to form a ground (0-volt). Both positive and negative dc pulsations can then be obtained by referencing the respective positive and negative outputs of *B1* to ground.

The positive and negative excursions from *B1* are applied to the inputs of, respectively, the 7805 and 7905 regulator chips. Capacitors *C1* and *C3* serve as filters to smooth out the voltage pulsations from *B1* into a reasonably steady dc.

Incidentally, if the connections between *C3* and the 7905 regulator chip exceed several inches in length, a capacitor having a value of at least 25 μF (aluminum electrolytic) or 2.2 μF (solid tantalum) must be connected from close to the chip's input to ground.

The 7805 can tolerate more distance between its input and the positive supply. If considerable separation is involved, connect a 0.22 μF capacitor from close to the chip's input to ground.

Though output capacitor *C2* improves the transient response of the 7805, this chip will operate *without* it. The 7905, however, requires output capacitor *C4* for operating stability.

Always exercise caution when building line-operated power supplies! In particular, the connections between the power cord and the circuit should be secure and well-insulated to provide short circuit protection. Likewise, the connections between power switch (*S1*), fuse (*F1*), and transformer (*T1*) should be well insulated.

For best results, assemble the supply on a perforated or etched circuit board and install it in an enclosure. It is essential to use an insulated strain relief (Radio Shack 278-1636 or similar) when connecting a power cord to a circuit housed in a metal enclosure. Failure to follow these safety precautions can pose a dangerous or even fatal shock hazard!

Both the 7805 and 7905 are available in 12- and 15-volt versions (7812, 7815, 7912 and 7915). You can use these chips in the circuit in Fig. 1 to obtain higher output voltages as long as a transformer capable of supplying the required input voltage is used. Of course, the voltage ratings for *B1* and all the capacitors will have to be adjusted upward. ◇

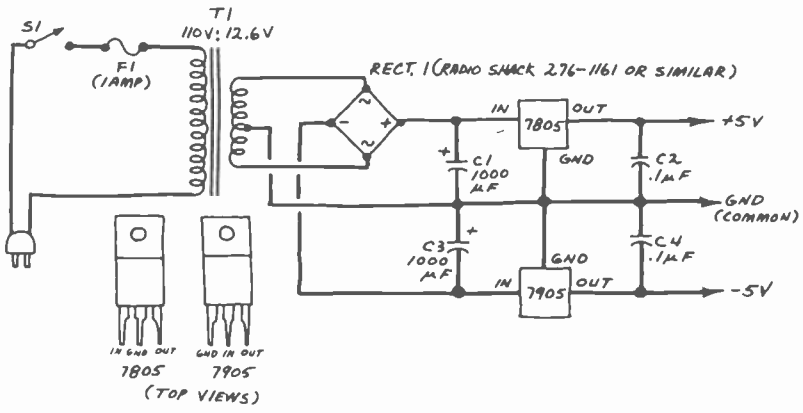

Fig. 1. Schematic of a standard dual-polarity 5-volt power supply.

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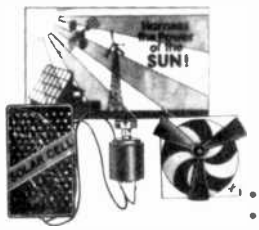
Solar Power Demo Kit



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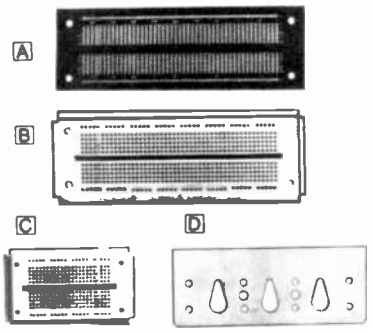

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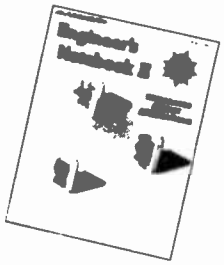

By Forrest Mims III

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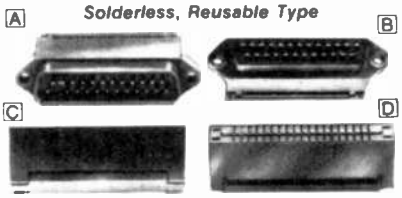

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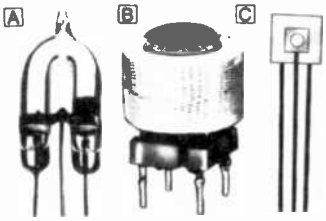

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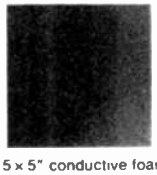

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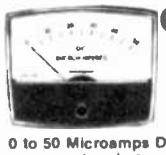

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2114L-3	1024 x 4	(LP) (300ns)	8/18.95	2.25
2114L-4	1024 x 4	(LP) (450ns)	8/17.95	2.10
2147	4096 x 1	(55ns)	9.95	CALL
TMS4044-4	4096 x 1	(450ns)	3.49	3.25
TMS4044-3	4096 x 1	(300ns)	3.99	3.75
TMS40L44-2	4096 x 1	(LP) (200ns)	4.49	4.25
TMM2016	2048 x 8	(200ns) (150ns)		CALL
HM6116	2048 x 8	(200ns) (150ns) (120ns)		CALL

LP = LOW POWER

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74LS00	.25	74LS85	1.15	74LS166	2.40	74LS293	1.85
74LS01	.25	74LS86	.40	74LS168	1.75	74LS295	1.05
74LS02	.25	74LS90	.65	74LS169	1.75	74LS298	1.20
74LS03	.25	74LS91	.89	74LS170	1.75	74LS324	1.75
74LS04	.25	74LS92	.70	74LS173	.80	74LS352	1.55
74LS05	.25	74LS93	.65	74LS174	.95	74LS353	1.55
74LS08	.35	74LS95	.85	74LS175	.95	74LS363	1.35
74LS10	.25	74LS96	.95	74LS181	2.15	74LS364	1.95
74LS11	.35	74LS107	.40	74LS189	9.95	74LS365	.95
74LS12	.35	74LS109	.40	74LS190	1.00	74LS366	.95
74LS13	.45	74LS112	.45	74LS191	1.00	74LS367	.70
74LS14	1.00	74LS113	.45	74LS192	.85	74LS368	.70
74LS15	.35	74LS114	.50	74LS193	.95	74LS373	.99
74LS20	.25	74LS122	.45	74LS194	1.00	74LS374	1.75
74LS21	.35	74LS123	.95	74LS195	.95	74LS377	1.45
74LS22	.25	74LS124	2.99	74LS196	.85	74LS378	1.18
74LS26	.35	74LS125	.95	74LS197	.85	74LS379	1.35
74LS27	.35	74LS126	.85	74LS221	1.20	74LS385	1.90
74LS28	.35	74LS132	.75	74LS240	.99	74LS386	.65
74LS30	.25	74LS136	.55	74LS241	.99	74LS390	1.90
74LS32	.35	74LS137	.99	74LS242	1.85	74LS393	1.90
74LS33	.55	74LS138	.75	74LS243	1.85	74LS395	1.65
74LS37	.55	74LS139	.75	74LS244	.99	74LS399	1.70
74LS38	.35	74LS145	1.20	74LS245	1.90	74LS424	2.95
74LS40	.35	74LS147	2.49	74LS247	.76	74LS447	.37
74LS42	.55	74LS148	1.35	74LS248	1.25	74LS490	1.95
74LS47	.75	74LS151	.75	74LS249	.99	74LS668	1.69
74LS48	.75	74LS153	.75	74LS251	1.30	74LS669	1.89
74LS49	.75	74LS154	2.35	74LS253	.85	74LS670	2.20
74LS51	.25	74LS155	1.15	74LS257	.85	74LS674	9.65
74LS54	.35	74LS156	.95	74LS258	.85	74LS682	3.20
74LS55	.35	74LS157	.75	74LS259	2.85	74LS683	2.30
74LS63	1.25	74LS158	.75	74LS260	.65	74LS684	2.40
74LS73	.40	74LS160	.90	74LS266	.55	74LS685	2.40
74LS74	.45	74LS161	.95	74LS273	1.65	74LS688	2.40
74LS75	.50	74LS162	.95	74LS275	3.35	74LS689	2.40
74LS76	.40	74LS163	.95	74LS279	.55	81LS95	1.69
74LS78	.50	74LS164	.95	74LS280	1.98	81LS96	1.69
74LS83	.75	74LS165	.95	74LS283	1.00	81LS97	1.69
				74LS290	1.25	81LS98	1.69

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74C14	1.50	74C906	.95	4024	.75	14412	12.95
74C20	.35	74C907	1.00	4025	.35	14419	4.95
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74C174	2.25	4011	.35	4075	.30	4585	.95
74C175	2.25	4012	.25	4076	.95	4702	12.95
74C192	2.25	4013	.45	4078	.30	4724	1.50
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74C195	2.25	4015	.95	4082	.30	80C95	.85
74C200	5.75	4016	.45	4085	.95	80C96	.95
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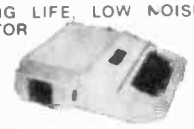

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22 pin ST	.30	.27
24 pin ST	.30	.27
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ST = SOLDERTAIL		
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MC1350V	1.29
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LM1414	1.59
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75453V	.39

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74S03	.48	74S86	1.44	74S169	5.44	74S260	1.83
74S04	.79	74S112	1.59	74S174	1.09	74S274	19.95
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74S38	1.68	74S153	1.19	74S240	3.98	74S471	9.95
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74S64	.79	74S161	2.85	74S251	1.90	74S482	15.60
74S65	1.25	74S162	3.70	74S253	7.45	74S570	7.80
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7401	.19	7453	.23	74141	.65	74190	1.15
7402	.19	7454	.23	74142	2.95	74191	1.15
7403	.19	7460	.23	74143	2.95	74192	.79
7404	.19	7470	.35	74144	2.95	74193	.79
7405	.22	7472	.29	74145	.60	74194	.85
7406	.22	7473	.34	74147	1.75	74195	.85
7407	.22	7474	.35	74148	1.20	74196	.79
7408	.24	7475	.49	74150	1.35	74197	.75
7409	.19	7476	.35	74151	.65	74198	1.35
7410	.19	7480	.59	74152	.65	74199	1.35
7411	.25	7481	1.10	74153	.55	74221	1.35
7412	.30	7482	.95	74154	1.40	74246	1.35
7413	.35	7483	.50	74155	.75	74247	1.25
7414	.55	7485	.65	74156	.65	74248	1.85
7416	.25	7486	.35	74157	.55	74249	1.95
7417	.25	7489	4.95	74159	1.65	74251	.75
7420	.19	7490	.35	74160	.85	74259	2.25
7421	.35	7491	.40	74161	.70	74265	1.35
7422	.29	7492	.50	74162	.85	74273	1.95
7423	.29	7493	.49	74163	.85	74276	1.25
7425	.29	7494	.65	74164	.85	74279	.75
7426	.29	7495	.55	74165	.85	74283	2.00
7427	.29	7496	.70	74166	1.00	74284	3.75
7428	.45	7497	2.75	74167	2.95	74285	3.75
7430	.19	74100	1.00	74170	1.65	74290	.95
7432	.29	74107	.30	74172	5.95	74293	.75
7433	.45	74109	.45	74173	.75	74298	.85
7437	.29	74110	.45	74174	.89	74351	2.25
7438	.29	74111	.55	74175	.89	74365	.65
7440	.19	74116	1.55	74176	.89	74366	.65
7442	.49	74120	1.20	74177	.75	74367	.65
7443	.65	74121	.29	74178	1.15	74368	.65
7444	.69	74122	.45	74179	1.75	74376	2.20
7445	.69	74123	.55	74180	.75	74390	1.75
7446	.59	74125	.45	74181	2.25	74393	1.35
7447	.69	74126	.45	74182	.75	74425	3.15
7448	.69	74128	.55	74184	2.00	74426	.85
7450	.19	74132	.45	74185	2.00	74490	2.55

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7400

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

74LS

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

74S

74S00	.45	74S124	3.95	74S243	3.25
74S02	.45	74S133	.55	74S244	3.25
74S03	.45	74S134	.69	74S251	1.45
74S04	.55	74S135	1.19	74S253	1.45
74S05	.55	74S136	1.75	74S257	1.35
74S08	.50	74S138	1.35	74S258	1.35
74S09	.50	74S139	1.35	74S260	.79
74S10	.45	74S140	.79	74S280	2.95
74S11	.45	74S151	1.35	74S287	3.25
74S15	.45	74S153	1.35	74S288	2.75
74S20	.45	74S157	1.35	74S373	3.49
74S22	.45	74S158	1.35	74S374	3.49
74S30	.45	74S159	1.35	74S387	2.95
74S32	.55	74S160	2.95	74S471	10.95
74S38	1.25	74S161	1.59	74S472	10.95
74S40	.50	74S175	1.59	74S473	10.95
74S51	.45	74S188	2.95	74S474	12.95
74S64	.50	74S194	1.95	74S475	12.95
74S65	.50	74S195	1.95	74S570	5.95
74S74	.75	74S196	1.95	74S571	5.95
74S86	.79	74S240	2.95	74S572	9.95
74S112	.79	74S241	2.95	74S573	9.95
74S113	.79	74S242	3.25	74S940	3.15
74S114	.79			74S941	3.15

CA–LINEAR

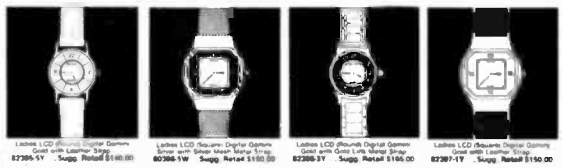
CA3010H	.99	CA3060N	3.25	CA3089N	3.75
CA3013H	2.15	CA3080H	1.25	CA3096N	3.95
CA3023H	3.25	CA3081H	2.00	CA3130H	1.39
CA3035H	2.49	CA3082H	2.00	CA3140H	1.25
CA3039H	1.35	CA3083H	1.60	CA3160H	1.25
CA3046N	1.30	CA3085N	.85	CA3401N	.59
CA3059N	3.25			CA3600N	3.50

CD–CMOS

CD4000	.39	CD4041	1.49	CD 4098	2.49
CD4001	.39	CD4042	.99	CD4506	.75
CD4002	.39	CD4043	.89	CD4507	.99
CD4006	1.19	CD4044	.89	CD4508	3.95
CD4007	.25	CD4046	1.79	CD4510	1.39
CD4009	.49	CD4047	2.50	CD4511	1.29
CD4010	.49	CD4048	1.35	CD4512	1.49
CD4011	.39	CD4049	.49	CD4514	3.95
CD4012	.25	CD4050	.69	CD4515	2.95
CD4013	.49	CD4051	1.19	CD4516	1.49
CD4014	1.39	CD4052	1.19	CD4518	1.79
CD4015	1.19	CD4053	1.19	CD4519	.89
CD4016	.59	CD4054	2.95	CD4520	1.29
CD4017	1.19	CD4055	2.95	CD4526	1.79
CD4018	.99	CD4056	2.95	CD4528	1.79
CD4019	.49	CD4059	9.95	CD4529	1.95
CD4020	1.19	CD4060	1.49	CD4543	2.79
CD4021	1.39	CD4066	.79	CD4562	11.95
CD4022	1.19	CD4068	.39	CD4566	2.79
CD4023	.29	CD4069	.45	CD4583	2.49
CD4024	.79	CD4070	.55	CD4584	.75
CD4025	.23	CD4071	.49	CD4723	1.95
CD4026	2.95	CD4072	.49	CD4724	1.95
CD4027	.69	CD4073	.39	MC14409	17.95
CD4028	.89	CD4075	.39	MC14410	18.95
CD4029	1.49	CD4076	1.39	MC14411	15.95
CD4030	.49	CD4078	.55	MC14412	15.95
CD4034	3.49	CD4081	.39	MC14419	7.95
CD4035	.99	CD4082	.39	MC14433	15.95
CD4040	1.49	CD4093	.99	MC14538	2.49
				MC14541	1.95

Bulova Quartz Ladies Watches

ONE YEAR FACTORY WARRANTY



Ladies LCD (Round) Digital Gamma Gold with Leather Strap 82386-5Y Sugg. Retail $140.00

Ladies LCD (Square) Digital Gamma Silver with Silver Mesh Metal Strap 80386-5W Sugg. Retail $160.00

Ladies LCD (Round) Digital Gamma Gold with Gold Link Metal Strap 82386-3Y Sugg. Retail $165.00

Ladies LCD (Square) Digital Gamma Gold with Leather Strap 82387-1Y Sugg. Retail $150.00

Your Choice — $69.95 ea. any Model

CALL OR SEND ORDER IN REFERENCING TO THIS AD FOR SPECIAL PRICE
Because of Limited Supply, please provide a second and third choice

LITRONIX Stick Display Sale

SALE!

MULTI-DIGIT REFLECTOR ARRAYS FOR CLOCKS

				2 FOR SALE
DL-480 (.3 Red)	12	CC MPX	8	2/3.95
DL-480 (.3 Red)	12	CA MPX	8	2/3.95
DL-6 (.3 Red)	6	CC MPX	8	2/3.95
DL-6 (.3 Red)	6	CA MPX	8	2/3.95

MULTI-DIGIT REFLECTOR ARRAYS

DL-280 (.3 Red)	8	CC MPX	1 Seg. / Digit — 8-DIP	.1"	.1"	.1"	10	11	11	8	2/3.99
DL-5 (.3 Red)	8	CA MPX	1 Seg. / Digit — 8-DIP	.1"	.1"	.1"	10	11	11	8	2/4.19
DL-480 (.3 Red)	12	CC MPX	1 Seg. / Digit — 8-DIP	.1"	.1"	.1"	10	11	11	8	2/4.99
DL-3 (.3 Red)	12	CA MPX	1 Seg. / Digit — 8-DIP	.1"	.1"	.1"	10	11	11	8	2/4.99

NATIONAL Stick Display Sale

LIMITED QUANTITY!

SALE!

LED NUMERIC ARRAYS

PART NO.	DIGIT SIZE (inch)	FORMAT	Comm. Cathode / Comm. Anode	OVERALL SIZE	PRICE
NSA-12	.100 (2.5 mm)		CC 6 Digit Multiplexed	.7" L - .72" W - .27" D	2/7.99
NSA-19	.100 (2.5 mm)		CC 8 Digit Multiplexed	.7" L - .72" W - .27" D	2/7.99
NSA-20	.100 (2.5 mm)		CC 8 Digit Multiplexed	1.06" L - .72" W - .27" D	2/7.99
NSA-140	.100 (2.5 mm)		CC 4 Digit Multiplexed	.7" L - .72" W - .27" D	2/7.79
NSA-150	.100 (2.5 mm)		CC 5 Digit Multiplexed	.7" L - .72" W - .27" D	2/7.79
NSA-160	.100 (2.5 mm)		CC 6 Digit Multiplexed	.7" L - .72" W - .27" D	2/7.79

MULTI-DIGIT LED NUMERIC DISPLAYS

NSM-3019	3 No Decimal		CC	3 Digit Direct	.85" L - .68" H - .295" D	2/7.79
NSM-3074	3 No Decimal		CA	3 Digit Direct	.85" L - .68" H - .295" D	2/7.99
NSM-5011	5 No Decimal		CC	5 Digit Direct	1.68" L x .56" W x .52" D + .4" max	2/11.49
NSM-5012	5 No Decimal		CA	5 Digit Direct	1.68" L x .56" W x .52" D + .4" max	2/11.49
NSM-5601	5		CC	5 Digit Direct	1.7" L x .68" W x .39" D + .4" max	2/11.99
NSM-5621	5		CA	5 Digit Direct	1.7" L x .68" W x .39" D + .4" max	2/11.99
NSM-7021	7		CC	7 Digit Direct	2.3" L - .72" W - .27" D	2/11.99
NSM-7041	7		CA	7 Digit Direct	2.3" L - .72" W - .27" D	2/11.99
NSA-1021	3		CC	3 Digit Multiplexed	.6" L - .68" W - .295" D	2/7.99
NSA-1041	3		CA	3 Digit Multiplexed	.6" L - .68" W - .295" D	2/7.99
NSM-3501	3		CC	3½ Digit Multiplexed	1.06" L - .72" W - .27" D	2/11.99
NSM-3521	3		CA	3½ Digit Multiplexed	1.06" L - .72" W - .27" D	2/11.99
NSM-5501	5		CC	5 Digit Multiplexed	1.68" L - .72" W - .27" D	2/11.99
NSM-5521	5		CA	5 Digit Multiplexed	1.68" L - .72" W - .27" D	2/11.99
NSA-1001	3		CC	3 Digit Multiplexed	1.06" L - .68" W - .295" D	2/7.99
NSA-1021	3		CA	3 Digit Multiplexed	1.06" L - .68" W - .295" D	2/7.99
NSA-1061	3		CC	3 Digit Multiplexed	1.06" L - .68" W - .295" D	2/7.99
NSA-1081	3		CA	3 Digit Multiplexed	1.06" L - .68" W - .295" D	2/7.99
NSM-3501	3		CC	3½ Digit Multiplexed	1.06" L - .72" W - .27" D	2/11.99
NSM-3521	3		CA	3½ Digit Multiplexed	1.06" L - .72" W - .27" D	2/11.99
NSM-5501	5		CC	5 Digit Multiplexed	1.68" L - .72" W - .27" D	2/11.99
NSM-5521	5		CA	5 Digit Multiplexed	1.68" L - .72" W - .27" D	2/11.99

* Intermediate 3 decimal figures — units per dot specific polarity available on non-stocked items

COMPUTER GRADE CAPACITORS

16 SALE!

MFD	WVDC	PRICE	MFD	WVDC	PRICE	MFD	WVDC	PRICE
250	150	1.95	10,000	15	2.95	74,000	20	2.95
500	100	2.49	10,000	16	3.00	77,000	12	2.95
1,250	3	.99	11,000	10	2.95	32,500	25	2.95
1,500	25	1.95	11,000	95	9.49	40,000	25	5.95
1,500	50	2.95	11,000	60	7.95	42,000	10	2.95
2,000	10	2.95	13,000	10	2.95	50,000	20	3.95
2,250	100	3.95	14,000	12	2.95	50,000	20	5.95
2,800	23	1.95	16,000	20	3.95	50,000	15	5.95
2,500	16	2.95	18,000	10	3.95	54,000	20	5.95
3,000	20	1.95	20,000	20	2.95	60,000	10	3.95
3,000	30	3.95	21,000	35	3.95	73,000	5	2.95
4,500	50	3.95	21,000	15	2.95	80,000	15	3.95
5,500	25	2.49	23,000	7	1.95	80,000	10	3.95
6,100	50	2.95	23,000	10	2.95	100,000	10	4.95
6,600	50	4.95	23,000	20	3.95	700,000	3	12.95

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

LOW PROFILE (TIN) SOCKETS

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

SOLDERTAIL STANDARD (TIN)

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

SOLDERTAIL (GOLD) STANDARD

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

WIRE WRAP SOCKETS (GOLD) LEVEL #3

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

1/4 WATT RESISTOR ASSORTMENTS – 5%

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

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INTERSIL

Part No.	Function	Price
7045IPI	CMOS Precision Timer	14.95
7045EV/Kit*	Stopwatch Chip, XTL	24.95
7106CPL	3½ Digit A/D (LCD Drive)	16.95
7106EV/Kit*	IC, Circuit Board, Display	34.95
7107CPL	3½ Digit A/D (LED Drive)	15.95
7107EV/Kit*	IC, Circuit Board, Display	29.95
7116CPL	3½ Digit A/D LCD Dis. HLD.	18.95
7117CPL	3½ Digit A/D LED Dis. HLD.	17.95
72011DR	Low Battery Volt Indicator	2.25
7205IPG	CMOS LED Stopwatch/Timer	12.95
7205EV/Kit*	Stopwatch Chip, XTL	19.95
7206CJPE	Tone Generator	5.15
7206CEV/Kit*	Tone Generator Chip, XTL	12.95
7207AIPD	Oscillator Controller	6.50
7207AEV/Kit*	Freq. Counter Chip, XTL	13.95
7208IPI	Seven Decade Counter	17.95
7209IPA	Clock Generator	3.95
7215IPG	4 Func. CMOS Stopwatch CKT	13.95
7215EV/Kit*	4 Func. Stopwatch Chip, XTL	19.95
7216AIJI	8-Digit Univ. Counter C.A.	32.00
7216CIJI	8-Digit Freq. Counter C.A.	26.95
7216DIPI	8-Digit Freq. Counter C.C.	21.95
7217IJI	6-Digit LED Up/Down Counter	12.95
7218CIJI	8-Digit Univ. LED Drive	10.95
7224IPL	LCD 4½ Digit Up Counter DRI	11.25
7226AIJL	8-Digit Univ. Counter	31.95
7226AEV/Kit*	5 Function Counter Chip, XTL	74.95
7240IJE	CMOS Bin Prog. Timer/Counter	4.95
7242IJA	CMOS Divide-by-256 RC Timer	2.05
7250IJE	CMOS BCD Prog. Timer/Counter	6.00
7260IJE	CMOS BCD Prog. Timer/Counter	5.25
7555IJA	CMOS 555 Timer (8 pin)	1.45
7556IPD	CMOS 556 Timer (14 pin)	2.20
7611BCPA	CMOS Op Amp Comparator 5MV	2.25
7612BCPA	CMOS Op Amp Ext. Cmvr. 5MV	2.95
7621BCPA	CMOS Dual Op Amp Comp. 5MV	3.95
7631CCPE	CMOS Tri Op Amp Comp. 10MV	5.35
7641CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7642CCPD	CMOS Quad Op Amp Comp. 10MV	7.50
7660CPA	Voltage Converter	2.95
8038CCPD	Waveform Generator	4.95
8048CCPE	Monolithic Logarithmic Amp	21.60
8069CCQ	50ppm Band—GAP Volt Ref. Diode	2.50
8211CPA	Volt Ref/Indicator	2.95
8212CPA	Volt Ref/Indicator	2.95

74C

74C00	.39	74C95	1.59	74C221	1.95
74C02	.39	74C107	1.89	74C240	2.25
74C04	.39	74C151	2.95	74C244	2.25
74C08	.39	74C154	3.95	74C373	3.49
74C10	.39	74C157	2.25	74C374	2.59
74C14	.75	74C160	1.69	74C901	.69
74C20	.39	74C161	1.60	74C903	.69
74C30	.39	74C162	1.49	74C911	10.95
74C42	1.39	74C163	1.69	74C912	10.95
74C48	1.95	74C164	1.59	74C915	1.69
74C73	.79	74C174	1.39	74C917	10.95
74C74	.79	74C173	1.39	74C922	5.49
74C85	1.95	74C174	1.39	74C923	5.75
74C86	.99	74C175	1.19	74C925	7.50
74C89	6.95	74C192	1.69	74C926	7.50
74C90	1.29	74C193	1.69	80C95	.79
74C93	1.29	74C195	1.59	80C97	.79

LINEAR

LH0002CN	6.85	LM340T-5	1.25	LM702H	.79
LM10CLH	4.50	LM340T-12	1.25	LM703CN	.89
LM11CLH	4.75	LM340T-15	1.25	LM709N	.29
LH0070-0H	4.95	LM341P-5	.75	LM710N	.79
TL071CP	.79	LM341P-12	.75	LM711N	.79
TL072CP	1.39	LM341P-15	.75	LM723N	.69
TL074CN	2.49	LM342P-5	.69	LM733N	1.00
LH0082CD	35.80	LM342P-12	.75	LM739N	1.19
TL082CP	1.19	LM342P-15	.69	LM741CN	.35
TL084CN	2.19	LM348N	1.25	MC1741SCG	3.00
LH0094CD	36.80	LM350K	5.75	LM747N	.79
LM300H	.99	LF351N	.60	LM748N	.59
LM301CN	.35	LM358N	1.00	LM1014N	2.75
LM302H	1.95	LF355N	1.10	LM1310N	1.95
LM304H	1.95	LF356N	1.10	LM1458CN	.59
LM305H	.99	LM358N	1.00	LM1488N	1.25
LM307CN	.45	LM359N	1.79	LM1489N	1.25
LM308CN	1.00	LM370N	4.49	LM1496N	1.95
LM309H	1.95	LM373N	3.25	LM1556V	1.75
LM309K	1.25	LM377N	2.95	LM1800N	2.95
LM310CN	1.75	LM380N	1.25	LM1871N	5.49
LM311/CN	.90	LM381N	1.95	LM1872N	5.49
LM312H	2.49	LM382N	1.75	LM1877N-9	3.25
LM317MP	1.15	LM384N	1.95	LM1889N	3.20
LM317T	1.75	LM386N-3	1.29	LM1896N	1.75
LM317K	3.95	LM387N	1.45	LM2002T	1.49
LM318CN	1.95	LM389N	1.35	LM2877P	2.05
LM319N	1.95	LM392N	.69	LM2878P	2.25
LM320K-5	1.35	LF398N	4.00	LM2896P-1	2.25
LM320K-12	1.35	LM399H	5.00	LM3189N	2.95
LM320K-15	1.35	TL494CN	4.49	LM3900N	.69
LM320T-5	1.25	TL496CP	1.75	LM3905CN	1.25
LM320T-12	1.25	NE510A	6.00	LM3909N	1.15
LM320T-15	1.25	NE529A	4.95	LM3914N	3.95
LM323K	5.95	NE531H	3.95	LM3915N	3.95
LM324N	.99	NE536H	6.00	LM3916N	3.95
LM329DZ	.65	NE540H	6.00	RC4136N	1.25
LM331N	3.95	NE544N	4.95	RC4151NB	3.95
LM334Z	1.30	NE550A	1.30	RC4194TK	6.95
LM335Z	1.40	NE555V	.39	RC4195TK	5.49
LM336Z	1.75	NE556A	1.30	LM4500AA	3.25
LM337T	1.95	NE556V	.39	ICL8038B	4.95
LM337MP	1.15	LM566N	.99	LM13080N	1.29
LM338K	6.95	NE564N	3.95	LM13600N	1.49
LM339N	.99	LM565N	1.25	75138N	1.95
LM340K-5	1.35	LM566CN	1.95	75450N	.89
LM340K-12	1.35	LM567V	1.25	75451CN	.39
LM340K-15	1.35	NE570N	4.95	75492	.89

CAPACITOR CORNER

50 VOLT CERAMIC DISC CAPACITORS

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

100 VOLT MYLAR FILM CAPACITORS

.001mf	.12	.10	.07	.022mf	.13	.11	.08
.0022mf	.12	.10	.07	.047mf	.21	.17	.13
.0047mf	.12	.10	.07	.1mf	.27	.23	.17
.01mf	.12	.10	.07	.22mf	.33	.27	.22

+20% DIPPED TANTALUMS (Solid) CAPACITORS

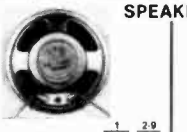
.1/35V	.39	.34	.29	1.5/35V	.41	.37	.29
.15/35V	.39	.34	.29	2.2/35V	.51	.45	.34
.22/35V	.39	.34	.29	3.3/25V	.53	.47	.37
.33/35V	.39	.34	.29	4.7/25V	.63	.56	.45
.47/35V	.39	.34	.29	6.8/25V	.79	.69	.55
.68/35V	.39	.34	.29	15/25V	1.39	1.25	.95
1.0/35V	.39	.34	.29

UTIC
MINI STEREO FM RECEIVER
WITH HEADPHONES
For Joggers, Cyclists, and Skaters!

FEATURES: Lightweight headphones. Left/right balance control. Full fidelity stereo sound. Additional flexible soft carrying case & shoulder strap. Belt clip (hands free). Operates on 3 AA cell batteries (not incl.). Compact size: 3⅛" x 4⅞" x 1". Wt. 6 oz.

Model 1810 List Price $89.95 ..... **$29.95**

SPEAKERS



	1	2
Part # A0201	1.25	.99
Part # SF-25016	1.39	1.25

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

2½" Square — 16 Ohm .25 Watt (4 mount. holes) Large Ceramic Magnet Size: 2⅝" x 2⅝" x ¾"

National Semiconductor
RAM SALE

STATIC RAMS

MM2114N-2 4K (200NS) ..... $2.49 each
(8 EACH $18.95/lot) (100 EACH $195.95/lot)

MM2114N-2L 4K (200NS) Low Power .... $2.95 each
(8 EACH $19.95/lot) (100 EACH $225.00/lot)

MM2147N 4K (70NS) ..... $4.95 each
(8 EACH $34.95/lot) (100 EACH $419.95/lot)

MM6116P-4 16K (200NS) ..... $14.95 each
(8 EACH $99.95/lot) (100 EACH $1195.00/lot)

DYNAMIC RAMS

MM4164N-20 64K (200NS) ..... $14.95 each
(8 EACH $99.95/lot) (100 EACH $1195.00/lot)

MM5290N-2 16K (150NS) 4116 ..... $2.95 each
(8 EACH $19.95/lot) (100 EACH $225.00/lot)

MM5290N-4 16K (250NS) 4116 ..... $1.95 each
(8 EACH $14.95/lot) (100 each $175.00/lot)

EPROM Erasing Lamp

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

UVS-11EL Replacement Bulb $16.95

UVS-11E **$79.95**

JOYSTICKS

JS-5K

JVC-40

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

MUFFIN® FAN

The dependable, low cost, largest selling fan for commercial cooling applications.

- 105cfm free air delivery
- 4.68" sq. x 1.50" depth. Weight - 17 oz
- acoustical rating as low as NC-36
- more than 10 yrs. cont. duty at 10°C
- impedance protected
- for ambients to 70°C
- UL yellow card recognized & CSA approved

115V, 50/60Hz, 14 Watts, 105cfm — Ultrasonically cleaned & tested.

MU2A1 .... **$9.95 ea.**

NEW!
JE215 Adjustable Dual Power Supply

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

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

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

(Picture not shown but similar in construction to above)

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

MICROPROCESSOR COMPONENTS

8080A/8080A SUPPORT DEVICES

INS8080A-4	CPU	9.95
DP8212	8-Bit Input/Output	3.25
DP8214	Priority Interrupt Control	5.95
DP8216	Bi-Directional Bus Driver	3.95
DP8224	Clock Generator/Driver	3.95
DP8226	Bus Driver	3.95
DP8228	System Controller/Bus Driver	4.95
DP8238	System Controller	5.95
INS8251	I/O Expander for 48 Series	9.95
INS8250	Asynchronous Comm. Element	16.95
DP8251	Prog. Comm. I/O (USART)	6.95
DP8253	Prog. Interval Timer	8.95
DP8255	Prog. Peripheral I/O (PPI)	5.95
DP8257	Prog. DMA Control	9.95
DP8259	Prog. Interrupt Control	9.95
DP8275	Prog. CRT Controller	19.95
DP8279	Prog. Keyboard/Display Interface	9.95
DP8303	System Timing Element	6.95
DP8304	8-Bit Bi-Directional Receiver	3.95
DP8307	8-Bit Bi-Directional Receiver	3.95
DP8308	8-Bit Bi-Directional Receiver	3.95
DP8310	Octal Latched Peripheral Driver	5.25
DP8311	Octal Latched Peripheral Driver	5.25

6800/6800 SUPPORT DEVICES

MC6800	MPU	7.95
MC6602CP	MPU with Clock and RAM	14.95
MC6810API	128x8 Static RAM	4.95
MC6821	Peripheral Inter. Adapt (MC6820)	7.49
MC6828	Priority Interrupt Controller	17.95
MC6530-L8	1024x8 Bit ROM (MC68A30-B)	14.95
MC6850	Asynchronous Comm. Adapter	6.95
MC6852	Synchronous Serial Data Adapter	6.95
MC6860	0-600bps Digital MODEM	10.95
MC6862	2400bps Modulator	12.95
MC6880A	Quad 3-State Bus Trans. (MC8T26)	2.25

MICROPROCESSOR CHIPS

Z80 (780C)	CPU (MK3880N) (2MHz)	11.95
Z80A (780-1)	CPU (MK3880N-4) (4MHz)	13.95
COP1802	CPU	19.95
2650	MPU	16.95
IDM2901ADC	CPU—4-Bit Slice (Com, Temp, Grade)	19.95
MC5480Z	MPU w/Clock (16K Bytes Memory)	11.95
INS8035N-4	MPU—8-Bit (6MHz)	7.95
INS8039N-4	CPU-Sgl.Chip 8-Bit (128bytes RAM)	9.95
INS8040N-4	CPU (256 Bytes RAM)	24.95
INS8070N	CPU—64 Bytes RAM	24.95
INS8073N	CPU w/Basic Micro Interpreter	29.95
PB08S	CPU	9.95
TMS9900JL	MPU—16-Bit	39.95
1173AN-1	30 Tune Musical MPU Chip	8.95

SHIFT REGISTERS

MM500H	Dual 25-Bit Dynamic	.50
MM503H	Dual 50-Bit Dynamic	.50
MM506H	Dual 100-Bit Static	.50
MM510H	Dual 64-Bit Accumulator	.50
MM1402N	256-Bit Dynamic	2.95
MM5013N	1024-Bit Dynamic/Accumulator	1.95
MM5018N	500/512-Bit Dynamic	1.95
MM5034N	Octal 80-Bit	9.95
MM5035N	Octal 80-Bit	9.95
2504V(1404A)	1024-Bit Dynamic	1.95
2518N	Hex 32-Bit Static	3.95
2522V	Dual 132-Bit Static	2.95
2524V	512-Bit Dynamic	.99
2525V	1024-Bit Dynamic	2.95
2527V	Dual 256-Bit Static	2.95
2528V	Dual 250-Bit Static	4.00
2529V	Dual 240-Bit Static	4.00
2532N	Quad 80-Bit Static	2.95
3341PC	Fifo (Dual 80)	6.95

DATA ACQUISITION

AF100-1CN	Universal Active Filter 2.5%	3.95
AF121-1CJ	Touch Tone Low Band Filter	19.95
AF122-1CJ	Touch Tone High Band Filter	19.95
LM308CH	Super Gain Op Amp	1.15
LM334Z	Constant Current Source	1.35
LM335Z	Temperature Transducer	1.49
LF356N	JFET Input Op Amp	1.10
LF398N	Sample & Hold Amplifiers	3.95
LM399H	Temp. Comp. Prec. Ref. (.5ppm/°C)	5.00
ADC0804LCN	8-Bit A/D Converter (1 LSB)	4.95
DAC0808LCN	8-Bit D/A Converter (0.19% Lin.)	2.25

DATA ACQUISITION (CONTINUED)

ADC0809CCN	8-Bit A/D Converter (8-Ch, Multi.)	5.25
ADC0817CCN	8-Bit A/D Converter (16-Ch, Multi.)	10.95
DAC1000LCN	10-Bit D/A Conv. Micro. Comp. (0.05%)	13.95
DAC1008LCN	10-Bit D/A Conv. Micro. Comp. (0.20%)	8.95
DAC1020LCN	10-Bit D/A Converter (0.05% Lin.)	8.49
DAC1022LCN	10-Bit D/A Converter (0.20% Lin.)	5.95
DAC1222LCN	12-Bit D/A Converter (0.20% Lin.)	9.95
CD4051N	8-Channel Multiplexer	3.19
AY-5-1013	384 BAUD UART	6.95

RAM'S

1101	256x1 Static	1.49
1103	1024x1 Dynamic	.99
2101 (8101)	256x4 Static	3.95
2102	1024x1 Static	3.75
21L02	1024x1 Static	1.98
2111 (8111)	256x4 Static	3.95
2112	256x4 Static MOS	4.95
2114	1024x4 Static 450ns	2.25
2114L	1024x4 Static 450ns Low Power	2.49
2114-2	1024x4 Static 200ns	2.49
2114L-2	1024x4 Static 200ns Low Power	2.95
745200	256x1 Static	6.95
4116N-4 (UPD416)	16K Dynamic 250ns (MM5290N-4)	1.95
4164N-3	64K Dynamic 200ns	14.95
MM2147N	4096x1 Fast 70ns	4.95
5101	256x4 Static	7.95
MM5261	1024x1 Dynamic Fully Decoded	.99
MM5262	2Kx1 Dynamic	.95
MM5280/2107	4096x1 Dynamic	6.95
MM5290N-2 (4116)	16K Dynamic 150ns (UPD416C-3)	2.95
MM5298J-3A	8K Dyn. 200ns (lower Vp of MM5290J-3	3.95
HM6116-4	16K (2K x8) Static 200ns	14.95
82S25	64 Bit RAM (16x4OC)	3.49
UPD414/MK4027	4K Dynamic 16-pin	4.95
TMS4044-45NL	4K Static	9.95
TMS4045	1024x4 Static	9.95

PROMS/EPROMS

1702A	2K UV Erasable PROM	5.95
2708	8K EPROM	2.95
TMS2716	16K EPROM (5V, +5V, +12V)	9.95
2716(Intel/2516)TI	16K EPROM (Single +5V)	8.95
2732(Intel TI	32K EPROM	17.95
2758	8K EPROM (450ns) (Single +5V)	7.49
2764Q	64K EPROM (Hitachi HN462764)	49.95
5203	2048 PROM	14.95
82S23(74S188)	32x8 PROM (Open Collector)	3.95
82S115	4096 Bipolar PROM	14.95
82S123(74S288)	32x8 TriState Bipolar PROM	3.95
82S185	8K PROM	16.95

— Over 30 More PROMS Listed in Our Catalog —

ROM'S

2513(2401)	Character Generator (Upper Case)	9.95
2533(2021)	Character Generator (Lower Case)	9.95

NMOS READ ONLY MEMORIES

MCM66710P	128x8x7 ASCII Shifted w/Greek	13.50
MCM66740P	128x8x7 Math Symbol & Pictures	13.50
MCM66750P	128x8x7 Alpha, Control Char, Gen.	13.50

MICROPROCESSOR MANUALS

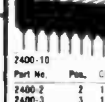
M-Z80	User Manual	7.50
MCP/1802	User Manual	7.50
M-2650	User Manual	5.00

SPECIAL FUNCTION

DS0025CN	Dual MOS Clock Driver (5MZ)	3.50
DS0026CN	Dual MOS Clock Driver (5MZ)	3.95
INS1177IN-1	Floppy Disc Controller	19.95
INS2651N	Communication Chip	19.95
MM58167N	Microprocessor Real Time Clock	9.95
MM5837NN	Microprocessor Compatible Clock	11.95
COP402N	Microcontroller with 64-Digit RAM and Direct LED Drive	6.95
COP402MN	Microcontroller with 64-Digit RAM & Direct LED Drive w/N Bus Int.	7.49
COP470N	12-Seg. VAC Fluor. Driver (20-pin pkg.)	3.25

TELEPHONE/KEYBOARD CHIPS

AY-5-9100	Push Button Telephone Dialer	14.95
AY-5-9200	Repertory Dialer	14.95
AY-5-9500	CMOS Clock Generator	4.95
AY-5-2376	Keyboard Encoder (66 keys)	11.95
HD0165-5	Keyboard Encoder (16 keys)	7.95
74C922	Keyboard Encoder (16 keys)	5.49
MC923	Keyboard Encoder (20 keys)	6.75
MM5318BN	Push Button Pulse Dialer	7.95
MM5709N	96/166-Key Serial Keyboard Encoder	8.95



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

2400-10

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	5	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	16 pin	1.39 - 10/12.95
2400-10	10	0123456789	20 pin	1.49 - 10/13.95

GRAB BAG SPECIALS

GB180 (Pictured Above)

CAPACITORS

Part No.	Description	Price
GB100	100 each Ceramic Disc (10pF - 1mF)	10.00
GB101	60 each Mylar	4.00
GB102	60 each Electrolytic	4.00
GB103	40 each Tantalum (tubular & dipped)	4.00
GB176	40 each Dipped Mica (10pF - 1000pF @ 100-500V)	4.00

INTEGRATED CIRCUITS

GB138	10 each TTL Servo — marked (7400, 7402, 7404, 7408, etc.)	4.00
GB139	30 each Linear — marked (LM301, 307, 741, 308, etc.)	4.00
GB148	20 each Misc. — marked (XR2320, 1310, 4136, etc.)	4.00
GB160	20 each Shift Registers — marked (2510, 2518, 2533, 2633, etc.)	4.00
GB187	10 each DTL Servo — marked (DM8830, 832, 930, 946, etc.)	3.00
GB188	8 each Positive Voltage Regulators (TO-3 case) (7805, 06, 12, 15, 18, 24, etc.) Lumpy marked	4.25
GB189	6 each Negative Voltage Regulators (TO-3 case) (7905, 06, 12, 15, 18, 24, etc.) Lumpy marked	4.00
GB170	25 each Assorted 74LS TTL Servo	4.00
GB172	10 pcs. 7864 Programmable Volt. Reg. (TO-4 case) (7805HVB, 8, 12, 15, 18, 24, etc.) Lumpy marked	5.00

LEDS — LAMPS — READOUTS

GB110	100 each Assorted LEDs (colors & sizes) (MV5053, 5753, etc.)	18.00
GB111	50 each 14-2 Neon Type Lamps	3.00
GB112	20 sq. Multiplex Readouts (common cathode, common anode, LED) No Numbers — Holes, used and rejects	4.00
GB162	50 each 7-Segment Displays (various colors and sizes)	5.00

POTENTIOMETERS

GB113	30 each Miniature Trimpots (100 ohm-1 Meg)	6.00
GB134	24 each 3/8" square single-turn PC Mount (values — 10 ohm to 500K ohm)	3.00
GB139	24 each 3/8" square single-turn PC Mount (assorted — 1K to 2M ohm)	3.00
GB138	24 each 3/8" square single-turn PC Mount (assorted — 100K to 5 Meg)	3.00
GB175	50 ea. 3/8" sq. single-turn (U Take a Part)	5.00
GB174	25 ea. 6 each multi-function single-turn (500 ohm-5 Meg)	2.00

DIODES

GB115	80 each Assorted Germaniums (1N34, 1N60, 1N270)	12.00
GB107	100 each Silicon (1N914/1N4148)	2.00
GB164	100 each Mixed (small signal and rectifiers & zeners)	2.00
GB170	100 ea. 1 amp 3 amp (various types) silicon rectifiers	3.00

RESISTORS

Part No.	Description	Price
GB116	500 each 1/8 watt resistor assortment	10.00
GB117	300 each 1/2 watt resistor assortment	7.00
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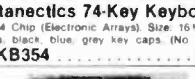

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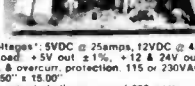

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(Continued from page 107)

ground in electronics is assumed even for the simpler experiments, although the experimental sequence is such that a student or hobbyist can practice the fundamentals of amplifier circuits before progressing to the electronics of r-f and touch-tone transmission. Specifically, the experiments cover such topics as AM and FM demodulation, SSB product detector demodulation, PLL detectors, touch-tone decoders, etc. Each experiment is presented with a parts list, and a list of the equipment required to test a circuit (usually a scope, function generator, DMM, and power supply). Self-test sections provide questions and answers. Device specification sheets are included.

Published by McGraw-Hill, 1221 Avenue of the Americas, N.Y., NY, 10020. Soft cover, 8½" x 11" size; 186 pages; $7.95.

Microprocessor Operating Systems

Edited by John Zarrella

This book describes nine of the more important operating systems for microprocessors. It is intended for anyone involved in selecting, evaluating, or designing operating systems to support applications software. Included are National Semiconductor's BLMX-80, Intel's iRMX 80/88 and iRMX 86, Data General's MP/OS, Texas Instruments' Rx, Bell Lab's UNIX, Motorola's VERSAdos, and Zilog's RIO/CP and ZRTS. Each company's system is explained by an employee of that company—which seems to make for a complete, though somewhat biased description—but the listing of competing systems in a single book can facilitate a more objective comparison on the part of the reader. The technical focus is on multitasking, memory management, interfacing, and language support.

Published by: Microcomputer Applications, Suisun City, CA 94585. Soft cover. 208 pages. $11.95.

The Complete Handbook of Magnetic Recording

by Finn Jorgensen

Here is a reference book that covers the entire field of magnetic recording in considerable detail. The first part is an overview of the history of recording. Then modern recording techniques and equipment are discussed, along with a comparison of their technical specifications. Attention is given to the theory of magnetism and acoustics, with ample diagrams and equations describing induction, coercivity, retentivity, etc. The language is clear; even a layman should be able to understand most of it. But if your only interest in magnetic recording is in deciding what tape deck or tape brand you should buy, you might find it tedious going through all the theory before you get to the pertinent information. This is an excellent books, however, if you're interested in theory.

Published by TAB Book., Inc., Monterey Ave., Blue Ridge Summit, PA 17214. Soft cover. 448 pages. $10.95

Computers and the Radio Amateur

by Phil Anderson

Written for the DXer with little background in computing, this book explores the possibilities that home computers can offer to the world of ham radio. The beginning chapters give an overview of the applications for computer equipment in the hamshack: a memory keyer for code paddles, a CW keyboard, 24-hour clock, RTTY or ASCII terminal, Morse reader, random code generator, message taker, QSL generator and filer, and station logger. The chapters explaining the principles of computer hardware and software are reasonably informative, but you're probably better off getting that kind of instruction from a source devoted exclusively to teaching a novice how to use a home micro. Once you have acquired some knowledge of computer fundamentals, you should know enough to go on to the chapter on interfacing the computer to your DX equipment.

Published by Prentice-Hall, Inc., Englewood Cliffs, NJ 07632. Hard cover. 208 pages. $18.95.

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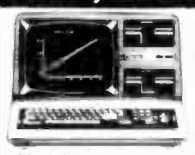

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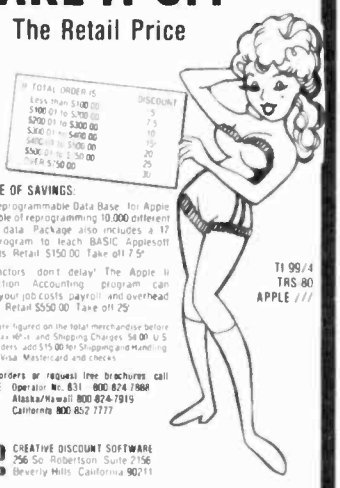

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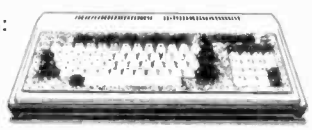

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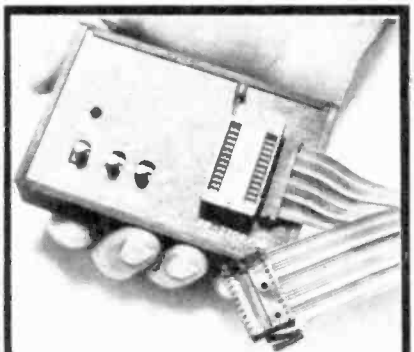

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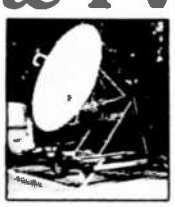

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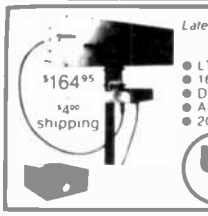

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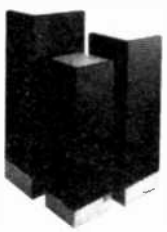

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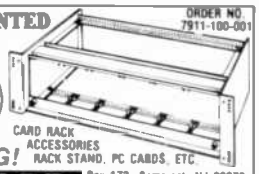

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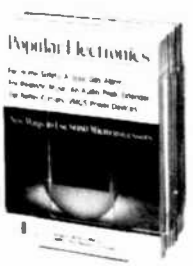

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Personal Electronics News

A COMPUTER REASONING PROGRAM has been developed at the Department of Energy's Argonne National Lab and Northern Illinois U. Called AURA, for "AUtomated Reasoning Assistant," it's being used as an intelligent colleague instead of being just a number cruncher. The new program is said to suggest paths of inquiry for a scientist to investigate, and has already been used to solve problems in formal logic and abstract math, as well as help design more efficient electronic circuits. It does this, say its developers, by inferences, as would a human, rather than by an exhaustive testing of all the possibilities, as, for example, in a chess program.

LOW-COST SCOPE SALES TO ZOOM, according to a recent Dataquest study. From $26.1 million sales in 1974, projections are for $171.5 million in 1984. With industry estimates that a sales call costs about $130, the study observes that, for low-cost oscilloscopes, direct sales channels are advantageous. Test-instrument makers have been taking this route for some time, and have recently been joined in this distribution method by Tektronix, which has telephones (1-800-547-1845) manned by sales engineers to provide immediate technical consultation and applications assistance for its new low-cost line of scopes. (They'll take your order, too.)

ATARI'S $25,000 STAR AWARD has been presented to Fernando Herrera, creator of My First Alphabet™, an educational computer program for children. Herrera, of Elmhurst, NY, submitted the program to the 1981 Atari Software Acquisition Contest, which offers cash and equipment prizes totaling $100,000 annually to developers of programs for Atari 400 and Atari 800 home computers. Contest winners are selected from among those whose programs have been chosen for publication in the Atari Program Exchange Catalog. My First Alphabet was originally designed to help Herrera's visually-impaired son learn to read, but Atari believes that its innovative graphics and large, colorful letters and numerals make it a useful learning aid for all children between the ages of two and eight.

CUBAN INTERFERENCE TO AM STATIONS has been the subject of a strongly worded condemnation by the National Association of Broadcasters (NAB). Accordingly, the NAB has instructed the Task Force on Radio Allocations to confer with representatives of Congress, the State Department, the National Telecommunications and Information Administration, and the FCC on ways to deal with the problem. The Cuban delegation to the Region II Conference on Medium Frequency Broadcasting has already "walked out."

BOSE CORP. WINS JUDGEMENT against Consumers Union, the publisher of Consumer Reports magazine. The damages, in the amount of $115,296, is the first libel suit Consumers Union has lost in its 45-year history. The court ruled that the Union "published a false statement of material fact with the knowledge that it was false or with reckless disregard of its truth or falsity." In May 1970 Consumer Reports stated that instruments heard through the Bose 901 speaker "tended to wander about the room." Chief Judge Gaffery noted that prior to publication of the article, the Bose 901 had received outstanding reviews from other sources.

MANUFACTURING ENGINEERING, which once took a back seat to less prosaic tasks such as sending men to the moon, has acquired a new status at engineering schools. The change, according to the New York Times, comes about largely in response to increased foreign competition in consumer electronics. Attention is being focused on robotics—especially the so-called third-generation robots that will be able to collect sensory information and act on it in a factory setting. Top academies are also incorporating computer-aided-design, materials science, and business management into their manufacturing engineering programs.

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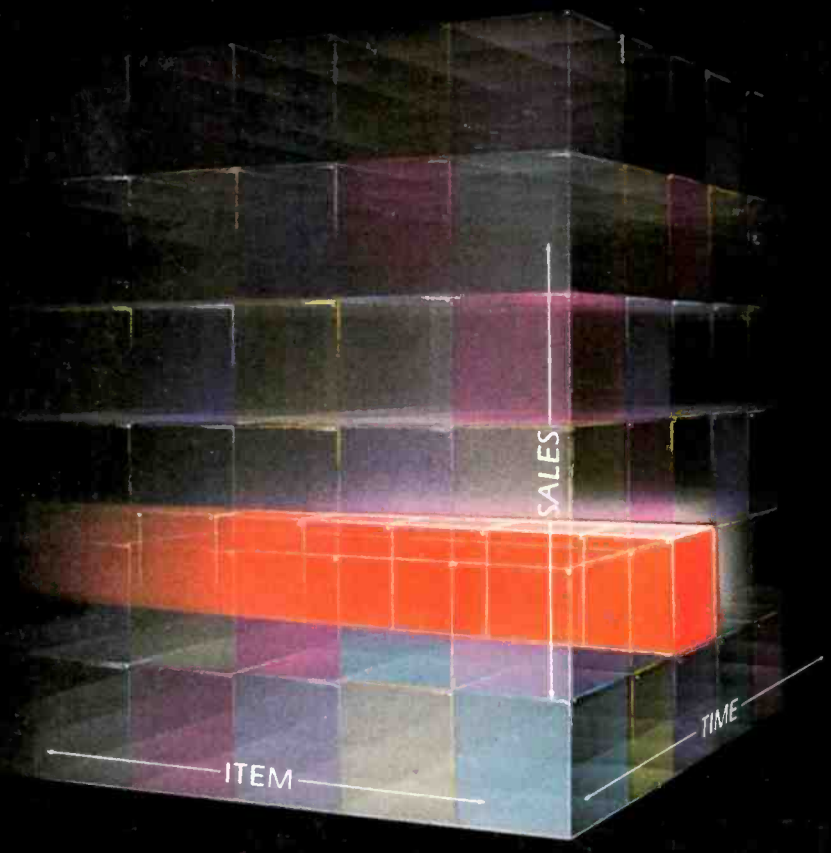

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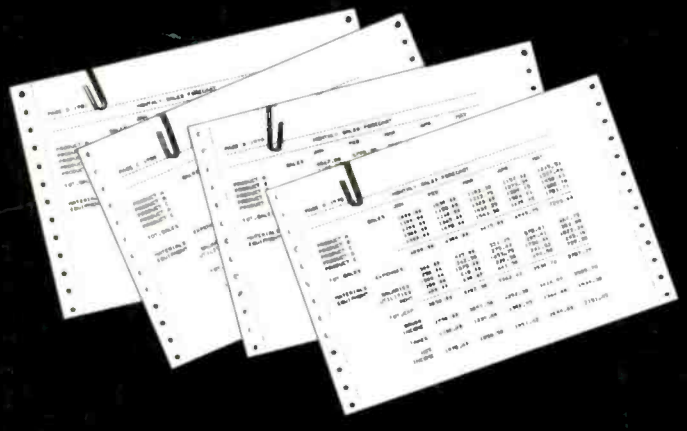

Sample printout showing use of X, Y, and Z axes.
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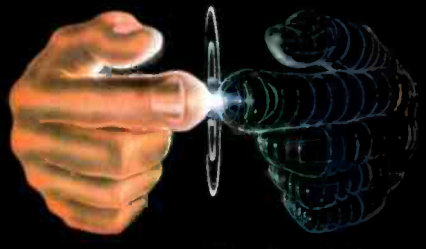

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